COURSES OF STUDIES
SCIENCE STREAM

Admission Batch - 2023-24

Buxi Jagabandhu Bidyadhar Autonomous College

Bhubaneswar - 751014

Accredited at the 'A' Level by

National Assessment and Accreditation Council (NAAC)

Telephone/Fax : 0674-2436971, Website : www.bjbcollege.ac.in

General Instructions

CBCS SYLLABUS

- Details of course structure for B.Sc/BA/B.Com (core) :
  (with suitable modification of draft model provided by OSHEC)

	Courses	**Credits Theory + Practical**
I.	Core Course (14 Papers)	14 x 4 = 56
	Core Course Practical/Tutorial (14 Papers)	14 x 2 = 28
II.	Elective Course	
	A.1 Discipline Specific Elective (3 Papers)	3 x 4 = 12
	A.2 Discipline Specific Elective Practical/Tutorial (3 Papers)	3 x 2 = 6
	A.3. Discipline Specific Elective	
	Project (Report and Presentation) (1 Paper)	6
III.	Generic Elective/Interdisciplinary 2 papers/2 subjects	
	(GE-1 & GE-2 in 1st year) and Generic Elective	4 x 4 = 16
	(GE-3 & GE4 in 2nd year) Practical/Tutorial	4 x 2 = 8
	(4 Papers each from GE - 1, GE - 2,GE - 3,GE - 4)	
IV.	Ability Enhancement Compulsory Course(AECC)	
	(2 Papers of 4 Credit each)	4 x 2 = 8
	(i) AECC-1 (Environmental Studies & Disaster mgt.)	
	(ii) AECC-2 Odia/Hindi/Communicative English	
	(iii) AECC-EV-I,II,III,IV,V,VI (From 2021 Adm. Batch)	1 x 6 = 6
V.	SECC (Skill Enhancement Compulsory Course)	4 x 2 = 8
	(2 Papers of 2 Credit each) Refer to 18.4,18.5,18.6.	
	Total Credit	**154**

Arts, Science and Commerce students can also opt for NCC and other subjects (as and when required by the Board of Studies) as additional Generic Elective in the 1st year (1st and 2nd Semester) to enhance their credit points.

- Mark Distribution Core Courses: 14x100=1400

Mark Distribution Core Courses:	14x100=1400
Discipline specific elective:	3x100=300
Project + Viva:	1x100 =100
Generic Elective- 1, 2	2x100=200
Generic Elective- 3, 4	2x100=200
Ability Enhancement (Compulsory)	2x100=200
AECC (Ethics & Values)	6 x 25 = 150
Skill Enhancement Compulsory Course	2x100=200

Total Mark = 2750, Total number of Papers = 32

Subjects with Practical: Theory-75 Marks, Practical-25 Marks
Mid Semester Theory-15 Marks, End Semester Theory-60 Marks
There is no Practical Exam. in Mid Semester.

Subjects without Practical : 100 Marks
Mid Semester-20 Marks, End Semester-80 Marks

SEMESTER	COURSE	COURSE NAME	Credits
I. 5 Papers	Ability Enhancement Compulsory Course-I AECC-EV-I	Environmental Studies & Disaster mgt Ethics & Value	04 01
	Core Course-I		4/5
(425 Marks)	Core Course-I Practical/Tutorial		2/1
	Core Course-II		4/5
23 credits	Core Course-II Practical/Tutorial		2/1
	Generic Elective -1	GE-1	4/5
	Generic Elective -1 Practical/Tutorial		2/1
II. 4 Papers	Ability Enhancement Compulsory Course-II AECC-EV-II	Communicative Eng / Odia / Hindi Ethics & Value	04 01
	Core Course-III		4/5
(425 Marks)	Core Course-III Practical/Tutorial		2/1
	Core Course-IV		4/5
23 credits	Core Course-IV Practical/Tutorial		2/1
	Generic Elective -2	GE-2	4/5
	Generic Elective -2 Practical/Tutorial		2/1
III.	AECC-EV -III	Ethics & Value	01
	Core Course-V		4/5
6 Papers	Core Course-V Practical/Tutorial		2/1
	Core Course-VI		4/5
(525 Marks)	Core Course-VI Practical/Tutorial		2/1
	Core Course-VII		4/5
28 credits/	Core Course-VII Practical/Tutorial		2/1
29 credits	Skill Enhancement Compulsory Course -1	SEC-1	4
	Generic Elective -3	GE-3	4/5
	Generic Elective -3 Practical/Tutorial		2/1
IV.	AECC-EV -IV	Ethics & Value	01
	Core Course-VIII		4/5
6 Papers	Core Course-VIII Practical/Tutorial		2/1
	Core Course-IX		4/5
(525 Marks)	Core Course-IX Practical/Tutorial		2/1
	Core Course-X		4/5
29 credits	Core Course-X Practical/Tutorial		2/1
	Skill Enhancement Compulsory Course -2	SEC -2	4
	Generic Elective -4	GE-4	4/5
	Generic Elective -4 Practical/Tutorial		2/1
V.	AECC-EV -V	Ethics & Value	01
	Core Course-XI		4/5
5 Papers	Core Course-XI Practical/Tutorial		2/1
	Core Course-XII		4/5
(425 Marks)	Core Course-XII Practical/Tutorial		2/1
	Discipline Specific Elective -1	DSE-1	4/5
25 credits	Discipline Specific Elective -1Practical/Tutorial	DSE-1 Practical/Tutorial	2/1
	Discipline Specific Elective -2	DSE-2	4/5
	Discipline Specific Elective- 2Practical/Tutorial	DSE-2 Practical/Tutorial	2/1
VI.	AECC-EV -VI	Ethics & Value	01
	Core course-XIII		4/5
5 Papers	Core Course-XIII Practical/Tutorial		2/1
	Core course-XIV		4/5
(425 Marks)	Core Course-XIV Practical/Tutorial		2/1
	Discipline Specific Elective3	DSE-3	4/5
25 credits	Discipline Specific Elective -3Practical/Tutorial	DSE-3 Practical/Tutorial	2/1
	Discipline Specific Elective-4	DSE-4 (Project Work)	6
Total Credits			**154**

Model Regulation for Under Graduate Programme
(BA/B.Com/B.Sc) As per CBCS system from 2019 admission batch
(with suitable modification)

1. Compulsory Registration for 1st Semester :

(A) Registration for 1^{st} semester is compulsory. A candidate admitted to +3 Course but not registered for 1^{st} semester examination, his/her admission will be automatically cancelled. If a student doesn't appear for all the papers in both first & second semester examination his/her admission for the said course will be cancelled.

(B) Only one admit card (called Examination card) for all semester examinations should be issued to the student by Controller of Examination (COE) in the first semester. This will be valid for all semesters.

2.
- Mid semester examination of will be of 01 hour duration for 20/15 marks (20 for subject having no practical and 15 for subject with practical papers). There shall be no pass mark in Mid semester Examination. The type of questions will be decided by the college authority. Absence in Mid semester Examination will be declared fall in that paper.
- A student who fails to appear in a Mid semester examination will allowed one more chance to take the same examination. There will be no provision to reappear in the Mid semester Examination for Improvement. This will be applicable for the students of 2019 admission batch.
- It a student does not appear for all the papers in both first and second semester examinations, his/her admission for the said course will be cancelled.

3. GRADING SYSTEM

Grading system in each paper (Mid+End Semester Exam) in a semester :

Qualification	Grade	Mark Secured from 100	Grade Points	Classification for Honours/Core
Outstanding	'O'	90-100	10	First class Hons.
Excellent	'A+'	80-89	9	
Very Good	'A'	70-79	8	
Good	'B+'	60-69	7	
Above average	'B'	50-59	6	second class Hons
Fair	'C'	45-49	5	
Pass	'D'	40-44	4	Pass
Failed	'F'	Below 400	0	Fail
Absent	'ABS'	00	0	Fail
Malpractice	'M'	00	0	M.P.

(a) The Candidate obtaining Grade-F is considered failed and will be required to clear the Back paper(s) in the subsequent examinations within the stipulated time.

(b) Candidate in Honours Courses securing “B” Grade and above in aggregate in their first appearance will be awarded Distinction. However, students who could not appear at an examination due to their representing the University or state in Inter-University or Inter-State competitions in Games and Sports at National/International level or attending National level NCC/NSS camps will get one chance exemption for Distinction.

(c) FAIL/ MP/ HARD CASE and Back Paper Clearance candidates in any Semester Examination are not award of Distinction

(d) Minimum percentage of marks to be secured for passing:

40% (40 out of 100) in theory paper by taking both components (i.e. Mid + End Semester Examination) and minimum pass mark for practical paper in 40%.

(i) No pass mark for Mid-Semester Examination, A student has to appear at the Mid Semester Examination. Securing “ABS” in Mid-Semester Examination students will be declared fail in that paper, through he/she secures pass mark in theory and practical paper. Such candidates would require to appear at the Mid-Semester Examinations in subsequent semester.

(ii) There will be no Mid-Semester examination (for AECC-Ethics and value)

(iii) In order to clear a semester examination a candidate is required to pass in all theory and practical papers/project component of the said paper.

(e) Mark Distribution:

A. Subjects without Practical :

Mid Semester	End Semester	Total
20	80	100

B. Subjects with Practical :

<table>
<tr><td rowspan="2">Mid Semester</td><td colspan="2">End Semester</td><td rowspan="2">Total</td></tr>
<tr><td>(a)Theory</td><td>(b)practical</td></tr>
<tr><td>15</td><td>60 25</td><td>(20+05 Record)</td><td>100</td></tr>
</table>

C. DSE-4 for all Core students (6th semester) is the project.

Project- The mark distribution would be subject specific. In general the project will carry 80 marks and Viva Voce/Seminar will carry 20 marks. The project paper will not have mid semester Examination and it will be evaluated by an internal examiner specified by the college.

D. AECC (EV - I to EV - VI) there is no mid semester exam for students.

N.B.: A Candidate has to secure Grade-D or above to pass in each of the Papers.

4. A student’s level of competence shall be categorized by a GRADE POINT AVERAGE to be specified as :

SGPA - **Semester Grade Point Average**

CGPA - **Cumulative Grade Point Average**

(a) **POINT** - Integer equivalent of each letter grade

(b) **CREDIT** - Integer signifying the relative emphasis of individual course item(s) in a semester as indicated by the Course structure and syllabus.

CREDIT POINT - (b) x (a) for each course item

CREDIT INDEX - $\sum$**CREDIT POINT** of course items in each semester.

GRADE POINT AVERAGE - $\dfrac{\textbf{CREDIT INDEX}}{\sum \textbf{CREDIT}}$

SEMESTER GRADE POINT AVERAGE (SGPA)= $\dfrac{\textbf{CREDIT INDEX}\text{ for each Semester}}{\sum \textbf{CREDIT}}$

CUMULATIVE GRADE POINT AVERAGE(CGPA) =

$$\frac{\textbf{CREDIT INDEX}\text{ of all previous Semester up to 6th Semester}}{\sum \textbf{CREDIT}}$$

(c) Formula of Equivalent percentage of marks

Case (a) Equivalent percentage of marks =

(**CGPA -** 0.5) x 10 for 4 < **CGPA**s 10

case (b) Equivalent percentage of marks = CGPA x 10 for CGPA < 4.

- A student in order to retain honours has to secure Grade ‘C’ and above in each of the Core papers. Further in order to obtain distinction a student has to secure Grade ‘C’ in all the papers in 1st appearance
- The details of grading system and percentage of mark calculation shall be printed on the backside of University Gradesheet.

REPEAT EXAMINATION

- A student has to clear back papers (i.e., in the paper/papers one has failed) by appearing at subsequent two consecutive semesters of the same nomenclature.
- A student after passing out may appear in improvement in any number of papers in the two immediate examinations with batch students. The higher marks shall be retained.
- A student has to pass the course within 6 years from the date of admission for Under Graduate students. For post Graduate students, it has to be completed within 4 years from the date of admission.
- No improvment will be allowed for the students who have cleared the semesters by appearing special back examination.

HARD CASE RULE

- 2% of grace mark on the aggregate mark subject to maximum of 5 (five) marks in single papare shall be given. This shall be applicable in each semester.
- 0.5% (point five percent) grace mark can be given for award of B & B+ Grade in single semester provided grace mark, under 6.1 hasn’t been awarded.

QUESTION PATTERN

A. FOR NON-PRACTICAL SUBJUCTS OTHER THAN ENGLISH, ODIA, HINDI AND SANSKRIT (TOTAL MARKS 80) (CORE, DSE, GE)

1. Part-I will carry 12 one - mark questions in the from of fill in the blanks and one word answer (1x12=12)
2. Part-II will carry 10 two-mark questions of which 8 have to be answered. The answer should be two or three sentences maximum (2 x 8 = 16).
3. Part-III will carry 10 three - marks questions out of which 8 have to be answered. The answer should be within 75 words (3 x 8 = 24)
4. Part- IV will carry 4 seveven-marks questions or format. The question can be set from each unit. the answer should be within 500 words maximum. (7 x 4 = 28)

B. FOR PRACTICAL SUBJECTS (TOTAL MARKS 60) (CORE, DSE, GE)

1. Part-I will carry 8 one-mark questions in the form of fill in the blanks and one word answer (1x 8 = 8)
2. Part-II will carry 10 one point five (1.5) mark question of which 8 have tobe answered. The answer should be written in two or three sentence maximum (1.5 x 8 = 12)
3. Part-III will carry 10 two (2) marks questions out of which 8have to be answered. the aswered. The answer should be within 75 words maximum (2 x 8 = 16)
4. part-IV will carry 4 six marks questions of either or format. The either or question can be set from each unit. the answer should be within 500 words maximum (6 x 4 = 24)

C. FOR LANGUAGE SUBJECTS (TOTAL MARKS 80) ENGLISH :

1. (Core, Course, DSE & GE)

Part-I : 4 short questions of 14 marks each to be set from units-1-4 in either or format (14 x 4 = 56)

Part-II : 4 short notes / annotatio / analysis of 6 marks each covering all the units with internal choice (6 x 4 = 24)

2. FOR AECC- II COMMUNICATION (ENGLISH) (TOTAL MARKS - 80)

Part-I : 5 short questions of 4 marks each to be set from unit 1 covering all prescribed stories with internal choice (4 x 5 = 20)

Part-II : 5 short questions of 4 marks each to be set from unit 2 covering all prescribed prose pieces with internal choice (4 x 5 = 20)

Part-III : An unknown passage to be set with 5 questions carrying 4 marks each. (4 x 5 = 20)

Part-IV : 10 bit questions carrying 2 marks each from grammar / vocabulary and usage (2 x 10 = 20)

D. FOR LANGUAGE SUBJECTS : AECC II (ODIA / HINDI / SANSKRIT) MIL COMMUNICATION / CORE / DSE / GE FOR TOTAL MARKS - 80

Part-I it will carry 12 two (2) - marks questions out of which 10 have to be answered. (2 x 10 = 20)

Part-II it will carry 4 15-mark questions of either or format. The either or question can be set from each unit. (15 x 4 = 60)

E. FOR AECC- I FOR (EVS & DM) (TOTAL MARKS- 80)

Part-I it will carry 12 two (2) marks questions out of which 10 have to be answered. (2 x 10 = 20)

Part-II it will carry 4 15-mark questions of either or format. the either or question can be set from each unit. (15 x 4 = 60)

F. FOR ETHICS & VALUES (EV 1-6) (TOTAL MARKS 25)

Part- I it will carry 5 Nos. of questions each carrying 1 mark (1 x 5 = 5)

Part-II it will carry 5 (five) 2marks questions (2 x 5 = 10)

Part-III it will carry 2 (two) questions each carrying 5 marks, to be answered within 250 words each (5 x 2 = 10)

G. FOR SEC- I COMMUNICATIVE ENGLISH (TOTAL MARKS 80)

Part-I: 20 Nos. 1-Marks Questions from grammar and Usage (choose the best, fill up...)(1 x 20 = 20)

Part-II: 10 Nos. 2-Marks Questions from Proof Reading (Punctuation, article...)(2 x 10 = 20)

Part-III: 5 Nos. 2-Marks Questions on very short notes on the Reading process, skills.... (2 x 5 =10)

Part-IV: 5 Nos. 2-Marks Questions from Reading comprehesion (very short questions from an unseen extract) (2 x 5 =10)

Part-V: 10 Nos. 2-Marks Questions: Vocabulary and usage (contextual pattern) (2 x 5 = 10)

Part-VI: 10 Nos. 2-Marks Questions: Vocabulary and usage (contextual pattern) (2 x 10 = 20)

H. FOR SEC- II QUANTITATIVE AND LOGICAL THINKING (TOTAL MARKS 80)

Part-I: 10 Nos. questions of 2 marks each (2 x 10 = 20)

Part-II: 10 Nos. questions of 3 marks each (3 x 10 = 30)

Part-III: 6 Nos. questions of 5 marks each (5 x 6 = 30)

IN ARTS HE / SHE SHALL HAVE TO CHOOSE

(a) One core subject from among the list of following subjects: Anthropology, Economics, Education, English, Geography, Hindi, History, Mathematics, Indian Music(HV), Odia, Philosophy, Political Science, Psychology, Sanskrit, Sociology, Statistics or any other subject to be opened in the future as per the rule of the College/University.

(b) One Generic elective (GE) subjects : one for First Year from group I and one for the 2nd year from group II. Each elective subject is composed of two papers of 100 marks each.

Group I - (GE-1,GE-2):Anthropology, English, Philosophy, Hindi, History, Psychology, Mathematics, Sanskrit & NCC.

Group II - (GE-3, GE-4): Economics, Education, Geography, Indian Music(HV), Odia, political science, Sociology & Statistics.

(c) All the compulsory subjects for Science & Arts

Semester	**AECC Course**	**SEC Course**
1st Sem	AECC- Environment studies and Disaster Mgt. AECC- EV1	
2nd Sem	AECC - 2 MIL Communication (English/Odia/Hindi) AECC- EV2	
3rd Sem	AECC- EV-3	SEC-1 Communicative English
4th Sem	AECC- EV-4	SEC-2 QLT (Quantitative & Logical Thinking)
5th Sem	AECC- EV-5	
6th Sem	AECC- EV-6	

(d) Discipline Specific Electives (DSE) This particular course is related to respective core subjects. The students can choose

(i) Two DSE subjects related to their core subjects in 5th Semester provided in the syllabus

(ii) Two DSE courses including the project work in the 6th Semester.

* The students have to go through the required tests to be eligible for N.C.C.

GRADE SHEET

At the end of 6(six) semester, a grade sheet shall be made available to each student.

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2021 Admission Batch Onwards
CBCS Syllabus (Science Stream)

SEMESTER -I

AECC-1- Environmental Studies & Disaster Mgt.		: 100 (80 + 20)
Core - 1		: 100 (80 + 20)
Core - 2		: 100 (80 + 20)
AECC (EV-I) Ethics and Values		: 25
For Practical Subjects		
Core - 1	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
Core - 2	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
For Practical Subjects		
GE - 1	(Theory)	: 75 (60 + 15)
	(Lab)	: 25

SEMESTER -II

AECC-2-	MIL Communication (Eng /Odia / Hindi	: 100 (80 + 20)
AECC (EV-II) Ethics and Values		: 25
Core - 3		: 100 (80 + 20)
Core - 4		: 100 (80 + 20)
For Practical Subjects		
Core - 3	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
Core - 4	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
For Practical Subjects		
GE - 2	(Theory)	: 75 (60 + 15)
	(Lab)	: 25

SEMESTER -III

AECC(EV-III) Ethics and Values		: 25
SECC -1 Communicative English		: 100 (80 + 20)
Core - 5		: 100 (80 + 20)
Core - 6		: 100 (80 + 20)
Core - 7		: 100 (80 + 20)
For Practical Subjects		
Core - 5	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
Core - 6	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
Core - 7	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
GE - 3		: 100 (80 + 20)
For Practical Subjects		
GE - 3	(Theory)	: 75 (60 + 15)
	(Lab)	: 25

SEMESTER -IV

AECC (EV-IV) Ethics and Values		: 25
SEC C-2	Qnty. & Logical Thinking	: 100 (80 + 20)
Core - 8		: 100 (80 + 20)
Core - 9		: 100 (80 + 20)
Core -10		: 100 (80 + 20)
For Practical Subjects		
Core - 8	(Theory)	: 75 (60 +15)
	(Lab)	: 25
Core - 9	(Theory)	: 75 (60 +15)
	(Lab)	: 25
Core -10	(Theory)	: 75 (60 +15)
	(Lab)	: 25
GE - 4		: 100 (80 + 20)
For Practical Subjects		
GE - 4	(Theory)	: 75 (60 +15)
	(Lab)	: 25

SEMESTER -V

AECC(EV-V) Ethics and Values		: 25
Core -11		: 100 (80 + 20)
Core -12 :		100 (80 + 20)
For Practical Subjects		
Core -11	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
Core -12	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
Core - 7	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
DSE - 1		: 100 (80 + 20)
DSE - 2		: 100 (80 + 20)
For Practical Subjects		
DSE - 1	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
DSE - 2	(Theory)	: 75 (60 + 15)
	(Lab)	: 25

SEMESTER -VI

AECC(EV-VI) Ethics and Values		: 25
Core -13		: 100 (80 + 20)
Core -14		: 100 (80 + 20)
For Practical Subjects		
Core -13	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
Core -14	(Theory)	: 75 (60 + 15)
	(Lab)	: 25
DSE - 3		: 100 (80 + 20)
DSE - 4 (Project)		: 100
For Practical Subjects		
DSE - 3	(Theory)	: 75 (60 + 15)
	(Lab)	: 25

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+3 FIRST YEAR FIRST SEMESTER

Addl. Generic Elective - I

PAPER - I

NCC (Arts/Science/Commerce)

Time : **3 Hours** End Semester : **60** Marks,
Credit : **6** Mid-Semester : **15** Marks

The NCC

Unit-1

(a) Aims and Objectives of NCC.
Organisation &Training and NCC Song. Incentives.

(b) Basic organisation of the Armed Forces Organisation, Army Badges of Rank.

(c) Religions, Culture, Traditions and Customs of India. National Integration : Importance and Necessity.

Unit-2

(a) Introduction to Personality Development, Factors Influencing / shaping Personality, Self Awareness-know yourself, change your mind set.

(b) Types of communications.

Unit-3

(a) Civil Defence organisation, types of emergencies/National Disaster

(b) National Resources, Conservation, Water conservation, Rain water Harvesting

(c) Basics of Social service, weaker sections of our society & their needs., Social & Rural Development projects: MNREGA.SASY, NSAP etc., Contribution of youth towards social Welfare

Unit-4

(a) Introduction to types of maps & conventional signs.

(b) Scales & Grid system, Topographical Forms & Technical terms.

(c) Relief, contours and Gradient.

PRACTICAL-1

Mark - **25**

1.	Foot-Drill	-	15
2.	Health & Hygiene	-	10

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+3 FIRST YEAR SECOND SEMESTER

AECC - 2

COMMUNICATION ODIA (Arts/ Science)

Time : **3** Hours
Credit : **6**

End Semester Theory : **80** Marks
Mid Semester Theory : **20** Marks

ଦକ୍ଷତାବର୍ଦ୍ଧକ ବାଧ୍ୟତାମୂଳକ ପାଠ୍ୟକ୍ରମ

ଯୋଗାଯୋଗମୂଳକ ମାତୃଭାଷା - ଓଡ଼ିଆ

ପ୍ରଥମ ପତ୍ର

କଳା ଓ ବିଜ୍ଞାନ (ସାଧାରଣ / ସମ୍ମାନ) ଶ୍ରେଣୀ ପାଇଁ ଉଦ୍ଦିଷ୍ଟ

ପାଠ୍ୟକ୍ରମର ଭୂମିକା :

ଏହି ପାଠ୍ୟଖସଡ଼ାଟି ପସନ୍ଦ ଓ ଆସ୍ଥାଭିତ୍ତିକ (ସିବିସିଏସ୍) ପାଠ୍ୟ ପ୍ରଣାଳୀ ଅନୁସାରେ ପ୍ରସ୍ତୁତ ହୋଇଛି। ବିଭିନ୍ନ ସ୍ତରରେ ଆବଶ୍ୟକ ଅନୁସାରେ ସମସାମୟିକ ପରିସ୍ଥିତିକୁ ନେଇ ଭାବବିନିମୟ ଓ ପାରସ୍ପରିକ ଯୋଗାଯୋଗ ସ୍ଥାପନ କିପରି ଓଡ଼ିଆ ଭାଷାରେ ସହଜରେ, ସରଳରେ ହୋଇପାରିବ- ଏ ଦିଗ ପ୍ରତି ଏଥିରେ ଧ୍ୟାନ ଦିଆଯାଇଛି। ଓଡ଼ିଆ ଭାଷା ଓ ସାହିତ୍ୟର ପ୍ରାୟୋଗିକ ଜ୍ଞାନର ବିକାଶ ନିମିତ୍ତ +୩ ସ୍ତରୀୟ ବିଦ୍ୟାର୍ଥୀଙ୍କୁ ଏହି ପାଠ୍ୟକ୍ରମର ଖସଡ଼ାଟି ସାହାର୍ଯ୍ୟ କରିବ। ସେଥିପାଇଁ ପ୍ରଚଳିତ ଭାଷାର ବୈୟାକରଣିକ, ବ୍ୟାବହାରିକ ଓ ପ୍ରାୟୋଗିକ ଦିଗ ପ୍ରତି ଏଥିରେ ଧ୍ୟାନ ଦିଆଯାଇଛି। ଏଥିରେ ସଂଯୋଗ ପ୍ରକ୍ରିୟାର ଅନୁବିଧି, ଯୋଗାଯୋଗର ତଥ୍ୟ ଓ ତତ୍ତ୍ୱ ପ୍ରତି ଗୁରୁତ୍ୱ ଦିଆଯାଇଛି। ସରକାରୀ କାର୍ଯ୍ୟାଳୟରେ ଓଡ଼ିଆ ଭାଷାର ବ୍ୟବହାରରେ ଏହା ଦକ୍ଷତା ବୃଦ୍ଧି କରିବ। ଓଡ଼ିଆ ଭାଷାର ପ୍ରୟୋଗରେ ସେମାନେ ଶୁଦ୍ଧ ଓ ପରିଚ୍ଛନ୍ନ ଭାବରେ ଯେ କୌଣସି ପ୍ରକାର ଜ୍ଞାନର ସୂଚନା ତଥ୍ୟ ଓ ସିଦ୍ଧାନ୍ତକୁ ମୌଖିକ ଓ ଲିଖିତ ସ୍ତରରେ ସହଜରେ ପ୍ରକାଶ କରିପାରିବେ ଏବଂ ସେମାନଙ୍କ ମାତୃଭାଷା ପ୍ରୟୋଗର ବିକାଶ ଘଟିପାରିବ।

ମୂଲ୍ୟ ବିଭାଜନ ପଦ୍ଧତି : (ସବୁଥିରୁ ବିକଳ୍ପ ପଡ଼ିବ)

(କ) ନିର୍ଦ୍ଧାରିତ ପାଠ୍ୟର ସବୁ ଏକକ (ୟୁନିଟ୍)ରୁ ବିକଳ୍ପ ସହ ଦୁଇଟି ଲେଖାଏଁ ମୋଟ ୮ଟି ୧୫ ନମ୍ବର ବିଶିଷ୍ଟ ଦୀର୍ଘପ୍ରଶ୍ନ ପଡ଼ିବ। ବିଦ୍ୟାର୍ଥୀଙ୍କୁ ୪ଟି ପ୍ରଶ୍ନର ଉତ୍ତର ଦେବାକୁ ହେବ। **(୧୫ X ୪ = ୬୦)**

(ଖ) ନିର୍ଦ୍ଧାରିତ ପାଠ୍ୟର ସବୁ ଏକକରୁ ୧୨ ଟି ଅତି ସଂକ୍ଷିପ୍ତ ପ୍ରଶ୍ନ ପଡ଼ିବ। ସେଥିରୁ ୧୦ଟି ପ୍ରଶ୍ନ ଉତ୍ତର ଦେବାକୁ ହେବ। **(୧୫ X ୪ = ୬୦)**

(ଗ) ମହାବିଦ୍ୟାଳୟ ସ୍ତରୀୟ ପରୀକ୍ଷା **-୨୦**

ମୋଟ ମୂଲ୍ୟାଙ୍କ - **୧୦୦**

ଦକ୍ଷତାବର୍ଦ୍ଧକ ବାଧ୍ୟତାମୂଳକ ପାଠ୍ୟକ୍ରମ

ଯୋଗାଯୋଗମୂଳକ ମାତୃଭାଷା - ଓଡ଼ିଆ

ଦ୍ୱିତୀୟ ପତ୍ର

କଳା ଓ ବିଜ୍ଞାନ (ସାଧାରଣ / ସମ୍ମାନ) ଶ୍ରେଣୀ ପାଇଁ ଉଦ୍ଦିଷ୍ଟ

୧ମ ଏକକ / ୟୁନିଟ୍ : ଯୋଗାଯୋଗର ପରିଭାଷା, ଅନୁବିଧି, ପରିସର ଓ ପ୍ରକାରଭେଦ।

୨ୟ ଏକକ /ୟୁନିଟ୍ : ସାକ୍ଷାତ୍କାର, ଭାଷଣ କଳା।

୩ୟ ଏକକ / ୟୁନିଟ୍ : ସମ୍ବାଦର ପରିଭାଷା, ପରିସର ଓ ସମ୍ବାଦ ପ୍ରସ୍ତୁତି ।

୪ର୍ଥ ଏକକ / ୟୁନିଟ୍ : ଓଡ଼ିଆ ଭାଷାର ବର୍ଣ୍ଣମାଳା, ବର୍ଣ୍ଣାଶୁଦ୍ଧିର ନିରାକରଣ । (ବନାନ ତ୍ରୁଟି - ସାଦୃଶ୍ୟ ଜନିତ ଅଶୁଦ୍ଧି, ବାକ୍ୟ ବିଧିଜନିତ ଅଶୁଦ୍ଧି, ସମାର୍ଥବୋଧକ ଶବ୍ଦଶୁଦ୍ଧି, ପ୍ରତ୍ୟୟ ଜନିତ ଅଶୁଦ୍ଧି, ଶବ୍ଦ ସଂଯୋଗାତ୍ମକ ଓ ସ୍ୱରସଙ୍ଗତି ଜନିତ ଅଶୁଦ୍ଧି ।

ସହାୟକ ଗ୍ରନ୍ଥସୂଚୀ :

୧. ଯୋଗାଯୋଗ ମୂଳକ ମାତୃଭାଷା (ଓଡ଼ିଆ) ସାମଲ ବିରଞ୍ଚି ନାରାୟଣ, ସତ୍ୟନାରାୟଣ ବୁକ୍ ଷ୍ଟୋର, କଟକ ।

୨. ସଂଯୋଗ ଅନୁବିଧି, ସନ୍ତୋଷ କୁମାର ତ୍ରିପାଠୀ, ନାଳନ୍ଦା, କଟକ ।

୩. ଭାଷଣ କଳା ଓ ଅନ୍ୟାନ୍ୟ ପ୍ରସଙ୍ଗ - କୃଷ୍ଣଚନ୍ଦ୍ର ପ୍ରଧାନ, ସତ୍ୟନାରାୟଣ ବୁକ୍ ଷ୍ଟୋର, କଟକ ।

୪. ପ୍ରାୟୋଗିକ ଓଡ଼ିଆ ଭାଷା - ଓଡ଼ିଆ ରାଜ୍ୟ ପାଠ୍ୟ ପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା, ଭୁବନେଶ୍ୱର ।

୫. ସମ୍ବାଦ ଓ ସମ୍ବାଦିକତା - ଚନ୍ଦ୍ରଶେଖର ମହାପାତ୍ର, ଓଡ଼ିଆ ରାଜ୍ୟ ପାଠ୍ୟପୁସ୍ତକ ପ୍ରଣୟନ ଓ ପ୍ରକାଶନ ସଂସ୍ଥା, ଭୁବନେଶ୍ୱର

୬. ନିର୍ଭୁଲ ଲେଖାର ମୂଳସୂତ୍ର, ନୀଳାଦ୍ରି ଭୂଷଣ ହରିଚନ୍ଦନ, ପି.ସି.ଆଇ ପବ୍ଲିକେସନ, ଭୁବନେଶ୍ୱର ।

୭. ସର୍ବସାର ବ୍ୟାକରଣ - ନାରାୟଣ ମହାପାତ୍ର ଓ ଶ୍ରୀଧର ଦାସ, ନିୟୁ ଷ୍ଟୁଡେଣ୍ଟସ୍ ଷ୍ଟୋର, କଟକ ।

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+3 THIRD YEAR FIFTH SEMESTER

AECC - 2

COMMUNICATION HINDI (Arts/ Science)

Time : **3** Hrs. End Semester Theory : **80** Marks
Credit: **06** Mid-Semester Theory : **20** Marks

Unit- 1:

कविता

(ग) कबीर - साखी : १ से १०

(गग) तुलसी - विनयपत्रिका - पद १ और २

(गगग) प्रसाद - मधुमय देश

(गन्) निराला - भिक्षुक

(न्) अज्ञेय - हिरोशिमा

Unit -II; Basic:

गद्य

(ग) रामचन्द्र शुक्ल - उत्साह

(गग) हजारी प्रसाद द्विवेदी - कुटज

(गगग) हरिशंकर परसाई - सदाचार का तावीज

Unit -Iit:

शब्द ज्ञान

(ग) शब्द शुद्धि (गग) वाक्य शुद्धि

(गगग) पर्यायवाची शब्द (गन्) विलोम शब्द

Unit - IV:

सामान्य ज्ञान

(ग) निबंध लेखन (Eassy Writing)

पाठ्य पुस्तक :

१) हिन्दी प्रसून - सं. डॉ. अंजुमन आरा, प्लानेट वी, कटक

२) आधुनिक हिन्दी व्याकरण और रचना - वासुदेवनन्दन प्रसाद, भारती भवन, दिल्ली

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+ 3 FIRST YEAR SECOND SEMESTER

AECC - 2

MIL COMMUNICATION ENGLISH (Arts/Science)

Time: 3 Hours **End Semester: 80 Marks**
Credits: 06 **Mid Semester: 20 Marks**

INTRODUCTION :

The paper is focused upon developing one fundamental skill of Language learning; reading which needs a through rethink and revision. In order to build a strong base for acquisition of the communication skills, suitable reading content is selected from diverse areas in prose form. This would boost the learner's competence in expressive and comprehension skills. The well researhed language exercises in the form of usage, vocabulary and grammar is the other area that should attract the teacher and learner to work out for giving decent shape to the mastery of English language.

UNIT 1 : Short story

(i) Jim Corbett - The Fight between Leopards
(ii) Dash Benhur - The Bicycle
(iii) Dinanath Pathy - George V High School
(iv) Alexander Baron - The Man who knew too much
(v) Will f Jenkins - Uneasy Homecoming

UNIT 2 : Prose

(i) Mahatma Gandhi - The way to Equal Distribution
(ii) S Radhakrishnan - A call to Youth
(iii) CV Raman - Water - The Elixir of Life
(iv) Harold Nicolson - An Educated Person
(v) Claire Needell Hollander - No Learning without FeelingS

UNIT 3 :

Comprehension of a passage and answering the questions

UNIT 4 :

Language exercises, test of vocabulary, usage and grammar

Text Books :

All stories and prose pieces

Refernce Books :

- The Widening Arc: A Selection of prose and stories, Ed. AR Parhi, S Deepika, P Jani, Kitab Bhavan, Bhubaneswar.
- A Communicative Grammar of English, Geoffrey Leech.
- A University Grammar of English, Randolph quirk and Sidney Greenbaum
- Developing Reading Skills. F. Grellet. Combridge: Combridge University Press, 1981.

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+ 3 FIRST YEAR THIRD SEMESTER
SEC - 1
(COMMUNICATIVE ENGLISH)

Time: **3** Hours | End Semester: **50** Marks
Credits: **4** | Mid Semester: **20** Marks

This special course of Communicative English aims to engage the students more creatively to impove their English language and communication skills. This paper will be taught unde Skill Enhancement compulsory course - 1 (SECC -1). The main intent of this paper is to strengthen the language competency of graduate students, majority of who are set to enter the job market with high hopes. Needless to say, a good command over English language is one skill which various companies expect from the prospective employees.

UNIT - I : CONTEXTS OF COMMUNICATION AND PHONETIC FEATURES

1. Why English Communication is essential and how to improve the skill ?
2. Introduction to voice and Accent
    a. Why do we have such different accents ?
    b. Accent Training - Consequences
    c. Voice and accent in the Enterprise Industry
    d. Globally Comprehensible Accent
    e. Intrernationl Phonetic
    f. International Phonetic Alphabet
3. Consonant Sounds
4. Vowels
5. Diphthongs
6. A Few Phonic Rules
7. Word Stress: Syllables
8. Intonation and Stress
9. Pacing and Chunking
a. Common Patterns of Pacing
b. Importance of Chunking
10. Fluency
11. Indianisms - Errors in pronuciation

UNIT II : GRAMMAR

1. English: Spoken Versus Written Communication
2. Nouns
    a. Kinds of Nouns
    b. Nouns Number
    c. Noun Gender
    d. Countable and Uncountable Nouns

3. Pronouns
4. Adjectives
    a. Positioning of adjectives
    b. Comparative Degrees of Adjectives
    c. Order of Adjectives
5. Adverbs
    a. Kinds of Adverb
    b. Degree of Comparison
    c. Word Order with Adverbs
6. Prepositions

    Prepositions with Adjectives, Nouns and Verbs
7. Conjunctions
    a. Coordinating Conjunctions
    b. Subordinating Conjunctions
    c. Correlative Conjunctions
    d. Connenting Adverbs
8. Verbs
    a. Verb Classification
    b. List of irregular verbs
9. subject and verb agreement
10. Determiners and Modifiers
11. Proof Reading and Punctuation
12. Tenses
13. Common errors in grammar and vocabulary

UNIT II : READING COMPREHENSION

Reading A-7 Step Process, Techniques to enhance students reading skills, types of reading skills (Skimming, Scanning, Extensive reading, Intensive reading). Three levels of Reading, improving your reading speed. Reading comprehension practice exercises.

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ENVIRONMENTAL STUDIES
&
DISASTER MANAGEMENT

(AECC - 1)/ SEMESTER-1 (From 2021 Admission Batch)

Time : **3 Hours** End Semester : **80** Marks
Credit : **4** Mid Semester : **20** Marks

Unit 1 (Environment)

The Environment : The Atmosphere, Lithosphere. Hydrosphere, Biosphere (01 period)

Ecosystem : Energy flow in the ecosystem (01 period)

Biogeochemical cycle : Water Cycle, Carbon Cycle, Nitrogen Cycle (02 periods)

Pollution : Water Pollution, Air Pollution, Soil Pollution, Radiation Pollution, Industrial Pollution, Light Pollution, Sound Pollution (05 periods)

Environmental Laws (Water Act 1974, Air Act 1981, The Wildlife Protection Act 1972, The Environment Protection Act 1986), The Forest Conservation Act 1980 (04 periods)

Unit 2 : (Climate Change & Sustainable Development)

Population Ecology : Individuals, Species. Population, Community (01 period)

Human Population Growth, Population Control Methods (01 period)

Urbanization and its effect on society (01 period)

Climate Change : Causes, effect, Global Warming, Corbon Footprint and environmental protection (05 periods)

Steps taken towards Sustainable Development : Ban of single use plastics, Automobile Scrapping policy, Promotio of Electrical Vehicles (03 periods)

Brief idea on Sustainable Development : Goals (SDGs), Agenda 21 of Rio Earth Summit (02 periods)

UNIT III (DISASTER MANAGEMENT)

Disaster Management : Types of disasters (Natural and Man- made) and their causes and effect. (02 periods)

Vulnerability Assessment and Risk Analysis : Vulnerability to various disasters (Flood, Cyclone, Earthquake, Heat waves and Lightning) (02 periods)

Institutional Framework : Institutional arrangements for disaster management (National Disaster Management Authority (NDMA), state Disaster Management Authority (SDMA), District Disaster Management Authority (DDMA), National Disaster Response Force (NDRF) and Odisha Disaster Rapid Action Force (ODRAF) (02 periods)

Preparedness Measures : Disaster Management Cycle, Early Warning System Pre-Disaster and Post-Disaster Preparedness, Strengthening of SDMA and DDMA, Community Preparedness, Stakeholder participation, Corporate Social Responsibility (CSR) (05 periods)

Survival Skills : Survival skills adopted during an after disaster (Flood, Cyclone, Earthquake, Heat waves and Lightning) (02 periods)

UNIT IV (Public Health Management)

Brief idea on epidemics and Pandemics (01 period)

Non - communicable diseases with special reference to cardiovascular diseases, Cance, Diabetes, Hypertension and Obsity and their prevention (02 period)

communicable disease with special refernce to Covid-19, Flu, Hepatitis, AIDS and Tuberculosis and their transmission (02 periods)

Dynamics of Disease Transmission : Mode of transmission (Direct/Indirect), Events after infection: immunity (Active vrs Passive, Innate vrs Acquired, Herd Immunity), Incubation Period (02 periods)

Prevention of Epidemics/Pandemics Diseases : Preventing Measure (Quarantine, Sanitization, Personal Protective measures such as Hand washing and use of protective devices, Vaccination); Control Measures (Surveillance, Isolation, Contact Tracing) (03 periods)

Life Style Management : (Diet, Physical Exercise, Yoga and Sleeping habit) (02 periods)

Role of Differnt sectors in Managing Health Disaster : Role of Government (Centre and State), Community, Civil Socieaty student mass, NGOs (01 periods)

Books Recommended :

1. Asthana DK and Asthana M:A Text Book of Environmental Studies, S. Chand, New Delhi
2. Bharucha E: A Text Book of Environmental Studies, New Delhi : UGC
3. Dash MC and Mishra PC: Man and Environmental, McMillan, London
4. Disaster Management and Mitigation Plan, 2013 of Dept. of Health & Family Welfare, Govt. of Odisha
5. Mishra DD: Fundamental Concepts in Environmental Studies, S. Chand, New Delhi
6. National Policy on Disaster Management, 2009
7. National Disaster Management Plan, 2019*
8. Odum EP: Fundamentals of Ecology, Natraj Publications
9. State Disaster Managment Plan, 2019 of Government of Odisha*
10. Standard Operating Procedure (SOP) issued by Govt. of India and Govt. of Odisha on Public Health Managements in the websites: www.mohfw.gov.in and health.odisha.gov.in*
11. The Disaster Management Act, 2005 of Government of India*

[Note: star(*) marked References, published by the state as well as Central Government are available in the open sources]

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AECC EV - I (Ethics &Values) From 2021 Admission Batch

SEMESTER - I/ Unit - 1

Title : ISSUES RELATING TO WOMEN

Total No. of periods: **15** Full Mark- **25** Credit Point **- 1** in each semester

1.1 Introduction:

General introduction on Ethics and Values, Gender equality as an essential precursorto society progress, the present scenario, Desirable gender related values.

(Taught by Sociology Deptt. -3classes per month)

1.2 Women and Family

Pre-natal sex selection, Gendered practices in the family, Gender based division of labour in the family, Marriage and women, Marriage and women's consent, Child marrigem Practice of dowry, Women and family violence.

(Taught by Socal Deptt. -3classes per month)

1.3 Women and Work

Women's work : The invisible hands, Exploitation of Women at work, Working women and role conflict.

(Taught by Psychology Deptt. -4classes per month)

1.4 Women, Community and Society

Violence against women in public spaces, Gender sensitive language and communication, Gendered language, Sexist Language, Gender neutal language, Women and property Rights, woments propertry in Indian laws, The functionality of women's Property Rights.

(Taught by Psychology Deptt. -4classes per month)

EV - II SEMESTER - II/ UNIT - 2

TITLE : VALUES AND GOOD CITIZENSHIP

2.1 Indian Constitution

Salient Values of Preamble : soverign, Socialist, Secular, Democratic, Republic, Justice, liberty, Equality and Fraternity.

(Taught by Poltical Science Deptt. -3classes per month)

2.2 Potriotism

Patriotic Value and ingredients of nation building, Concept of Good Citizenship, Emotional Connention with the country, Duties of Citizens and Qualities of Good Citizens.

(Taught by History Deptt. -4classes per month)

2.3 Volunteerism

Concept and facets of Voluteerism and Leadership, Building a better society through Volunteerism, Blood Donation, Social Work Helping the Aged, Environmental Protection.

(Taught by Social Work Deptt. -4classes per month)

2.4 Work Ethics

Punctuality, Cleanliness, Law abidingness, Rational Thinking and Scientific Temper.

(Taught by E.V.S. Deptt. -4classes per month)

EV - III SEMESTER - III/ UNIT - 3
TITLE : ISSUES OF DRUG, TOBACCO AND ALCOHAL ADDICTION

(All the Papers taught by Social Work Deptt.)

3.1 Extent of the problem

Extent of Drug and Tobacco addiction and alchoholism in India, Myths associated with them, Health hazrds associated with them and how they become silent killers.

3.2 Social-Ecoomic Impact

Social- economic impact of drug and tabacco addiction and alcoholism :

Loss of physical and mental strenght, Loss of character, Loss of family ties and relationship, Loss of earning and livelihoo potentials, Loss of societal respect and dignity etc.

3.3 Laws to Address this Problem

Salient features of social legislation such as NDPS Act, 1985 and COTPA Act, 2003, Mechanism and Government Schemes for prevention, de-addiction and rehabilitation.

3.4 Role of Stake - holders

Provision of Tobacco free campus and role of students, Role of students in their family and immediate surroundings, Role of NGOs and other agencies.

EV -IV SEMESTER - IV/ UNIT -4
TITLE: ETHICAL VALUES FOR STUDENT LIFE

4.1 Meaning and Objective of Education

Knowledge is power and quest for knowledge is the real meaning of education, not quest for Degree and qualifications; Real education builds character : Difference between Aca demic Qualification and Ability. Academic failure could be failure within the classroom, but not outside (i.e. Failed in Exam , passed in life !) (Taught by Edn/B.Ed. Deptt.- 3 Classes Per Month)

4.2 Challenges for Ethical Practices in Institution of Higher Education :

Ragging, Suicide and Need for Educational Counseling, Violence vs. Peaceful protest, conflict resolution, Plagiarism and violation of intellectual property Rights, Cheating in Examinationand other Fraudulent Practices. (Taught by E.V.S. Deptt. - 4 Classes Per Month)

4.3 Inter personal Relation and Community Life in HEI :

Green precher and conservation of Energy, Community Life in Campus including Hostels, Local common area, Inter perrsonal relations (Students - Teacher, Students - student and Man-Woman, Positive Friendship). (Taught by Geography Deptt. - 4 Classes Per Month)

4.4 Ethical Leadership in Academic Institution :

Concept and Traits of Leadership to provide solution, everyone has Leadership Role (not limited to position), concept of Eathical leadership, Scope of Leadership in College and Universities for students, Teachers and Administrators, Importance of Co-curRucular and extra-curicular activities. (Taught by psychology Deptt. - Classes Per Month)

EV - V SEMESTER - V/ UNIT - 5
TITLE: VULNERABLE SECTIONS OF SOCIETY : UNDERSTANDING THEIR ISSUES

5.1 Issues Relating to Children :

Nutrition and health, Child Exploitation : Child labour, Trafficing, Sexual Exploitation

5.2 Issues Relating to Elderly Persons :

Abuse of elders, Financial Insecurity, Loneliness and social Insecurity, Health Care Issues, Needs for a Happy and Dignified Ageing

5.3 Issues Relating to Persons with Disability :

Rights of PWD, affirmative action, Prevention of discrimination, providing equal opportunity, various scheme for empowering PWD and social justice for PWD

5.4 Issues Relating to Third Gende :

Understanding the Third Gender, Social justice for them, Removal of discrimination, Affirmative action and Acceptance of diversity of gender.

EV - VI SEMESTER - V/ UNIT - 6
TITLE: ENVIRONMENTAL & TECHNO ETHICS

6.1 Environmental Ethics :

Types of Ecological Values, Environmental Values & Valuing, Nature, Equitable use of resources, Role of Individual in the conservation of resources for future generation, Bio-Ethics-Genetic manipulation in plants and animals for benefit of society and cruelty and cruelty against animal.

6.2 Promotion of Green Technology :

Goal of Green Technology : Reduce recycling, **Renew** (removal of chemicals)

Refuse and **Responsibility**

Green Technology in relation to : Energy and Construction.

6.3 Ethics and Technology :

Ethics and Technology with reference to Science, gadget, machine etc. and interaction with each other.

Agricultural, Industrial, Digital, Globalized, Age etc.

6.4 Judicious Use of Technology :

Judicious Use of Mobile Phones, Electrical machines, Plastics, Television, Computers and their harmful effects.
Ethics and Use of Digital Technology : Cyber ethic - Crimes and Ethical hacking.
Ethics and Social Media : WhatsApp, Facebook, Twitter and others.

+ 3 FIRST YEAR FOURTH SEMESTER
SEC - 2
QUANTITATIVE AND LOGICAL THINKING

Time: 3 Hours **End Semester: 80 Marks**
Credits: 06 **Mid Semester: 20 Marks**

Unit - 1 : QUANTITATIVE APTITUDE & DATA INTERPRETATION

1. Whole numbers, Integers, Rational and irrational numbers, Fractions, Square roots and cube roots, Surds and indices, Problems on Numbers, Diversibility.

   Steps of Long Division Method fo Finding Square Roots.
2. Basic concepts, Different formula of Percentage, Profit and Loss, Discount, Simple Interest, Ratio and Proportion, Mixture.
3. Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and Speed; relationship among them
4. Concept of Angles, Different Polygons like tringles, rectangle, square, right angled triangle, Phythagorean Theorem, Perimeter and Area of Tringles, Rectangles, Circles.
5. Raw and Grouped Data, Ba graphs, Pie charts, Mean, Mode, Events and sample space, Probability.

Unit - II : LOGICAL REASONING

1. Analogy basing on Kinds of relationships, Simple Analogy; Pattern and Serier of Numbers, Letters, Figures. Coding-Decoding of Numbers, Letters, Sysbols (Figures), Blood relations.
2. Logical Statements-Two premise argument, More than two premise argument using connective

Unit - III :

Venn Diagrams, Mirror Images, Problems on Cubes and Dices

+3 FIRST YEAR SECOND SEMESTER
GENERIC ELECTIVE - 2
NCC (Arts/Science/Commerce)

Time : **3 Hours** End Semester : **60** Marks,
Credit : **6** Mid-Semester : **20** Marks

Unit-1

a) Freedom struggle and Nationalist Movement in India, Nationalist Interest, objectives threats and opportunities,

b) Self defence

Unit-2

a) Scount and Patrol

b) Judging Distance

Unit-3

a) Dressing of Wounds
b) Yoga : Introduction and Exercises, Physical and Mental Health
c) Fractures : types and treatment, evacuation of Casualties

Unit-4

a) Cardinal points & types of north
b) Types of bearing & use of Service Protractor
c) Prismatic compass & its use

PRACTICAL-2

Full Mark - **25** Marks

1.	Map Reading	-	15
2.	Judging Distance	-	10

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BIOTECHNOLOGY

Program Outcomes:

PO 1 Students develop global competencies in the area of basic and applied biological sciences

PO 2 Enhancing the subject knowledge of students by using traditional and modern ICT based teaching methods and learning by doing.

PO 3 To enrich students' knowledge and train them in various branches of Biotechnology such as genetics, molecular biology, biochemistry, immunology, fermentation technology, environmental biotechnology and tissue culture techniques.

PO 4 To groom the students to meet futuristic challenges and national interests

PO 5 As Biotechnology is an interdisciplinary course, empower the students to acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology.

PO 6 Acquire knowledge in students of biotechnology enabling their applications in industry and research

PO 7 Understand the issues of environmental deterioration, pollution and sustainable development. Developing critical problem-solving approach for these societal concerns via bioremediation and integrated management

Program Specific Outcomes:

PSO 1 To bestow the students with all the research skills required to work independently

PSO 2 To develop scientific temperament and social responsibilities in the students.

PSO 3 To inculcate nature care by imparting knowledge of advance modern techniques

PSO 4 As Biotechnology is an interdisciplinary course, empower the students to acquire technological knowhow by connecting disciplinary and interdisciplinary aspects of biotechnology.

PSO 5 Acquire knowledge in students of biotechnology enabling their applications in industry and research

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 1

MICROBIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used, including molecular approaches, Microbial phylogeny, Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa, Archea (Halophyles, Methanogens, Thermophyles), Virus (structure of viruses, Bacterial, plant, animal and tumor viruses, DNA- and RNA- viruses.

Unit- II

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria.

Unit- III

Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria. Nutritional Classification of Microorganisms.

Unit- IV

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents, Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: molds, Yeasts, bacteria.

Course Outcome :

CO 1 Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity;

CO 2 To understand the Growth, Nutrition, extraction of microbes under In vitro conditions

CO 3 To understand the metabolism and the metabolic pathways of Micro organisms, their mode of transformation and reproduction

CO 4 To understand and identify the Microbes and their products used for industrial purposes as wellacting as pollutants in the atmosphere.

PRACTICAL

Credit : **02** **25** Marks

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.

Course Outcome:

CO 1 To isolate specific colonies of Microbes and to classify them on the basis of their metabolism.

CO 2 To identify the microbial cells using staining procedures

CO 3 To prepare growth media for the Microorganisms and to create pure culture on extraction of microbes from different sources like soil, water etc.

CO 4 To identify the Structure and Morphological study of various bacteria/ Micro organisms

CO 5 To calculate and quantify the amount of Bacteria present dead or alive in any given sample.

Text Books:

1. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
2. Prescott/Harley/Klein's Microbiology, by Joanne Willey (Author), Linda Sherwood (Author), Chris Woolverton (Author), McGraw Hill Education; 7 edition

Suggested Readings

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996). Introductory Mycology. 4 thedition.John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA. (2005). *Modern Food Microbiology*. 7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology. 2nd edition. Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12thedition. Pearson/Benjamin Cummings.
5. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5thedition. McMillan.

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 2

PLANT DIVERSITY AND PLANT PHYSIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Unit-I

Algae: General character, classification& economic importance.

Fungi: General characters, classification& economic importance.

Lichens: Classification, general structure, reproduction and economic importance.

Bryophytes: General characters, classification& economic importance.

Unit- II

General characters of pteridophytes, affinities with bryophytes & gymnosperms, classification, economic importance. Gymnosperms: General characters, classification, geological time scale, theories of fossil formation, types of fossils Life histories of Cycas & Pinus, economic importance of gymnosperms.

Unit- III

Plant water relations: Importance of water to plant life, diffusion, osmosis, plasmolysis, imbibition, guttation, transpiration, stomata & their mechanism of opening & closing. Micro & macro nutrients: criteria for identification of essentiality of nutrients, roles and deficiency systems of nutrients, mechanism of uptake of nutrients, mechanism of food transport Growth and development: Definitions, phases of growth, growth curve, growth hormones (auxins, gibberlins, cytokinins, abscisic acid, ethylene)

Unit- IV

Physiological role and mode of action, seed dormancy and seed germination, concept of photoperiodism and vernalization Photosynthesis- Photosynthesis pigments, concept of two photo systems, photophosphorylation, calvin cycle, CAM plants, photorespiration, compensation point Nitrogen metabolism- inorganic & molecular nitrogen fixation, nitrate reduction and ammonium assimilation in plants.

Course Outcome :

CO 1 about the structure, pigmentation, food reserves and methods of reproduction of Algae *

CO 2 Learn about the structure, pigmentation, food reserves and methods of reproduction of Fungi

CO 3 To know about the Economic importance of algae, Fungi and lichen, Studied some plant diseases with special reference to the causative agents, symptoms, etiology and control measures.

CO 4 To understand the essential nutrients and plant hormones in the growth and development of plants including the food transport mechanism

CO 5 To learn the mode of action due to climatic and nutritional changes in Plants for growth and development

PRACTICAL

Credit : **02** **25** Marks

1. Comparative study of thallus and reproductive organs of various algae mentioned in theory.
2. Separation of photosynthetic pigments by paper chromatography.
3. Study of various types of lichens.
4. Demonstration of aerobic respiration.
5. Preparation of root nodules from a leguminous plant.
6. Demonstration of plasmolysis by *Tradescantia* leaf peel.

Course Outcome:

CO 1 To learn and understand structures, and specialized reproductive organs in algae.

CO 2 To learn about the nature of the photosynthetic pigments through separartion.

CO 3 *To learn about lichens, their structure and other reproductive parts

CO 4 To understand the mechanism of partial and complete aerobic respiration.

CO 5 To learn the mode of action of varying concentration of solution on plant cells.

CO 6 To understand the amount of nitrogenous compound entrapped in the leguminous roots

Text Books:

1. Taiz, L. and Zeiger, E. 2006 Plant Physiology, 4th edition, Sinauer Associates Inc .MA, USA
2. Sambamurty 2008 A Textbook of Bryophytes, Pteridophytes, Gymnosperms and Paleobotany.

IK, International Publishers.

Suggested Reading:

1. Shaw, A.J. and Goffinet, B. 2000 Bryophyte Biology. Cambridge University Press.
2. Van den Hoek, C.; Mann, D.J. &Jahns, H.M. 1995. Algae: An introduction to Phycology. Cambridge Univ. Press.
3. A Test Book of Plant Physiology, Biochemistry & Biotechnology, Author: Verma & Verma, Pub: S. Chand
4. Plant Physiology, Author: Salisbury & Ross, Pub: WADSWORTH C engage learning
5. Unified Botany, Author: Agrawal S.B, Pub: Shivlal Agrawal A Textbook of Botany by Singh, Pande, Jain.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 3

CELL BIOLOGY & GENETICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit-I

Cell: Introduction and structural organization of prokaryotic and Eukaryotic cells, compartmentalization of eukaryotic cells, cell fractionation. Cell membrane and Permeability: Chemical components of biological membranes and its organization, Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport. Cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure & function, Golgi complex: Structure, biogenesis and function

Unit- II

Extracellular Matrix: Composition, molecules that mediate cell adhesion, membranes receptors for extra cellular matrix, macromolecules, regulation of receptors expression and function. Signal transduction Structure and functions; Lysosomes, Vacuoles and micro bodies, Ribosomes, Mitochondria, Chloroplasts, Nucleus: Chromosomes and their structure.

Unit- III

Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis: Control points in cell-cycle progression in yeast. Role of meiosis in life cycles of organisms. Mendelian genetics: Mendel's experimental design, mono, di- and tri hybrid crosses, Law of segregation & Principle of independent assortment. Chromosomal theory of inheritance. Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes.

Unit- IV

Structure and characteristics of bacterial and eukaryotic chromosome, chromosome morphology, concept of euchromatin and heterochromatin. packaging of DNA molecule into chromosomes, concept of cistron, exons, introns, genetic code, gene function. Chromos and gene mutations:

Definition and types of mutations, causes of mutations, position effects of gene expression, chromosomal aberrations in human beings, abonormalities– Aneuploidy and Euploidy. Sex determination and sex linkage: Mechanisms of sex determination, Environmental factors and sex determination, sex differentiation, Barr bodies, dosage compensation, genetic balance theory, Fragile-X-syndrome and chromosome, sex influenced dominance, sex limited gene expression, sex linked inheritance.

Course Outcome:

CO 1 Detailed understanding about cellular organelles, biological processes and their functions

CO 2 Will enable students to learn about essential cell organelles like mitochondria, lysosomes etc and ttheir significance.

CO 3 Students will learn about events and various stages of cell cycle, cell division and Mendelian Genetics.

CO 4 To understand the Sex Determination and Sex linked Gene Expression with the influence of environmental factors in it.

PRACTICAL

Credit : **02** **25** Marks

1. Study of plasmolysis and de-plasmolysis.
2. Study of structure of any prokaryotic Eukaryotic cell.
3. Microtomy: Fixation, Block making, Section cutting, Double staining of animal tissues like liver, Oesphagus, Stomach, pancreas, Intestine, Kidney, Ovary, testes.
4. Cell division in onion root tip/insect gonads.
5. Preparation of Nuclear, mitochondria & cytoplasmic fractions.
6. Study of polyploidy in onion root tip by colchicine treatment.
7. Karyo typing with the help of photographs

Course Outcome:

CO 1 To understand the behaviour of cells present in the solution of different concernatrations.

CO 2 Will enable students to learn about essential cell organelles like mitochondria, lysosomes, Chromosomes and their significance.

CO 3 Students will able to extract tissue level visualization under the microscope for better understanding of the tissue level arrangements.

CO 4 To understand the Karyotype and chromosomal structure of human chromosomes along with the method to identify structural differences in chromosomes..

Text Books:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2006). Principles of Genetics. VIII Edition John Wiley & Sons.

Suggested Readings

1. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

2. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASMPress& Sunderland, Washington, D.C.; Sinauer Associates, MA.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

4. Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings.

5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. IX Edition. Introduction to Genetic Analysis, W. H. Freeman & Co.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 4

ANIMAL DIVERSITY AND PHYSIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

Proto-chordates: Outline of classification, General features Outline of classification of Non-Chordates upto subclasses. Coelomata, Acoelomata, Symmetries, Deutrostomes, Protostomes. General characters, outline of Classification of Protozoa, Porifera, Coelenterata, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Hemichordata.

Unit - II

Proto-chordates: Outline of classification, General features and important characters of Herdmania, Branchiostoma Origin of Chordates Pisces: Migration in Pisces, Outline of classification Amphibia: Classification, Origin, Parental care, Paedogenesis Reptelia: Classification, Origin Aves: Classification, Origin, flight- adaptations, migration Mammalia: Classification, Origin, dentition

Unit - III

Digestion: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice Respiration: Exchange of gases, Transport of O2 and CO2, Oxygen dissociation curve, Chloride shift.Excretion: modes of excretion, Ornithine cycle, Mechanism of urine formation. Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heartbeat.

Unit - IV

Mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions, Mechanism of action of hormones (insulin and steroids)

Course Outcome:

CO 1 To learn about general features and Classification of Porifera and Coelenterata

CO 2 To learn about general features and Classification of protochordates, Fishes, Ambphibians and aves

CO 3 To learn about the structure and mechanism of Heart and cardiac output

CO 4 To learn the significance of glands, hormones and mechanism of action of human hormones

PRACTICAL

Credit : **02** **25** Marks

1. Identification of slides with two points of identification. Amoeba, Paramoecium, Ceratium, Plasmodium, Opalina, L.S. Sponge, Spicules ofsponges, L.S. Hydra, Obelia, Bougainvilliae, Larvae of Fasciola, Seta of Earthworm, Radula of Pcla.
2. Identification & Classification upto order of the following: Proto-chordata: Salpa, Doliolum, Herdmania, Branchiostoma
3. Finding the coagulation time of blood
4. Determination of blood groups
5. Determination of Haemoglobin
6. Counting of mammalian RBCs
7. Determination of TLC and DLC

Course Outcome:

CO 1 To learn about general features and structure of organisms from different phylums

CO 2 To learn about blood groups and its significance

CO 3 To learn about the presence of haemoglobin and its quantitative analysis.

CO 4 To learn the method of counting of Mammalian RBCs and Leucocytes present in the Human Body

Text Books:

1. Modern text book of zoology: invertebrates, R.L. Kotpal, Rastogi Publications,Meerut
2. Modern text book of zoology: vertebrates, R.L Kotpal, Rastogi Publications, Meerut
3. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition. John Wiley & Sons,Inc

Suggested Reading:

1. Barrington, E.J.W. (1979) Invertebrate Structure and Functions. II Edition. E.L.B.S. and Nelson.
2. Boradale, L.A. and Potts, E.A. (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
3. Young, J.Z. (2004). The life of vertebrates. III Edition. Oxford university press.
4. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. / W.B. Saunders Company.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 5

MOLECULAR BIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

DNA structure and replication: DNA as genetic material, Structure of DNA, Types of DNA, Nucleosome, Packaging of DNA molecule into chromosomes, Replication of DNA in prokaryotes and eukaryotes: Semiconservative nature of DNA replication, Bi -directional replication, DNA polymerases, The replication complex: Pre-priming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.

Unit- II

DNA damage, repair and homologous recombination: DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Homologous recombination: models and mechanism.

Unit- III

Transcription and RNA processing: RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5 cap formation, polyadenylation, splicing, rRNA and tRNA splicing.

Unit- IV

Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoa acyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Post translational modifications of proteins Regulation of gene expression and translation: Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics.

Course Outcome:

CO 1 To learn the Structure of DNA and its replication for both Prokaryotic and Eukaryotic cells

CO 2 To understand the post replication processes of DNA Damage and DNA repair

CO 3 To understand the process of Transcription and RNA processing

CO 4 To understand the process of Translation for protein synthesis and its expression

PRACTICAL

Credit: **02** **25** Marks

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from animal/bacterial cells.
3. Agarose gel electrophoresis of genomic DNA.
4. Quantitation of DNA by Spectrophotometry.
5. Extraction of protein
6. SDS PAGE and Native PAGE

Course Outcome:

CO 1 To learn preparation of different buffers, chemical solutions for Molecular Biology Experiments

CO 2 Isolation of Chromosomal DNA from Plants/Animal tissues and bacteria

CO 3 To learn the preparation and separation of DNA through Gel Electrophoresis

CO 4 To learn extraction and Quantification of Proteins

CO 5 Separation of Proteins by SDS PAGE.

Text Book:

1. Molecular Biology of the Gene-By Watson, Hopkins, Goberts, Steitz and Weiner (Pearson Education)

Suggested Readings

1. Cell and Molecular Biology - By Robertis & Robertis, Publ: Waverly
2. Genes - By B. Lewin - Oxford Univ. Press
3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
4. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Fundamentals of Molecular Biology. Jayant K Pal and SS Ghaskadbi, Oxford University Press.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 6

BIO-CHEMISTRY AND METABOLISM

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

pH and buffers, Preparation and significance of buffers in biological system. .Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero polysaccharides, Muco-polysaccharides, Bacterial cell wall polysaccharides, Glycoproteins and their biological functions. Carbohydrates Metabolism: Reactions, energetic and regulation. Glycolysis: Fate of pyruvate under aerobic and anerobic conditions. Pentose phosphate pathway and its significance, Gluconeogenesis, Glycogenolysis and glycogen synthesis. TCA cycle, Electron transport chain, Oxidative phosphorylation,

Unit- II

Amino acid & Proteins: Structure and properties of Amino acids, Types of Proteins and their Classification, Different levels of structural organization of proteins, Fibrous and globular proteins. Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenezyme, prosthetic groups, Enzyme activity, Specific activity,

Unit- III

Lipids: Structure and functions Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, Sphingolipids, Glycolipids, Cerebrosides, Gangliosides, Prostaglandins, Cholesterol. Beta-oxidation of fatty acids.

Unit- IV

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, Purines & Pyrimidines. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z DNA.

Course Outcome:

CO 1 To learn preparation of different buffers, and other biomolecules and their significance in Biological Systems.

CO 2 To understand the structure of enzymes, amino acids, proteins and their classification.

CO 3 To learn about the classification, structure and features of Lipids and its significance in biological systems

CO 4 To learn about nucleic acids, their structure and features of Nucleic Acids, DNA and RNA

CO 5 To understand the structure of DNA, purine pyrimidines and their arrangements in the structure of the DNA

PRACTICAL

Credit : **02** **25** Marks

1. To study activities of any enzyme under optimum conditions.
2. Preparation of buffers.
3. Separation of Amino acids by paper chromatography.
4. Qualitative and quantitative tests for Carbohydrates and lipids.
5. Qualitative and quantitative estimation of proteins.

Course Outcomes:

CO 1 To learn preparation of different buffers, chemical solutions fin Biochemistry Experiments

CO 2 To understand the separation of amino acids through paper chromatography

CO 3 To learn the qualitative and quantitative estimation of Carbohydrates and Lipids

CO 4 To learn extraction, estimation and quantification of Proteins

Text Book:

1. Nelson, D.L., Cox, M.M. (2004), Lehninger Principles of Biochemistry, 7th Edition, WH Freeman and Company, New York, USA.

Suggested Readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
2. Harper’s Illustrated Biochemistry (Harper’s Biochemistry) by Robert K. Murray, Darryl K. Granner, Peter A. Mayes, and Victor W. Rodwell.
3. Fundamentals of Biochemistry. Life at the molecular level (Fourth Edition) by Donald Voet, Judith G. Voet and Charlotte. W. Pratt. Willey 2010.
4. Biophysical Chemistry, Principles & Techniques – Upadhyay, Upadhyay&Nath-Himalaya Publ.
5. Biochemistry, 4th edition by U Satyanarayana and U Chakrapani, Elsevier India
6. Biochemistry Concepts and Connections, DR Appling, SpEncer J. Anthony-Cahill,& Christopher K.Mathews, Pearson

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 7

BIOSTATISTICS AND COMPUTER APPLICATIONS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Statistical methods and Developmental models: Graphical representation of statistical data, Mean, Poisson and Binomial, Distribution, Arithmetic, Geometric and Harmonic means, Median, Mode; Design of experiments,

Unit- II

Analysis of Variance, Standard Deviation, Standard error of mean, Correlation and regression of two variables, Test of significance, Probability, sampling, measurement and distribution of attributes, t-test, chi-square test, F-test. Collection, Classification and Tabulation of data,

Unit- III

Basic concept of computer: - Introduction, different components of computer, basic design of computer. Introduction to operating system, different management (processor, memory, device ,file), Processor management-Process concept ,Threads ,CPU Scheduling Process scheduling, Deadlocks ,Process synchronization. Memory management – Memory allocation rule, Swapping, Overlay, Paging, Demand paging, segmentation, virtual memory. Device management, File management.

Unit- IV

Computer application, DOS command, MS-Office, MS-Access, MS-Excel, MS-Power point, Assessing Internet. Services: Browsing, Downloading, e-correspondence. Introduction C programming: Structure of C Program, Execution of C Program, Constants, Variable, Datatypes, Operator and Expression, Decision making Branching and Decisionmaking looping, Array.

Course Outcome:

CO 1 To learn preparation and statistical analysis of biological data.

CO 2 To understand the test of significance using ANOVA and distribution of attributes using chi square, t Test and f Test

CO 3 To learn the basic features of Computers like file handling process management and Memory allocation

CO 4 To learn execution of command prompt files through DOS commands and other applications by using C Programs.

CO 5 Representation and analysis of data using various computer application of MS office Suite.

PRACTICAL

Credit : **02** **25** Marks

1. Calculation of mean, median & mode taking biological samples
2. Calculation of standard error of mean

3. Chi-square test using biological samples
4. DOS commands (Internal & External)
5. Some basic programs in C
6. Programs on Decision making branching
7. Programs Decision making Looping
8. Programs on operators

Course Outcome:

CO 1 Calculation of Mean median mode using various biological samples

CO 2 To learn the calculation of Standard error of mean and Chi square test using biological samples

CO 3 To learn and execute the syntax of C programs along with its operators and commands.

CO 4 Basic Program for Decision making with various operators and tools in C programming

Text Books:

1. C in Depth by Shrivastava SK, Shrivastava D, BPB Publication, 2nd revised edition.
2. Biostatistics Theory and Applications by G. Mishra & P.K. Mohanty G.B.N. Chainy.

Suggested Readings:

1. Taxmann's Information Technology by Dr.Sushila Madan.
2. Let Us C by YashwantKanetkar 11th Edition
3. Edmondson A and Druce D (1996) Advanced Biology Statistics, Oxford University Press.
4. Danial W (2004) Biostatistics : A foundation for Analysis in Health Sciences, John Wiley and Sons Inc.
5. S.C. Gupta, V.K. Kapoor Fundamentals of Mathematical Statistics, A Modern Approach, 10th edition, S Chand & Sons.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 8

IMMUNOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Immune Response - An overview, components of mammalian immune system, molecular structure of Immuno-globulins or Antibodies, Humoral & Cellular immune responses, T- lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by somatic recombination.

Unit- II

Regulation of immunoglobulin gene expression clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory.

Unit- III

Major Histocompatibility complexes class I & class II MHC antigens, antigen processing and presentation. Immunity to infection- immunity to different organisms, pathogen defence strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency diseases, AIDS.

Unit- IV

Vaccines & Vaccination adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics RIA, ELISA.

Course Outcome:

CO 1 To understand the immune response and various components of mammalian immune system

CO 2 To learn about regulation of immunoglobulin gene expression, immunoglobulins and their types.

CO 3 To learn about other immune molecules and their significance in the immune response.

CO 4 To study about the mechanism of immune respaonse towards immunity and infection, allergies.

CO 5 To understand the mechanism of Vaccines for prolonged immune response and their dection through RIA and ELISA

PRACTICAL

Credit : **02** **25** Marks

1. Differential leucocytes count.
2. Total leucocytes count.
3. Total RBC count.
4. Haemagglutination assay.
5. Haemagglutination inhibition assay.
6. Separation of serum from blood.

Course Outcome:

CO 1 To calculate the total leucocytes using Haemocytometer.

CO 3 To study and calculate the presence of Haemoglobin in Human Blood.

CO 4 To study and calculate the immunodiagnostic methods for RBC and WBCs.

CO 5 To understand the process of extraction of blood plasma and serum from blood

Text Book:

1. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology. 6th edition W. H. Freeman and Company, New York.

Suggested Readings

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology. 11thedition Wiley-Blackwell Scientific Publication, Oxford.
3. Essentials of immunology by Roitt(Blackwell scientific publication)
4. Immunology and immunotechnology by Ashim k. Chakravarty (Oxford university Press).

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 9

PLANT BIOTECHNOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Introduction, Cryo and organogenic differentiation, Types of culture: Seed, Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation Axillary bud proliferation, Meristem and shoot tip culture, cud culture, organogenesis, embryogenesis.

Unit- II

In vitro haploid production Androgenic methods: Anther culture, Microspore culture and ogenesis Significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.

Unit - III

Protoplast Isolation and fusion Methods of protoplast isolation, Protoplast development, Somatic hybridization, identifiation and selection of hybrid cells, Cybrids, Potential of somatic hybridization limitations. Somaclonal variation Nomenclautre, methods, applications basis and disadvantages.

Unit - IV

Plant Growth Promoting bacteria. Nitrogen fixation, Nitrogenase, Hydrogenase, Nodulation, Biocontrol of pathogens, Growth promotion by free-living bacteria.

Course Outcome:

CO 1 To learn various process used for invitro growth and development in plant growth and its propagation

CO 2 To learn about various plant tissue culture techniques like embryo, anther etc.

CO 3 To study about Protoplast culture, protoplat fusion methods and identification through hybridization.

CO 4 To understand the mechanism plant growth promoting bacteria through Nitrogen Fixation bacteria nd its action

PRACTICAL

Credit : **02** **25** Marks

1. Preparation of complex nutrient medium (Murashige& Skoog's medium)
2. To selection, Prune, sterilize and prepare an explant for culture.
3. Significance of growth hormones in culture medium.
4. To demonstrate various steps of Micropropagation

Course Outcome:

CO 1 To prepare the complex nutrient medium for the growth and development of Plants in invitro condition.

CO 2 To learn about method to sterilize the culture and prepare explants from various parts of the plants used in Plant tissue culture

CO 3 To study and learn about the effects of Growth hormones present in the culture media for the growth of explants and callus formation

CO 4 To study about the mechanism of Micropropagation used in development of plants in invitro conditions.

Text Book:

1. Introduction to Plant Biotechnology, H.S. Chawla,Science Publishers, 2002

Suggested Readings:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice.Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
4. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
5. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication
6. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 10

ANIMAL BIOTECHNOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Equipments and materials for animal cell culture: Design and layout of culture room, Basic equipments used in cell culture, Sterilization and aseptic techniques. Culture media: General considerations in media design, Natural media, synthetic media. Primary culture and its maintenance

Unit- II

Various methods of cell separation, Cell cloning: Dilution cloning and isolation cloning, Transformation of cells, Organ culture, In vitro Fertilization, Embryo culture. Three dimensional culture.

Unit- III

Gene transfer methods in Animals – Microinjection, Embryonic Stem cell, gene transfer, Retrovirus & Gene transfer. Animal propagation – Artificial insemination, Animal Clones. Conservation Biology-Embryo transfer techniques. Introduction to Stem Cell Technology and its applications.

Unit- IV

Genetic modification in Medicine - gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.

Course Outcome:

CO 1 To learn about various equipments and techniques necessary for primary/pure animal cell culture

CO 2 To understand various mechanism of cell differentiation, transfer and culture techniques.

CO 3 To learn about the various mechanism of animal propagation and gene transfer.

CO 4 To understand the mechanism of Gene Therapy, its significance, problems and ethics.

PRACTICAL

Credit : **02** **25** Marks

1. Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization, Laboratory sterilization
2. Sources of contamination and decontamination measures.
3. Cell counting and cell viability
4. Preparation of Hanks Balanced salt solution
5. Preparation of Minimal Essential Growth medium

Course Outcome:

CO 1 To learn various sterilization techniques used for tools and equipments used in animal cell culture

CO 2 To learn about maintaining asceptic conditions in cell culture and measures to decontaminate the samples.

CO 3 To study and learn the cell viability and cell counting of the primary cell culture

CO 4 To study about the mechanism and preparation of Hanks Balanced Salt solution

CO 5 To learn the methods to prepare Minimal essential Growth nutrients for the growth media.

Text Book:

1. Animal cell culture techniques, Ian Freshney, Wiley-Leiss

Suggested Readings:

1. Tissue Culture- Methods and Applications by Paul F. Kruse Jr. and M. K. Patterson, Jr.
2. Cell Culture LabFAx, M. Butler and M. Dawson, Bios scientific Publications Ltd
3. Cell and Tissue Culture: Laboratory Procedures in Biotechnology, A. Doyle and B.Griffith, Wiley publications.
4. Plant cell and Tissue Culture for the production of Food Ingradients by Fu, Singh and Curtis

5. Handbook of plant tissue culture, ICAR, publications & information division, New Delhi.
6. Animal Cell Culture- John R. W. Masters - Oxford University Press.
7. Introduction to Plant Biotechnology 2017 by H S Chawla - CRC Press.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 11

GENETIC ENGINEERING

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Molecular tools and applications- restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, lectroporation, Ultrasonication, Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.

Unit- II

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each).

Unit- III

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

Unit- IV

Genetic engineering in plants: Use of Agrobacterium tumefaciens and A. rhizogenes, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as episomal expression vectors.

Course Outcome:

CO 1 To study about various processes and techniques used in Genetic Engineering.

CO 2 To learn about various blotting techniques to extract DNA of interest and preparing cDNA libraries

CO 3 To study about Gene imprinting through genome mapping and fingerprinting techniques

CO 4 To understand the various mutation techniques and its study in genes and proteins.

CO 5 To study genetically engineered bacteria used in gene transfer in plants through expression vectors.

PRACTICAL

Credit : **02** **25** Marks

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Demonstration of PCR

Course Outcome:

CO 1 To learn about the process of isolation of genomic DNA in Plants and Bacteria

CO 2 To study and analyze the DNA using a spectrum absorption techniques

CO 3 To study about Gene imprinting through genome mapping and fingerprinting techniques

CO 4 To understand the technique of extracting specific DNA of interest using Restriction digestion method..

CO 5 To study about the process of amplification of DNA using PCR

Text Book:

1. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology - Principles and Applications of recombinant DNA. ASM Press, Washington

Suggested Readings:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing,Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Applying the Genetic
3. Revolution.Elsevier Academic Press, USA.
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
6. Biotechnology by B.D.Singh (Kalyani Publishers).

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 12
GENOMICS & PROTEOMICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Introduction to Genomics, DNA sequencing methods manual& automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.

Unit- II

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

Unit- III

Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures Edman degradation.

Unit- IV

Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilisation, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

Course Outcome:

CO 1 To study about various biological databases, and various methods used in Genomic/proteomic study.

CO 2 To learn about various genome and proteome servers/databases.

CO 3 To study the proteomics study using proteome databases.

CO 4 To learn about various proteins through proteome database and their structures through online softwares /databases etc.

CO 5 To identify various protein sequences and its separation using SDS PAGE and mass spectrometry.

PRACTICAL

Credit : **02** **25** Marks

1. Use of SNP databases at NCBI and other sites
2. Detection of Open Reading Frames using ORF Finder
3. Proteomics 2D PAGE database
4. Software for Protein localization.

5. Native PAGE
6. SDS-PAGE

Course Outcome:

CO 1 To study about various biological databases.

CO 2 To identify Open reding Frames in a DNA sequence through online ORF's finding software

CO 3 To study the proteomics study using proteome databases.

CO 4 To learn about various proteins through proteome databases

CO 5 To identify various protein sequences and its separation using SDS PAGE.

Text Books:

1. Charles Malkoff, 2016. Exploring Genomics, Proteomics and Bioinformatics, Syrawood Publishing House.
2. A.Malcolm Campbell Discovering Genomics, Proteomics and Bioinformatics,Pearson Education India; 2 edition

Suggested Readings:

1. Dunham, I., 2003. Genome Mapping and sequencing. Horizon Scientific.
2. Graur, D and W H Li, 2000. Fundamentals of molecular evolution. Sinauer Associates.
3. Hartwell, L. H., L. Hood, M. L. Goldberg, A. E. Reynolds, L. M. Silver and R. G. Veres.2004. Genetics from Genes to Genomes. McGraw Hill.
4. The Human Genome 2001, Nature Vol. 409.
5. The Drosophila Genome. 2000, Science Vol. 267.
6. The Caenorhabditis elegans genome 1998. Science Vol. 282. The Arabidopsis Genome 2000 Nature vol. 408

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 13

ENVIRONMENTAL BIOTECHNOLOGY & BIOETHICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Environment: Basic concepts and issues, Environmental modeling, Systems ecology, Ecosystem, Global Environmental Problems; Ozone depletion, Influence on Biodiversity of aquatic and terrestrial environment, Biodiversity of oceans, Estuaries and Lagoons. Acid rain, Arid and semi-arid plant biotechnology, Green house technology, Environmental pollution and measures; Air, Water, Soil, Radioactive pollutions.

Unit-II

Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation, Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinates hydrocarbons and petroleum products.

Unit-III

Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes, plants and animals.

Unit-IV

Bioethics-Necessity of Bioethics, different paradigms of Bioethics-National & International. Ethical issues against the molecular technologies. Introduction to intellectual property: Types of IP (Trademarks, Copyright & Related rights, Industrial design, Traditional knowledge, Geographical indications, Protection of GMOs). Basics of patents (Types of patent application and Specifications), concept of Prior Art and patent filing procedures

Course Outcome:

CO 1 To understand and impact of global environmental issues like pollution and its effect on the biodiversity.

CO 2 To study the bioremediation of soil and water for decontamination using microbes.

CO 3 To learn the treatment and extraction of minerals from ores and mines. Environmental significance of Genetically Modified Microbes and their importance.

CO 4 To learn about action of pH and enzyme kinetics and their reactions in industrial fermentation and determination in biosynthetic pathways

PRACTICAL

Credit : **02** **25** Marks

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.

4. A case study on clinical trials of drugs in India with emphasis on ethical issues.
5. Case study on women health ethics.
6. Case study on medical errors and negligence

Course Outcome:

CO 1 To analyze the amount of dissolved solvents in natural resources like river, ponds etc

CO 2 To study the presence of microbes and contamination in water bodies.

CO 3 To learn and analyze the dissolved chemicals in water bodies.

CO 4 To learn about action of drugs in clinical trials and its ethical issues.

CO 5 To study about various women health ethics and medical errors due to negligence

Text Book:

1. P.K. Mohapatra, Textbook of Environmental Biotechnology, I.K. International Publishing House; 1st Ed. edition.
2. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers

Suggested Readings:

1. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Jesef Winter
2. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
3. Agricultural Biotechnology, S.S. Purohit
4. Environmental Microbiology : Methods and Protocols, Alicia L.Ragout De Spencer, John F.T. Spencer
5. Introduction to Environmental Biotechnology, Milton Wainwright
6. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 14

BIOPROCESS ENGINEERING & TECHNOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Production of industrial chemicals, biochemicals and chemotherapeutic products. Propionicacid,butyric acid, 2-3 butanediol, gluconic acid, itaconic acid, Biofuels: Biogas, Ethanol, butanol,hydrogen, biodiesel, Microbial electricity, starch conversion processes. Microbial polysaccharides; Microbial insecticides; microbial flavours and fragrances, newer antibiotics, anti-cancer agents, amino acids.

Unit- II

Production of microbial metabolite, Secondary metabolism its significance and products. Metabolic engineering of secondary metabolism for highest productivity. Enzyme and cell immobilization techniques in industrial processing, enzymes in organic synthesis, proteolytic enzymes, hydrolytic enzymes, glucose isomerase, enzymes in food technology/organic synthesis.

Unit- III

Purification & characterization of proteins, Upstream and downstream processing. Distribution of microbial cells, centrifugation, filtration of fermentation broth, ultracentrifugation, liquid extraction, ion-exchange recovery of biological products. Experimental model for design of fermentation systems, Anaerobic fermentations.

Unit- IV

Rate equations for enzyme kinetics, simple and complex reactions. Inhibition kinetics; effect of pH and temperature on rate of enzyme reactions. Mathematical derivation of growth kinetics, mathematical derivations of batch and continuous culture operations; single stage CSTR; mass transfer in aerobic fermentation; resistances encountered; overall mass transfer co-efficient (Ka) determination, factors depending on scale up principle and different methods of scaling up. Metabolic engineering of antibiotic biosynthetic pathways.

Course Outcome:

CO 1 To learn about various techniques used in production of biofuels, flavouring agenta, Microbial insectisides etc.

CO 2 To learn about primary and secondary metabolites extracted from micorbes and enzymes used in industrial purposes.

CO 3 To study the proteomics and techniques used in industrial techniques for extraction of biosynthetic products

CO 4 To learn about action of pH and enzyme kinetics and their reactions in industrial fermentation and determination in biosynthetic pathways

PRACTICAL

Credit : **02** **25** Marks

1. Comparative analysis of design of a batch and continuous fermenter.
2. Calculation of Mathematical derivation of growth kinetics.
3. Solvent extraction & analysis of a metabolite from a bacterial culture.
4. Perform an enzyme assay demonstrating its hydrolytic activity (protease/peptidase/glucosidase etc.)
5. Production and analysis of Amylase.

Course Outcomes:

CO 1 To study the fermentation process and protocol for batch/ continuous fermentor.

CO 2 To learn about calculation and derivation of growth kinetics of a microorganism

CO 3 To study the hydrolytic activity of various proteolytic and hydrolystic enzymes

CO 4 To understand the production procedure of Amylase enzyme

Text Book:

1. Prescott & Dunn's Industrial Microbiology Paper back, 2004 by G. Reed (Author), CBS Publication.

Suggested Readings

1. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2ndedition, Elsevier Science Ltd.
2. Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
3. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
4. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
5. Salisbury, Whitaker and Hall. Principles of fermentation Technology

+3 THIRD YEAR FIFTH SEMESTER

DSE - 1

BIOTECHINIQUES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Simple microscopy, phase contrast microscopy, fluorescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

Unit- II

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared),centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

Unit- III

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

Unit- IV

Introduction to electrophoresis, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, immuno- electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

Course Outcome:

CO 1 To understand the mechanism of microscopy and magnification for observing microorganisms.

CO 2 To understand physical methods of separation on the basis of centrifugation and spectroscopy analysis

CO 3 To study and analyze about separation of biomolecules their Retardation Factor relationships through chromatography

CO 4 To study about separation of amino acids of any protein through Gel electrophoresis (SDS) and PAGE

PRACTICAL

Credit : **02** **25** Marks

1. Native gel electrophoresis of proteins
2. Determination of absorption maxima of given chemicals.
3. SDS-polyacrylamide slab gel electrophoresis of proteins under reducing conditions.
4. Separation of amino acids by paper chromatography.
5. To identify lipids in a given sample by TLC.
6. To verify the validity of Beers law and determine the molar extinction coefficient of NADH.

Course Outcome:

CO 1 Identify major categories of microorganisms and analyze their classification, diversity, and ubiquity;

CO 1 To study about separation of amino acids of any protein through Gel electrophoresis (SDS) and PAGE

CO 2 To analyze and study about absorption of given chemicals

CO 3 To study and analyze about separation of lipids and their Retardation Factor

CO 4 To analyze the Beer Lamberts law by using spectrum analysis and optical density.

Text Books:

1. Principle and Techniques of Biochemistry and Molecular biology, 7th ed By Keith Wilson and Jhon Walker, Cambridge Press
2. Rodney Boyer, Modern Experimental Biochemistry, Pearson Education; 3 Edition.

Suggested Readings:

1. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III,
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
3. An introduction to Practical Biochemistry - T. Plummer
4. Experimental Biochemistry- V. Deshpande and B. Sasidhar Rao (A Student Companion)
5. Biophysics – Vastala Piramal (Dominent Publishers)
6. Introductory Practical Biochemistry - S.K. Sawhney, Randhir Singh, Narosa Publishing.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 2

BIOINFORMATICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

History of Bioinformatics. The notion of Homology. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web.

Unit- II

Protein Information Sources, PDB, SWISSPROT, TREMBL, Understanding the structure of each source and using it on the web. Introduction of Data Generating Techniques and Bioinformatics problem posed by them- Restriction Digestion, Chromatograms, Blots, PCR,Mass Spectrometry.

Unit- III

Sequence and Phylogeny analysis, Detecting Open Reading Frames, Introduction to BLAST, using it on the web,Outline of sequence Assembly, Pairwise Alignments, Interpreting results, Multiple Sequence Alignment, Phylogenetic Analysis.

Unit- IV

Searching Databases: SRS, Entrez, Sequence Similarity Searches-BLAST, FASTA, Data Submission. Genome Annotation: Pattern and repeat finding, Gene identification tools.

Course Outcome:

CO 1 To study about various biological databases, tools and Server

CO 2 To analyse and study about Protein and Nucleotide databases with its statistical representation

CO 3 To study about Sequence alignment and their evolutionary relationship.

CO 4 To identify the reading frames and alignment search techniques through computational biology

CO 5 To study and learn the analysis of genes and Genomes and any alternation in their molecular phylogeny.

PRACTICAL

Credit : **02** **25** Marks

1. Sequence information resource
2. Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, Protein information resource (PIR)
3. Understanding and using: PDB, Swissprot, TREMBL
4. Using various BLAST and interpretation of results.
5. Retrieval of information from nucleotide databases.
6. Sequence alignment using BLAST.
7. Multiple sequence alignment using Clustal W.

Course Outcome:

CO 1 To study about various biological databases, tools and Server

CO 2 To analyse and study about Protein and Nucleotide sequence based databases

CO 3 To study about Sequence alignment and their evolutionary relationships through online softwares and tools

CO 4 To identify the reading frames and alignment of more than two sequences and understand the search patterns using MSA

Text Book:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.

Suggested Readings:

1. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
2. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

+3 THIRD YEAR SIXTH SEMESTER

DSE - 3

MEDICAL MICROBIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels. Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S. aureus, B. anthracis, C. tetani C. diphtheriae M. tuberculosis, M. leprae.*

Unit- II

Pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy caused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, S. typhi, S. dysenteriae, H. influenzae, V. cholerae, M. pneumoniae, Rickettsiaceae, Chlamydiae.*

Unit- III

Diseases caused by viruses - Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

Unit- IV

Fungal and Protozoan infections. Dermatophytoses (Trichophyton and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis), Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

Course Outcome:

CO 1 To learn about susceptibility and natural microflora of human body, their infection causative agents and pathogenicity.

CO 2 To learn about Pathogenesis, symptoms, prevention and cure against odd infections which occurs due to contaminations.

CO 3 To understand the infection and infectious agents of various natural occurring Microorganisms.

CO 4 To study and identify various disease causing Protozoans and their infection symptoms

PRACTICAL

Credit : **02** **25** Marks

1. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
2. Growth curve of a bacterium.
3. To perform antibacterial testing by Kirby-Bauer method.
4. To prepare temporary mounts of Aspergillus and Candida by apprpriate staining.
5. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

Course Outcome:

CO 1 To learn about morphology and growth of bacteria by using biochemical/morphological sexperiments and observations

CO 2 To learn about antibacterial sensitivity in the infections by using Kirby- Bauer Method.

CO 3 To understand the growth and proliferation of Fungus through various staining techniques.

CO 4 To study and identify various disease causing Protozoans using various staining protocols.

Text Book:

1. Ananthnarayan, Paniker, Arti Kapil Ananthanarayan and Paniker's Textbook of Microbiology, Universities Press (India) Private Limited

Suggested readings

1. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mim's Medical Microbiology. 4th edition. Elsevier.
3. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.

+3 THIRD YEAR SIXTH SEMESTER

DSE - 4

PROJECT REPORTS & SEMINAR

Credits-**6**, Project Report: **60** marks, Seminar: **20** marks, Viva: **20** marks & Total: **100** Marks

1. A selected Biotechnology based product
2· Review articles
3· Latest techniques and products of societal impact
4· Contribution/discovery of Scientists in the field of Biotechnology
5· Instrumentation and applications
6· Scale up/ Down stream processing
7· Models
8· Bioinformatics tools

Course Outcome:

CO 1 To develop research ethics and skills to write a thesis report

CO 2 To study the latest research article and to develop pipeline projects for experiments and observations

CO 3 To learn the use of biotechnology and its impact on socio economical issues.

CO 4 To learn and analyze about various interdisciplinary sciences related to Biotechnology research and industrial applications.

BOTANY

PROGRAMME OUTCOMES (POs)

PO-1 Acquire extensive knowledge in all disciplines of botany, including taxonomy, physiology, and ecology, and understand the fundamental concepts, principles, and applications related to plant biology. **(Domain Knowledge)**

PO-2 Develop skills to effectively communicate botanical concepts and research findings both orally and in writing to scientific and lay audiences. **(Communication Skill)**

PO-3 Employ critical thinking and scientific methods to design experiments, conduct field studies, and analyse botanical data. **(Critical Thinking)**

PO-4 Identify botanical problems and apply methodical and independent reasoning to formulate hypotheses and draw logical conclusions. **(Problem Solving)**

PO-5 Acquire technical skills in botany through laboratory experiments, fieldwork, and research projects to enhance job prospects and research opportunities. **(Technical/Research Skill)**

PO-6 Develop digital competencies for e-learning, botanical research, data analysis, and presentation using modern information and communication technologies. **(Digital Skill)**

PO-7 Cultivate an awareness of the impact of plant sciences on environmental sustainability, society, and ethical considerations in research and application. **(Moral/Ethical/Societal Awareness)**

PO-8 Foster cooperation, teamwork, and leadership qualities in students through collaborative projects and team-based research activities. **(Teamwork/Leadership)**

PO-9 Master the application of botanical knowledge in industries such as agriculture, pharmacology, and biotechnology, and develop entrepreneurial skills to innovate in these sectors. **(Self-Directed Learning)**

PROGRAM SPECIFIC OUTCOMES (PSOs)

PSO-1 Develop a comprehensive understanding of plant sciences, mastering areas such as plant physiology, taxonomy, ecology, and genetics, to solve complex biological and environmental problems.

PSO-2 Gain proficiency in experimental techniques and field research in botany, from microscopic analyses to ecological surveys, ensuring accurate data collection and adherence to scientific protocols.

PSO-3 Enhance communication skills to articulate botanical research and insights effectively across diverse platforms, catering to both academic audiences and community stakeholders.

PSO-4 Cultivate teamwork and leadership abilities through collaborative scientific projects and interdisciplinary research, preparing for roles in both academic and industrial settings.

BOTANY

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 1

MICROBIOLOGY AND PHYCOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

Introduction to microbial world, microbial nutrition, growth and metabolism.

Viruses:- Discovery, physicochemical and biological characteristics; classification (Baltimore), general structure with special reference to viroids and prions; replication (general account), DNA virus (T-phage), lytic and lysogenic cycle; RNA virus (TMV). Economic importance of viruses with reference to vaccine production, role in research, medicine and diagnostics, as causal organisms of plant diseases.

Unit- II

(i) **Bacteria: -** Discovery, general characteristics, types- archaebacteria, eubacteria, wall- less forms (mycoplasma and spheroplasts), cell structure, nutritional types, reproduction- vegetative, asexual and recombination (conjugation, transformation and transduction). Economic importance of bacteria with reference to their role in agriculture and industry (fermentation and medicine).

(ii) **Cyanobacteria:-** Ecology and occurrence, cell structure, heterocyst, reproduction, economic importance; role in biotechnology. Morphology and life- cycle of Nostoc. General characteristics of prochlorophyceae, Evolutionary significance of Prochloron.

Unit- III

(i) **Algae:-** General characteristics; Ecology and distribution; range of thallus organization; Origin & evolution of sex in algae, Cell structure and components; cell wall, pigment system, reserve food(of only groups represented in the syllabus), flagella and methods of reproduction, classification; criteria, system of Fritsch, and evolutionary classification of Lee (only upto groups); Role of algae in the environment, agriculture, biotechnology and industry.

(ii) **Chlorophyta:-** General characteristics, occurrence, range of thallus organization, cell structure and reproduction. Morphology and life-cycles of *Chlamydomonas, Volvox, Oedogonium* and *Coleochaete* & *Ulothrix.*

Unit- IV

(i) **Charophyta:-** General characteristics; occurrence, morphology, cell structure and life- cycle of *Chara*; evolutionary significance.

(ii) **Xanthophyta:-** General characteristics; Occurrence, morphology and life- cycle of *Vaucheria.*

(iii) **Phaeophyta:-** Characteristics, occurrence, cell structure and reproduction. Morphology and life-cycles of *Ectocarpus* and *Fucus.*

(iv) **Rhodophyta:-**General characteristics, occurrence, cell structure and reproduction. Morphology and life- cycle of *Polysiphonia.*

Course outcome:

CO-1 Understand the basics of the microbial world, focusing on nutrition, growth, and metabolism.

CO-2 Study the characteristics, classification, and economic roles of viruses in medicine and agriculture

CO-3 Learn about bacterial diversity, structure, reproduction, and their industrial and agricultural applications.

CO-4 Explore cyanobacteria and other algal groups, emphasizing their ecological roles and biotechnological uses.

CO-5 Investigate the characteristics and life cycles of various algae, including their evolutionary significance.

PRACTICAL

Credit:**02** **25**Marks

Microbiology

(i) Electron micrographs/Models of viruses – T-Phage and TMV, Line drawings/ Photographs of Lytic and Lysogenic Cycle.

(ii) Types of Bacteria to be observed from temporary/ permanent slides/ photographs.

(iii) Examination of bacteria by Gram's Staining method.

(iv) Electron micrographs of bacteria, binary fission, endospore, conjugation, root nodule (live materials and photographs).

Phycology

Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas* (electron micrographs), *Volvox, Oedogonium, Coleochaete, Ulothrix, Chara, Vaucheria, Ectocarpus, Fucus* and *Polysiphonia, Prochloron,* Diatoms through, temporary preparations and permanent slides.

Couse outcomes:

CO-1 Interpret electron micrographs and models of viruses such as T-Phage and TMV, understanding their structure and life cycles.

CO-2 Observe and identify various types of bacteria using different visualization methods including temporary and permanent slides or photographs.

CO-3 Apply Gram's Staining method to examine bacterial cultures, gaining insights into their structural details.

CO-4 Analyze bacterial reproductive and survival mechanisms through electron micrographs and observe structures like binary fission, endospores, conjugation, and root nodules.

CO-5 Study and analyze the vegetative and reproductive structures of a diverse range of algae including *Nostoc, Chlamydomonas, Volvox, Oedogonium,* and others, using temporary preparations and permanent slides to understand their biological functions and ecological roles.

Text Books:

1. Singh, V. Pandey, P.C. and Jain, D.K.(2017). Microbiology and Phycology, Rastogi Publication, Meerut.

Reference Books:

1. Lee, R.E. (2008). Phycology, Cambridge University Press, Cambridge. 4th edition.
2. Prescott, L.M. Harley, J.P. Klein, D.A. (2010). Microbiology, Mc Graw-Hill, India. 8th edition.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East- West Press, Delhi.
4. Campbell, N.A. Reece, J.B. Urry, L.A. Cain, M.L. Wasserman, S.A. Minorsky, P.V. Jackson R.B. (2008). Biology, Pearson Benjamin Cummings, USA. 8th edition.
5. Pelczar,M.J. Chan, E.C.S. Krieg, N.R. (2011) Microbiology, 8th edition, Tata Mc Graw- Hill Co, New Delhi.
6. Willey, Sherwood and Christopher. Laboratory exercises in Microbiology. McGraw-Hill, India. 9th edition.
7. Vasistha B.R. (2017) Botany for Degree student, Algae, S.Chand Publication, NewDelhi.
8. Mishra B.K. (2018) Microbiology and Phycology, Kalyani Publishers, New Delhi.

+3 FIRST YEAR FIRST SEMESTER

Core Paper-2

BIOMOLECULES AND CELL BIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit- I

(i) Biomolecules and Bioenergenetics: Types and significance of chemical bonds; Structure and properties of water; pH and buffers. Laws of thermodynamics, concept off renergy, endergonic and exergonic reactions, coupled reactions, redox reactions.

(ii) Enzymes: Structure of enzyme: holoenzyme, apoenzyme, cofactors, coenzymes and prosthetic group; Classification of enzymes; Features of active site, substrate specificity, properties of enzymes, mechanism of action (activation energy, lock and key hypothesis, induced- fit theory), Michaelis - Menten equation, enzyme inhibition and factors affecting enzyme activity.

(iii) Carbohydrates: Nomenclature, classification, structure and function of Monosaccharides, Oligosaccharides and polysaccharides.

Unit - II

(i) Lipids: Definition and major classes of storage and structural lipids. Fatty acids structure and functions. Essential fatty acids. Triacyl glycerols structure, functions and properties.

(ii) Proteins: Structure and classification of aminoacids; Peptide bonds; Levels of protein structure-primary, secondary, tertiary and quarternary; Iso electric point; Protein denaturation and biological roles of proteins.

(iii) Nucleic acids: Structure of nitrogenous bases; Structure and function of nucleotides; Types of nucleic acids; Structure of A, B, Z types of DNA; Types of RNA; Structure of tRNA.

Unit - III

(i) The cell: Cell as a unit of structure and function; Characteristics of prokaryotic and eukaryotic cells; Origin of eukaryotic cell (Endo symbiotic theory).

(ii) Cell wall and plasma membrane: Chemistry, structure and function of Plant Cell Wall. Overview of membrane function; fluid mosaic model; Chemical composition of membranes; Membrane transport-Passive, active and facilitated transport, endocytosis and exocytosis.

(iii) Cell organelles: Nucleus; Structure- nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus, structure of chromosome.

Unit - IV

(i) Cell organelles: Chloroplast, mitochondria and peroxisomes: Structural organization; Function; Semi autonomous nature of mitochondria and chloroplast. Endoplasmic Reticulum, Golgi Apparatus, Lysosomes.

(ii) Cytoskeleton: Role and structure of micro tubules, micro filaments and intermediary filament.

(iii) Cell division: Eukaryotic cell cycle, different stages of mitosis and meiosis. Cell cycle, Regulation of cell cycle.

Couse outcomes:

CO-1 Understand the types and significance of chemical bonds, properties of water, pH, buffers, and basic thermodynamics relevant to biological systems.

CO-2 Analyze enzyme structure, function, and kinetics, including the mechanisms of enzyme action and factors affecting enzyme activity.

CO-3 Describe the structure, classification, and function of major biomolecules such as carbohydrates, lipids, proteins, and nucleic acids.

CO-4 Examine the structure and function of cell components, including the cell wall, plasma membrane, and various cell organelles like the nucleus, mitochondria, and chloroplasts.

CO-5 Explore the principles of cell structure and function, with emphasis on the eukaryotic cell cycle, mechanisms of cell division, and cellular transport processes.

PRACTICAL

Credit:**02** **25**Marks

(i) Qualitative tests for carbohydrates, reducing sugars, non-reducing sugars, lipids and proteins.

(ii) Study of plant cell structure with the help of epidermal peel mount of Onion/ *Rhoeo*

(iii) Demonstration of the phenomenon of protoplasmic streaming in *Hydrilla* leaf.

(iv) Counting the cells per unit volume with the help of haemocyto meter. (Yeast/pollengrains).

(v) Study of the phenomenon of plasmolysis and deplasmolysis.

(vi) Study of different stages of mitosis and meiosis using acetocarmine and acetoorcine method from Onion root tip and bud respectively

Course outcomes:

CO-1 Perform qualitative tests for carbohydrates, lipids, and proteins.

CO-2 Microscopically examine plant cell structures and protoplasmic streaming.

CO-3 Use a haemocytometer for accurate cell counting.

CO-4 Study the effects of osmosis through plasmolysis and deplasmolysis experiments.

CO-5 Analyze cell division stages using staining techniques on onion samples.

Text Books:

1. Rastogi, V.B.(2016). Introductory Cytology, Kedar Nath & Ram Nath, Meerut
2. Gupta, P.K.(2017). Biomolecules and Cell Biology, Rastogi Publication, Meerut.

Reference Books:

1. Sahoo, K.(2017) Biomolecules and Cell Biology, Kalyani Publishers, NewDelhi.
2. Tymoczko, J.L., Berg, J.M. and Stryer, L.(2012) Biochemistry: Ashortcourse, 2 nd ed. W.H.Freeman
3. Nelson, D.L. and Cox, M.M. (2008) Lehninger Principles of Biochemistry, 5th Edition. W.H. Freeman and Company.
4. Cooper, G.M. and Hausman, R.E. 2009 The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C. Sinauer Associates, MA.
5. Becker, W.M. Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7thedition. Pearson Benjamin Cummings Publishing, San Francisco

+3 FIRST YEAR SECOND SEMESTER

Core Paper-3
MYCOLOGY AND PHYTOPATHOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit-I

(i) Introduction to fungi: Definition, General characteristics; Affinities with plants and animals; Thallus organization; Cell wall composition; Nutrition; Classification.

(ii) Zygomycota: General characteristics; Ecology; Thallus organisation; Life cycle with reference to *Rhizopus.*

(iii) Ascomycota: General characteristics (asexual and sexual fruiting bodies); Ecology; Life cycle, Hetero karyosis and parasexuality; life cycle and classification with reference to *Saccharomyces, Aspergillus, Penicillium,* and *Neurospora.*

(iv) Basidiomycota: General characteristics; Ecology and Classification; Life cycle of *Puccinia* and *Agaricus.*

Unit-II

(i) Allied Fungi: General characteristics; Status of Slimemolds, Classification; Occurrence; Types of plasmodia; Types of fruiting bodies.

(ii) Oomycota: General characteristic; Ecology; Life cycle and classification with reference to *Phytophthora* and *Albugo.*

(iii) Symbiotic associations: Lichen- Occurrence; General characteristics; Growth forms and range of thallus organization; Nature of associations of algal and fungal partners; Reproduction. Mycorrhiza- Ectomycorrhiza, Endomycorrhiza and their significance. Economic importance of Lichens.

Unit- III

Applied Mycology: Role of fungi in biotechnology, Mushroom cultivation, Application of fungi in food industry (Flavour & texture, Fermentation, Baking, Organic acids, Enzymes, Mycoproteins); Secondary metabolites (Pharmaceutical preparations); Agri/culture (Bio-fertilizers); Mycotoxins; Biological control (Mycofungicides, Mycoherbicides, Mycoinsecticides, Myconematicides); Medical mycology.

Unit- IV

Phytopathology: Terms and concepts; General symptoms; Geographical distribution of diseases; etiology; symptomology; Host- Pathogen relationships; disease cycle and environmental relation; prevention and control of plant diseases, and role of quarantine. Bacterial diseases- Citrus canker and angular /leaf spot disease of Cotton. Viral diseases- Tobacco Mosaic disease, vein clearing disease. Fungal diseases - Early blight of potato, Loose and covered smut.

Course outcomes:

CO-1 Understand the definition, general characteristics, and classification of true fungi, along with their ecological roles and nutritional strategies.

CO-2 Explore the life cycles and ecological relationships of key fungal groups, including Zygomycota, Ascomycota, Basidiomycota, and Oomycota.

CO-3 Examine symbiotic associations in fungi, focusing on lichens and mycorrhizae, and their economic importance.

CO-4 Analyze the role of fungi in biotechnology, food industry, agriculture, and pharmaceuticals, including applications in mushroom cultivation and biological control.

CO-5 Study the fundamentals of phytopathology, including disease cycles, host-pathogen relationships, and management strategies for bacterial, viral, and fungal plant diseases.

PRACTICAL

Credit:**02** **25** Marks

(i) Introduction to the world of fungi (Unicellular, coenocytic/ septate mycelium, ascocarps & basidiocarps). Permanent slides / photographs.

(ii) Rhizopus: study of a sexual stage from temporary mounts and sexual structures through permanent slides.

(iii) *Aspergillus, Penicillium* and *Saccharomyces*: study of asexual stage from temporary mounts. Study of Sexual stage from permanent slides/photographs.

(iv) *Puccinia*: Study of different stages from temporary mounts and permanent slides.

(v) *Agaricus*: Specimens of button stage and full grown mushroom; sectioning of gills of Agaricus, and fairy rings are to be shown.

(vi) *Albugo*: Study of symptoms of plants in fected with Albugo; a sexual phases tudy through section/ temporary mounts and sexual structures through permanent slides.

(vii) Phytopathology: Herbarium specimens of bacterial diseases; Citrus Canker; Viral diseases: Mosaic disease of ladies finger, papaya, cucurbits, moong, black gram, Fungal diseases: Blast ofrice, Tikka disease of ground nut, powdery mildew of locally available plants and White rust of crucifers.

Course outcomes:

CO-1 Identify fungal structures including mycelium, ascocarps, and basidiocarps.

CO-2 Examine the asexual and sexual stages of *Rhizopus, Aspergillus, Penicillium,* and Saccharomyces.

CO-3 Study life cycle features of *Puccinia* and *Agaricus*, including detailed mushroom anatomy.

CO-4 Analyze symptoms and reproductive phases of *Albugo* on infected plants.

CO-5 Document and diagnose plant diseases caused by bacterial, viral, and fungal pathogens.

Text Books:

1. Mishra, B.K. (2017), Mycology and Phytopathology, Kalynai Publishers, New Delhi.

Reference Books:

1. Sharma, P.D. (2017). Mycology and Phytopathology Rastogi Publication, Meerut.
2. Agrios, G.N. (1997) Plant Pathology, 4th edition, Academic Press, U.K.
3. Alexopoulos, C.J. Mims, C.W. Blackwell, M.(1996). Introductory Mycology, John Wiley & Sons (Asia) Singapore. 4th edition.
4. Webster, J. and Weber, R.(2007). Introduction to Fungi, Cambridge University Press, Cambridge. 3rd edition.
5. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi and Their Allies, Macmillan Publishers India Ltd.
6. Mehrotra, R. S.(2011). Plant Pathology. Tata Mc Graw-Hill Publishing Company Limited, New Delhi

+3 FIRST YEAR SECOND SEMESTER

Core Paper-4
ARCHEGONIATAE

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Introduction: Unifying features of archegoniates; Transition to land habit; Alternation of generations. General characteristics; Origin of land plants and Adaptations to land habit;

(ii) Bryophytes: Origin and Classification; Range of thallus organization. Structure, Reproduction and evolutionary trends in *Riccia, Marchantia, Anthoceros* and *Funaria* (developmental stages not included). Progressive sterilization of sporogenous tissue in bryophytes, Ecological and economic importance of bryophytes.

Unit - II

Pteridophytes: General characteristics, classification. Classification (up to family), morphology, anatomy and reproduction of *Psilotum, Selaginella, Equisetum, Pteris* and *Marsilea*. Apogamy, and apospory, heterospory and seed habit, telome theory, stelar evolution and economic importance.

Unit - III

Gymnosperms: General characteristics, classification (upto family), morphology, anatomy and reproduction of *Cycas, Pinus, Ginkgo* and *Gnetum*. (Developmental details not to be included). Ecological and economic importance.

Unit - IV

Palaeobotany: Geological time scale, fossils and fossilization process. Morphology, anatomy and affinities of *Rhynia, Calamites, Lepidodendron, Lyginopteris, Cycadeoidea* and *Williamsonnia*.

Course Outcomes:

CO-1 Understand key features of archegoniates and their adaptations to terrestrial life.

CO-2 Study the classification, structure, and reproduction of Bryophytes and their ecological roles.

CO-3 Examine Pteridophytes' morphology, anatomy, and reproductive traits, including evolutionary aspects.

CO-4 Analyze Gymnosperms for their characteristics, reproduction, and economic importance.

CO-5 Explore fossil records and affinities of ancient plants in Palaeobotany.

PRACTICAL

Credit:**02** **25** Marks

(i) Morphology ,anatomy and reproductive structures of *Riccia, Marchantia, Anthoceros, Funaria.* (Temporary mounts)

(ii) Psilotum-Study of specimen, transverse section of synangium (permanent slide).

(iii) Selaginella- Morphology, whole mount of leaf with ligule, transverse section of stem, whole mount of strobilus, whole mount of microsporophyll and megasporophyll (temporary slides), longitudinal section of strobilus (permanent slide).

(iv) Equisetum- Morphology, transverse section of internode, longitudinal section of strobilus, transverse section of strobilus, whole mount of sporangiophore, whole mount of spores (wet and dry) (temporary slide), transverse section of rhizome (permanent slide).

(v) Study of temporary preparations and permanent slides of *Marsilea*.

(vi) *Pteris*- Morphology, transverse section of rachis, vertical section of sporophyll, whole mount of sporangium, whole mount of spores (temporary slides), transverse section of rhizome, whole mount of prothallus with sex organs and young sporophyte (permanent slide).

(vii) *Cycas*- Morphology (coralloid roots, bulbil, leaf), whole mount of microsporophyll and megaspore, T.S of root, leaflet, rachis

(viii) *Pinus*- Morphology (long and dwarf shoots, whole mount of dwarf shoot, male and female cones),T.S. of Needle, stem, L.S. male cone, whole mount of microsporophyll, whole mount of Microspores (temporary slides), L.S.of female cone.

(ix) *Gnetum*- Morphology (stem, male & female cones), transverse section of stem, vertical section of ovule (permanent slide).

(x) Study of some fossil slides/ photographs as per theory.

Course Outcomes:

CO-1 Examine the morphology, anatomy, and reproductive structures of Bryophytes such as *Riccia, Marchantia, Anthoceros,* and *Funaria.*

CO-2 Analyze structural details of Pteridophytes including *Psilotum, Selaginella*, *Equisetum*, *Marsilea*, and *Pteris* through various mounts and sections.

CO-3 Study the external and internal features of Gymnosperms like *Cycas* and *Pinus,* focusing on their reproductive and vegetative parts.

CO-4 Observe *Gnetum's* morphology and reproductive structures through detailed anatomical sections.

CO-5 Examine fossils and related materials to connect practical observations with theoretical knowledge of ancient plants.

Text Books:

1. Vasistha, B.R.(2017) Botany for Degree student, Bryophyta, S. Chand Publication, New Delhi.

2. Singh, V. Pandey, P.C. and Jain, D.K.(2017). Archegoniate, Rastogi Publication, Meerut.

Reference Books:

1. Acharya, B.S.(2017), Archegoniate, Kalyani Publishers, New Delhi.
2. Vashistha, P.C. Sinha, A.K. Kumar, A.(2010). Pteridophyta. S. Chand. New Delhi, India.
3. Bhatnagar, S.P. & Moitra, A.(1996). Gymnosperms. New Age International (P) Ltd. Publishers, New Delhi, India.
4. Raven, P.H. Johnson, G. B. Losos, J.B. Singer, S. R.(2005). Biology. Tata Mc Graw Hill, Delhi.

+3 SECOND YEAR THIRD SEMESTER

Core Paper-5

ANATOMY OF ANGIOSPERMS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Introduction and scope of Plant Anatomy: Applications in systematics, forensics and pharmacognosy.

(ii) Tissues: Classification of tissues; Simple and complex tissues (no phylogeny); cyto- differentiation of tracheary elements and sieve elements; Pits and plasmodesmata; Cell wall ingrowths and transfer cells, adcrustation and incrustation, Ergastic substances.

Unit - II

(i) Stem: Organization of shoot apex (Apical cell theory, Histogen theory, Tunica Corpus theory, continuing meristematic residue, cyto-histological zonation); Types of vascular bundles; Anatomy of dicot and monocot stem. Vascular Cambium: Structure, function and seasonal activity of cambium; secondary growth in stem (normal and anomalous). Root Stem transition.

(ii) Leaf: Anatomy of dicot and monocot leaf, Kranzanatomy.

Unit - III

(i) Root: Organization of root apex (Apical cell theory, Histogen theory, Korper-Kappe theory); Quiescent centre; Rootcap; Anatomy of dicot and monocot root; Endodermis, exodermis and origin of lateral root. Secondary growth in roots.

(ii) Wood: Axially and radially oriented elements; Types of rays and axial parenchyma; Cyclic aspects and reaction wood; Sapwood and heartwood; Ring and diffuse porous wood; Early and late wood, tyloses; Dendrochronology.

(iii) Periderm: Development and composition of periderm, rhytidome and lenticels.

Unit - IV

(i) Adaptive and Protective Systems Epidermal tissue system, cuticle, epicuticular waxes, trichomes (uni- and multi cellular, glandular and nonglandular: two examples of each), stomata (classification); Anatomical adaptations of xerophytes and hydrophytes.

(ii) SecretorySystem: Hydathodes, cavities, lithocysts and laticifers.

(iii) Mechanical tissue system: Origin, nature, types, principle governing distribution of mechanical tissue system.

Course Outcomes:

CO-1 Explore the scope of plant anatomy and its applications in systematics, forensics, and pharmacognosy.

CO-2 Understand the classification and cyto-differentiation of plant tissues, including the detailed study of tracheary and sieve elements.

CO-3 Examine the anatomical features of dicot and monocot stems and leaves, including their vascular systems and secondary growth processes.

CO-4 Analyse the root structures of dicots and monocots, focusing on root apex organization, secondary growth, and wood formation.

CO-5 Investigate the adaptive, protective, and secretory systems in plants, including epidermal structures, secretory tissues, and mechanical support systems.

PRACTICAL

Credit:**02** **25** Marks

1. Study of distribution and types of parenchyma, collenchyma and sclerenchyma, Xylem: Tracheary elements- tracheids, vessel elements; thickenings; perforation plates; xylem fibres, Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
2. Wood: ring porous; diffuse porous; tyloses; heart- and sapwood.
3. Epidermal system: cell types, stomata types; trichomes: non- glandular and glandular.
4. Root: monocot, dicot, secondary growth.

5. Stem: monocot, dicot- primary and secondary growth (normal and anomalous); periderm; lenticels.
6. Leaf: isobilateral, dorsiventral, C_4 leaves (Kranz anatomy).
7. Ecological anatomy.

Course outcomes:

CO-1 Investigate the distribution and types of ground tissues: parenchyma, collenchyma, and sclerenchyma.

CO-2 Examine the structure and function of xylem and phloem, including tracheary and vessel elements, and companion cells.

CO-3 Analyze the characteristics of wood, including types of porous wood, and the distinctions between heartwood and sapwood.

CO-4 Study the epidermal system of plants, focusing on cell types, stomata, and trichomes.

CO-5 Observe anatomical features and growth patterns in roots, stems, and leaves, including adaptations in different plant types.

Text Books:

1. Singh, V. Pandey, P.C. and Jain, D.K.(2017). Anatomy of Angiosperms, Rastogi Publication, Meerut.

Reference Books:

1. Eames, A.J. and Mc Daniels, L.H. (1953). An introduction to plant anatomy, Tata Mc Grow Hills, New Delhi
2. Esau, K.(1977). Anatomy of Seed Plants. John Wiley & Sons, Inc. Delhi.
3. Tayal, M.S. (2012) Plant Anatomy Rajpal and Sons, New Delhi
4. Mishra, B.K. (2017). Anatomy of Angiosperms, Kalyani Publishers, New Delhi.
5. Pandey, B.P. (2017) Plant Anatomy, S. Chand Publication, New Delhi.

+3 SECOND YEAR THIRD SEMESTER

Core Paper-6

ECONOMIC BOTANY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Origin of Cultivated Plants: Concept of Centres of Origin, their importance with reference to Vavilov's work. Examples of major plant in troductions; Crop domestication and loss of genetic diversity; evolution of new crops/ varieties, importance of germplasm diversity.

(ii) Cereals: Cultivation and brief account of Wheat, Rice and millets.

(iii) Legumes: General account, importance to man and ecosystem.

(iv) Sugars & Starches: Morphology, cultivation and processing of sugarcane, products and by-products of sugarcane industry. Potato – morphology, cultivation, propagation & uses.

Unit-II

(i) Spices: Listing of important spices, their family and part used, economic importance with special reference to fennel, saffron, clove and black pepper Beverages: Tea, Coffee (morphology, processing & uses)

(ii) Drug- yielding plants: Therapeutic and habit- forming drugs with special reference to *Cinchona, Digitalis, Papaver* and *Cannabis.*

(iii) Tobacco: Tobacco (Morphology, processing, uses and health hazards)

Unit - III

(i) Oils & Fats: General description, classification, extraction, their uses and health implications groundnut, coconut, linseed and Brassica (Botanical name, family & uses)

(ii) Essential Oils: General account, extraction methods, comparison with fatty oils & their uses.

Unit - IV

(i) Natural Rubber: Para- rubber: tapping, processing and uses.

(ii) Timber plants: General account with special reference to teak and pine. Fibers: Classification based on the origin of fibers, Cotton and Jute (morphology, extraction and uses).

Course Outcomes:

CO-1 Understand the concept of the origin of cultivated plants, including Vavilov's work on centres of origin, crop domestication, and the importance of germplasm diversity.

CO-2 Explore the cultivation, uses, and economic significance of major groups like cereals, legumes, sugars, starches, and their industrial by-products.

CO-3 Study the economic importance of spices and beverages, detailing specific examples such as fennel, saffron, clove, black pepper, tea, and coffee.

CO-4 Examine the role and processing of drug-yielding plants, tobacco, and their impacts on health and society.

CO-5 Analyze the production and uses of natural products such as oils, fats, essential oils, natural rubber, timber, and fibers, focusing on their extraction methods and commercial applications.

PRACTICAL

Credit:**02** **25**Marks

(i) Cereals: Rice (habit sketch, study of paddy and grain, starch grains).

(ii) Legumes: Soyabean/ moongbean/ blackgram, Groundnut, (habit, fruit, seed structure, micro-chemical tests).

(iii) Sugars & Starches: Sugarcane (habit sketch; cane juice- micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, starch grains, micro-chemical tests).

(iv) Spice and Beverages: clove, black pepper ,Tea (plant specimen, tea leaves), Coffee (plant specimen, beans).

(v) Oils & Fats: Groundnut, Mustard- plant specimen, seeds; tests for fats in crushed seeds.

(vi) Drug- yielding plants: Specimens of *Digitalis, Papaver* and *Cannabis.*

(vii) Woods: *Tectona, Pinus*/ Sal: Specimen, Section of youngstem.

(viii) Fiber- yielding plants: Cotton (specimen, whole mount of seed to show lint and fuzz; whole mount of fiber and test force llulose), Jute (specimen, transverse section of stem, test for lignin on transverse section of stem and fiber).

(ix) Preparation of charts with economically important plants included in the syllabus.

Course Outcomes:

CO-1 Analyse the structural and starch components of cereals such as rice, focusing on paddy and grain morphology.

CO-2 Examine the habit, fruit, seed structure, and conduct microchemical tests on legumes including soybean, moong bean, black gram, and groundnut.

CO-3 Study the morphology and starch localization in sugarcane and potatoes, and perform microchemical tests on cane juice and potato tubers.

CO-4 Observe and identify plant specimens and processed products of spices and beverages like clove, black pepper, tea, and coffee.

CO-5 Investigate oil and fat content in seeds of groundnut and mustard through extraction tests, and analyse plant structures of drug-yielding and fibre-yielding plants including *Digitalis, Papaver, Cannabis*, cotton, and jute.

Text Books:

1. Pandey, B.P. (2017) Economic Botany. S. Chand Publication, New Delhi.

Reference Books:

1. Kochhar, S.L.(2012). Economic Botany in Tropics, Mac Millan & Co. New Delhi, India.
2. Samba Murty, A.V.S.S. and Subrahmanyam, N.S. (2011). Text Book of Modern Economic Botany, CBS Publishers and Distributors, New Delhi.
3. Hill, Albert F. Economic Botany, Tata Mc Grow Hill Publishing Company, Ltd. New Delhi.
4. Wickens, G.E.(2001). Economic Botany: Principles & Practices. Kluwer Academic Publishers, The Netherlands.
5. Singh,V. Pandey, P.C. and Jain, D.K.(2017). Economic Botany, Rastogi Publication, Meerut.
6. Baruah, B.(2017). Economic Botany, Kalyani Publishers, New Delhi.

+3 SECOND YEAR THIRD SEMESTER

Core Paper-7

GENETICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit-I

(i) Mendelian genetics and its extension: Mendelism; History; Principles of inheritance; Chromosome theory of inheritance; Structure of sex chromosomes; Incomplete dominance and codominance; Multiple alleles, Lethal alleles, Interaction of genes, Pleiotropy, Recessive and Dominant traits, Polygenic inheritance.

(ii) Extra chromosomal Inheritance: Chloroplast mutation: Variegation in Four o'clock plant; Mitochondrial mutations in yeast; cytoplasmic male sterility; Maternal effects-shell coiling in snail; Infective heredity- Kappa particles in Paramecium.

Unit-II

Linkage, crossing over and chromosome mapping: Linkage and crossing over- Cytological basis of crossing over; Recombination frequency, two factor and three factor crosses; Interference and coincidence; Numericals based on gene mapping; Sex Linkage & sex determination in plants.

Unit-III

(i) Variation in chromosome number and structure: Deletion, Duplication, Inversion, Translocation, Position effect, Euploidy and Aneuploidy

(ii) Gene mutations: Types of mutations; Molecular basis of Mutations; Mutagens – physical and chemical (Base analogs, deaminating, alkylating and intercalating agents); Detection of mutations: CIB method. Role of Transposons in mutation. DNA repair mechanisms.

Unit-IV

(i) Fine structure of gene: Classical vs. molecular concepts of gene; Cis-Trans complementation test for functional allelism; Structure of Phage T4, rII Locus.

(ii) Population and Evolutionary Genetics: Gene pool,Allele frequencies, Genotype frequencies, Hardy-Weinberg Law, role of natural selection, mutation, genetic drift. Genetic variation and Speciation.

Course Outcomes:

CO-1 Understand Mendelian genetics, including the principles of inheritance, chromosome theory, and extensions such as incomplete dominance, codominance, and polygenic inheritance.

CO-2 Explore extrachromosomal inheritance, focusing on mitochondrial and chloroplast mutations, and other phenomena like maternal effects and infective heredity.

CO-3 Analyze the concepts of linkage, crossing over, and chromosome mapping, including the calculation of recombination frequencies and the use of numerical problems for gene mapping.

CO-4 Examine variations in chromosome number and structure, understand different types of gene mutations, their molecular basis, and the role of DNA repair mechanisms.

CO-5 Study the molecular concepts of gene structure, population genetics, and evolutionary genetics, including Hardy-Weinberg equilibrium and factors affecting genetic variation and speciation.

PRACTICAL

Credit:**02** **25**Marks

1. Analysis of allelic and geno typic frequencies.
2. Mendel's laws through seed ratios. Laboratory exercises in probability and chi- square analysis.
3. Chromosome mapping using test cross data.
4. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
5. Incompleted ominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).

6. Blood Typing: AB O groups & Rh factor.
7. Chromosome anomaly: Translocation Ring, Laggards and Inversion Bridge, break, Aneuploidy in human etc. (through photographs).

Course Outcomes:

CO-1 Analyze allelic and genotypic frequencies to understand population genetics.

CO-2 Apply Mendel's laws and use statistical methods such as chi-square to analyze seed ratios.

CO-3 Construct chromosome maps from test cross data to study genetic linkage and recombination.

CO-4 Perform pedigree analysis and blood typing to explore genetic inheritance and blood group determination.

CO-5 Examine specific chromosome anomalies using photographic evidence to identify structural changes.

Text Books:

1. Singh B.D. (2017). Fundamental of Genetics, Kalyani Publishers, New Delhi.
2. Gupta P.K. (2017). Genetics, Rastogi Publication, Meerut.

Reference Books:

1. Gardner, E.J. Simmons, M.J. Snustad, D.P. (1991). Principles of Genetics,John Wiley & Sons, India. 8th edition.
2. Sinnot, E.W. Dunn, L.C. and Dobzhansky, T.(1985) Principles of Genetics, Tata Mc Grow Hill, New Delhi
3. Klug, W.S. Cummings, M.R. Spencer, C.A.(2012). Concepts of Genetics. Benjamin Cummings, U.S.A. 10th edition.
4. Griffiths, A.J.F. Wessler, S.R. Carroll, S.B. Doebley, J.(2010). Introduction to Genetic Analysis. W.H.F reeman and Co. U.S.A. 10th edition.
5. Strick berger, M.W.Genetics, Pearson Publishers, 3rd Edition
6. Rastogi V.B. (2017). Genetics, Kedar Nath & Ram Nath, Meerut

+3 SECOND YEAR FOURTH SEMESTER

Core Paper- 8

MOLECULAR BIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

Nucleic acids: Carriers of genetic information: Historical perspective; DNA as the carrier of genetic information (Griffith's, Hershey & Chase, Avery, Mc Leod & Mc Carty), Types of genetic material, denaturation and renaturation, Cot curves. Organization of DNA and structure of RNA- Prokaryotes, Viruses, Eukaryotes, Fraenkel- Conrat'sex periment. Organelle DNA- mitochondria and chloro plast DNA. The Nucleo some- Chromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultative heterochromatin.

Unit - II

(i) The replication of DNA: Chemistry of DNA synthesis (Kornberg's discovery); General principles - bidirectional, semi-conservative and semi discontinuous replication, RNA priming; Various models of DNA replication, including rolling circle, θ (theta) mode of replication, replication of linear ds-DNA, replication of the 5' end of linear chromosome; Enzymes involved in DNA replication.

(ii) Central dogma and genetic code: Key experiments establishing- The Central Dogma (Adaptor hypothesis and discovery of mRNA template), Genetic code (deciphering & salient features)

(iii) Processing and modification of RNA: Split genes-concept of introns and exons, removal of introns, spliceosome machinery, splicing path ways, group I & group II intronsplicing, alternative splicing eukaryoticm RNA processing (5'cap,3'poly A tail); Ribozymes, exon shuffling; RNA editing and mRNA transport.

Unit - III

Mechanism of Transcription: Transcription in prokaryotesand eukaryotes; Regulation of transcription in prokaryotes and eukaryotes: Principles of transcriptional regulation; Prokaryotes: Operon concept- Regulation of lactose metabolism and tryptophan synthesis in *E.coli.* Eukaryotes: transcription factors, heat shock proteins, steroids and peptide hormones; Gene silencing

Unit - IV

Translation (Prokaryotes and eukaryotes): Ribosome structure and assembly; Charging of tRNA, aminoacylt RNA synthetases; Various steps in protein synthesis, proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Post- translational modifications of proteins.

Course Ooutcomes:

CO-1 Understand the historical development of molecular biology, including key experiments that established DNA as the carrier of genetic information.

CO-2 Explore the structure and function of nucleic acids in different organisms, and understand the organization of chromatin in eukaryotes.

CO-3 Examine the mechanisms of DNA replication, including the roles of enzymes and different replication models, and understand the central dogma of molecular biology.

CO-4 Analyze the processes and regulatory mechanisms of transcription in both prokaryotes and eukaryotes, including operon models and transcription factors.

CO-5 Study the translation process, ribosome structure, and the role of tRNA in protein synthesis, including post-translational modifications and the impact of translation inhibitors.

PRACTICAL

Credit:**02** **25**Marks

1. Preparation of LB medium and raising *E.coli.*
2. Isolation of genomic DNA from suitable plant material.
3. RNA estimation by orcinol method.
4. DNA estimation by diphenylamine reagent/UV Spectrophotometry.

5. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Avery et al, Griffith's, Hershey & Chase's and Fraenkel & Conrat's experiments), models of DNA replication (rolling circle, θ mode of replication, linear replication)

6. Study of Barr body from buccal smear preparation.

Course outcomes:

CO-1 Prepare LB medium and cultivate E. coli to understand bacterial growth conditions.

CO-2 Isolate genomic DNA from plant materials to study its properties and applications.

CO-3 Estimate RNA concentration using the orcinol method to analyse RNA integrity and quantity.

CO-4 Measure DNA concentration using diphenylamine reagent or UV spectrophotometry for quantification and purity assessment.

CO-5 Examine photographic evidence from key experiments that established nucleic acids as genetic material, enhancing understanding of historical molecular biology break throughs.

Text Books:

1. Gupta P.K.(2017). Molecular Biology, Rastogi Publication, Meerut.

Reference Books:

1. Watson, J.D. Baker, T.A. Bell, S.P. Gann, A. Levine, M. Losick, R.(2007). Molecular Biology of the Gene, Pearson Benjamin Cummings, CSHL Press, New York, U.S.A. 6th edition.

2. Snustad, D.P. and Simmons, M.J.(2010). Principles of Genetics. John Wiley and SonsInc. U.S.A. 5th edition.

3. Klug, W.S. Cummings, M.R. Spencer, C.A.(2009). Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.

4. Sheeler, P. and Bianchi, D.E. (2009) Molecular Biology of the Cell, Willey Publisher, New Delhi

5. Griffiths, A.J.F. Wessler, S.R. Carroll, S.B. Doebley, J.(2010). Introduction to Genetic Analysis. W.H.F reeman and Co. U.S.A.10th edition.

6. Alberts, B.etal. (2014). Molecular Biology of the cell Garl and Science. 6th Edition

7. Power, C.B.(2017) Cell Biology, Himalaya Publishing House, New Delhi

8. Sahu, A.C.(2017). Essentials of Molecular Biology, Kalynai Publishers, New Delhi.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper-9
PLANT ECOLOGY & PHYTOGEOGRAPHY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Introduction Concept of ecology, Autecology, Synecology, system ecology, Levels of organization. Inter- relationships between the living world and the environment, the components of environment, concept of hydrosphere and lithosphere and dynamism, homeostasis.

(ii) Light, temperature, wind and fire: Variations; adaptations of plants to their variation.

Unit - II

(i) Soil: Formation; Composition; Physical; Chemical and Biological components; Soil profile; Role of climate in soil development.

(ii) Water: Importance: States of water in the environment; Atmospheric moisture; Precipitation types (rain, fog, snow, hail, dew); Hydrological Cycle; Water in soil; Water table.

Unit - III

Biotic interactions and Population ecology: Characteristics and Dynamics. Plant communities: Concept of ecological amplitude; Habitat and niche; Characters: analytical and synthetic; Ecotone and edge effect; Dynamics: succession - processes, types; climax concepts.(Lithosere, xerosere & Hydrosere).

Unit - IV

(i) Eco systems: Structure; Processes; Trophic organisation; Food chains and Food webs; Ecological pyramids.

(ii) Functional aspects of ecosystem: Principles and models of energy flow; Production and productivity; Ecological efficiencies; Biogeochemical cycles; Cycling of Carbon, Nitrogen and Phosphorus.

(iii) Phytogeography: Principles; Continental drift; Theory of tolerance; Endemism; Phytogeographical division of India; Vegetation of Odisha.

Course Outcomes:

CO-1 Understand the foundational concepts of ecology, including levels of ecological organization and the dynamic interactions between biotic and abiotic environmental components.

CO-2 Explore plant adaptations to abiotic factors such as light, temperature, wind, and fire, and understand their ecological implications.

CO-3 Examine soil and water dynamics in ecosystems, including soil formation, composition, and the hydrological cycle.

CO-4 Analyse biotic interactions, population dynamics, and the structure and processes of ecosystems, including food webs, ecological pyramids, and succession.

CO-5 Study the principles of phytogeography, including the impacts of continental drift and bio-geographical factors on plant distribution and vegetation patterns.

PRACTICAL

Credit:**02** **25** Marks

1. Determination of pH of various soil and water samples (pHmeter, universal indicator/ Lovibond comparator and pH paper)
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter and based eficiency from two soil samples by rapid field tests.
3. Determination of dissolved oxygen of water samples from polluted and unpolluted sources.
4. Study of morphological adaptations of hydrophytes, xerophytes, halophytes (two each).
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method (species to be listed).
6. Quantitative analysis of herbaceous vegetation for frequency, density and abundance in the college campus.
7. Field visit to familiarize students with ecology of different sites.

Course Outcomes:

CO-1 Determine the pH and analyze soil components using rapid field tests for soil and water samples.

CO-2 Measure dissolved oxygen levels in water samples to assess environmental quality.

CO-3 Study morphological adaptations in specific plant groups like hydrophytes, xerophytes, and halophytes.

CO-4 Conduct quantitative analysis of herbaceous vegetation using methods like species-area curves and measurements of frequency, density, and abundance.

CO-5 Engage in field visits to directly study and analyse different ecological sites and their vegetation.

Text Books:

1. Sharma, P.D.(2017). Fundamentals of Ecology. Rastogi Publications, Meerut, India.

Reference Books:

1. Odum, E.P. (2005). Fundamentals of ecology. Cengage Learning India Pvt. Ltd., New Delhi. 5thedition.
2. Singh, J.S. Singh, S.P. Gupta, S.(2006). Ecology Environment and Resource Conservation. Anamaya Publications, New Delhi, India.
3. Wilkinson, D.M. (2007). Fundamental Processes in Ecology: An Earth Systems Approach. Oxford University Press. U.S.A.
4. Kormondy, E.J. (1996). Concepts of ecology. PHI Learning Pvt.Ltd. Delhi, India. 4th edition.
5. Santra, S.C.(2015) Environmental Science. New Central Book Agency(P) Ltd. Kolkata.
6. Das M.C. and Das S.P.(2009). Fundamental of Ecology. Tata Mc Grow Hill, New Delhi.
7. Shukla and Chandel (2016). A text book of Plant Ecology. S. Chand Publication, New Delhi

+3 SECOND YEAR FOURTH SEMESTER

Core Paper- 10
PLANT SYSTEMATICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

Plant identification, Classification, Nomenclature; Biosystematics. Identification: Field inventory; Functions of Herbarium; Important herbaria and botanical gardens of the world and India; Virtual herbarium; E-flora; Documentation: Flora, Monographs, Journals; Keys: Single access and Multi-access.

Unit - II

Taxonomic hierarchy: Concept of taxa (family, genus, species); Categories and taxonomic hierarchy; Species concept (taxonomic, biological, evolutionary). Botanical nomenclature: Principles and rules (ICN); Ranks and names; Typification, author citation, valid publication, rejection of names, principle of priority and its limitations; Names of hybrids.

Unit - III

(i) Systematics- an inter disciplinary science: Evidence from palynology, cytology, phytochemistry and molecular data.

(ii) Systems of classification: Major contributions of Theophrastus, Bauhin, Tournefort, Linnaeus, Adanson, de Candolle, Bessey, Hutchinson, Takhtajan and Cronquist; Classification systems of Bentham and Hooker (up to series) and Hutchinson (up to series); Brief reference of Angiosperm Phylogeny Group (APG III) classification.

Unit - IV

Phylogeny of Angiosperms: Terms and concepts (primitive and advanced, homology and analogy, parallelism and convergence, monophyly, Paraphyly, polyphyly and clades). Origin & evolution of angiosperms; co- evolution of angiosperms and animals; methods of illustrating evolutionary relationship (phylogenetic tree, cladogram). Families of Angiosperms: Descriptive studies of Magnoliaceae, Rosaceae, Rubiacae, Poaceae, Orchidaceae, Musaceae, Acanthaceae, Apocynaceae, Asclepiadaceae, Lamiaceae, Cyperaceae & Scrophulariaceae.

Course Outcomes:

CO-1 Practise plant identification, classification, and nomenclature, including the use of herbaria and botanical gardens.

CO-2 Understand taxonomic hierarchy and species concepts, and apply principles of botanical nomenclature.

CO-3 Explore systematics using interdisciplinary evidence from palynology, cytology, and molecular data.

CO-4 Study historical and modern classification systems, including significant contributions from key taxonomists.

CO-5 Analyse the phylogeny and evolution of angiosperms, and understand concepts like monophyly and paraphyly.

PRACTICAL

Credit:**02** **25** Marks

(i) Study of vegetative and floral characters of available materials of the families included in theory syllabus (Description, V.S. flower, section of ovary, floral diagrams, floral formula/e and systematic position according to Bentham & Hooker's system of classification).

(ii) Field visit, plant collection and herbarium preparation and submission. Mounting of properly dried and pressed specimen of atleast fifteen plants with herbarium label (to be submitted in the record book).

(iii) Quick spotting as per theory syllabus.

Course Outcomes:

CO-1 Examine vegetative and floral characteristics of plants from key families in the syllabus.

CO-2 Analyse floral structures through vertical sections, diagrams, and formulas.

CO-3 Apply Bentham & Hooker's classification system to categorize plant materials.

CO-4 Conduct field visits for direct plant collection and ecological observation.

CO-5 Prepare and submit a herbarium with at least fifteen properly documented wild plant specimens.

Text Books:

1. Sharma O.P.(2009) Plant Taxonomy, Tata Mc Grow Hill, New Delhi

Reference Books:

1. Singh, G.(2012). Plant Systematics: Theory and Practice. Oxford & IBH Pvt.Ltd. New Delhi. 3rd edition.
2. Jeffrey, C.(1982). An Introduction to Plant Taxonomy. Cambridge University Press, Cambridge.
3. Judd, W.S. Campbell, C.S. Kellogg, E.A. Stevens, P.F. (2002). Plant Systematics- AP hylogenetic Approach. Sinauer Associates Inc. U.S.A. 2nd edition.
4. Saxena, H.O. and Brahman.M. The Flora of Orissa, CSIR Publication.
5. Bose T.K.(2009). Trees of the World, Regional Plant Resource Centre, Bhubaneswar, Odisha, India
6. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper and Row, New York.
7. Haines, H.H.(2009). Botany of Bihar and Orissa,
8. Mohanty, C.R. (2017). Text Book of Plant Systematics, Kalyani Publisher, New Delhi.
9. Subrahmainayam, M.S.(2011) Modern Plant Taxonomy, Vikash Publishing House, New Delhi
10. Pandey, B.P. (2017). Taxonomy of Angiosperm. S.Chand Publication.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper-11
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit-I

(i) Introduction: History and scope.

(ii) Anther: Anther wall: Structure and functions, micro-sporogenesis, callose deposition and its significance.

(iii) Pollen biology: Micro-gametogenesis; Pollen wall structure, MGU (male germ unit) structure, NPC system; Palynology and scope (a brief account); Pollen wall proteins; Pollen viability, storage and germination; Abnormal features: Pseudomonads, polyads, massulae, pollinia.

Unit - II

Ovule: Structure; Types; Special structures endothelium, obturator, aril, caruncle and hypostase; Female gametophyte mega- sporogenesis and mega- gametogenesis; Types and ultra structure of different mature embryo sacs(Details of *Polygonum* type), Developmental pattern of mono, bi- and tetrasporic embryo sacs.

Unit - III

(i) Pollination and fertilization: Pollination types and significance; adaptations; structure of stigma and style; path of pollen tube in pistil; double fertilization.

(ii) Self incompatibility: Basic concepts; Methods to overcome self- incompatibility: mixed pollination, bud pollination, stub pollination; Intraovarian and in *vitro* pollination; Modification of stigma surface.

(iii) Endosperm: Development, types, structure and functions.

Unit - IV

(i) Embryo: Types of embryogeny; General pattern of development of dicot and monocot embryo; Suspensor: structure and functions; Embryo- endosperm relationship; Nutrition of embryo; Embryo development in *Paeonia.*

(ii) Seed: Structure, importanceand dispersal mechanisms.

(iii) Poly embryony and apomixes: Introduction; Classification; Causes and applications.

Course outcomes:

CO-1 Understand the structure and function of anthers, including micro-sporogenesis and pollen biology.

CO-2 Explore the development and types of ovules and the formation of the female gametophyte.

CO-3 Examine pollination mechanisms, fertilization processes, and self-incompatibility solutions.

CO-4 Study the development and functions of the endosperm and embryo, including nutritional aspects.

CO-5 Investigate seed dispersal mechanisms, polyembryony, and apomixes.

PRACTICAL

Credit:**02** **25**Marks

(i) Anther: Wall and its ontogeny; Tapetum (amoeboid and glandular); MMC, spore tetrads, uninucleate, bicelled and dehisced anther stages through slides/ micrographs, male germ unit (MGU) through photographs and schematic representation.

(ii) Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, psuedomonads, polyads, pollinia (slides/photographs, fresh material), ultra structure of pollen wall (micrograph); Pollenviability: Tetrazoliumtest ,Germination: Calculation of percentage germination in different media using hanging drop method.

(iii) Ovule: Types- anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, unitegmic, bitegmic; Tenuinucellate and crassinucellate; Special structures: Endothelium, obturator, hypostase, caruncle and aril (permanent slides/ specimens/ photographs). Female gametophyte through permanent slides/ photographs: Types, ultrastructure of mature egg apparatus.

(iv) Embryogenesis: Study of development of dicot embryo through permanent slides/ photographs; dissection of developing seeds for embryos at various developmental stages; Study of suspensor through electron micrographs.

(v) Tracing the path of pollentube.

(vi) Study of haustorial endosperm.

Course outcomes:

CO-1 Examine anther development stages including wall ontogeny, tapetum types, and male germ unit (MGU) through slides and schematic representations.

CO-2 Study pollen grain structures and viability using acetolysis, ornamentation examination, Tetrazolium tests, and germination percentage calculations.

CO-3 Analyze various types of ovules and special structures, and investigate the female gametophyte's ultrastructure through permanent slides.

CO-4 Observe embryogenesis, including dicot embryo development, suspensor structure, and developmental stages of seeds.

CO-5 Trace the path of the pollen tube and study the haustorial endosperm to understand fertilization and nutrient transfer processes.

Text Books:

1. Singh, V.Pandey, P.C and Jain, D.K.(2017). Reproductive Biology of Angiosperms, Rastogi Publications, Meerut

Reference Books:

1. Maheswari, P.(2009). Embryology of Angiosperms.
2. Shivanna, K.R.(2003). Pollen Biology and Biotechnology. Oxford and IBH Publishing Co.Pvt.Ltd. Delhi.
3. Raghavan, V.(2000). Developmental Biology of Flowering plants, Springer, Netherlands.
4. Johri, B.M.I (1984). Embryology of Angiosperms, Springer- Verlag, Netherlands.
5. Bhojwani, S.S. and Bhatnagar, S.P. (2011). The Embryology of Angiosperms, Vikas Publishing House. Delhi. 5th edition.
6. Mishra, B.K.(2017). Reproductive Biology of Angiosperms Kalyani Publishers, New Delhi.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper-12

PLANT PHYSIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Plant water relationship: Water Potential and its components, plasmolysis and imbibitions, water absorption by roots, aquaporins, path way of water movement, symplast, apoplast, trans-membrane pathways, root pressure, guttation. Ascent of sap- cohesion- tension theory. Transpiration and factors affecting transpiration, anti-transpirants, mechanism of stomatal movement.

(ii) Translocation in the phloem: Experimental evidence in support of phloem as the site of sugar translocation. Pressure- Flow Model; Phloem loading and unloading; Source- sink relationship.

Unit - II

(i) Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

(ii) Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATP ase pump and ion flux, uniport, co-transport, symport, and antiport.

Unit - III

Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Brassinosteroids and Jasmonic acid.

Unit - IV

(i) Physiology of flowering: Photoperiodism, flowering stimulus, florigen concept, vernalization, seed dormancy. Senescence: Types and causes.

(ii) Phytochrome: Discovery, chemical nature, role of phytochrome in photo- morphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action.

Course outcomes:

CO-1 Understand plant water relations, including water absorption, movement, and transpiration mechanisms.

CO-2 Explore phloem translocation processes, focusing on the Pressure- Flow Model and source-sink dynamics.

CO-3 Examine the roles and absorption mechanisms of essential and beneficial mineral nutrients in plants.

CO-4 Study the chemical nature and physiological effects of various plant growth regulators such as auxins, gibberellins, cytokinins, and other hormones.

CO-5 Investigate the physiological aspects of flowering, photoperiodism, and the function of phytochromes in plant development.

PRACTICAL

Credit:**02** **25**Marks

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method.
3. Study of the effect of wind velocity and light on the rate of transpiration in excised twig/ leaf.
4. Calculation of stomatal index and stomatal frequency from the two surfaces of leaves of a mesophyte and xerophyte.
5. To calculate the area of an open stoma and percentage of leaf area open through stomata in a mesophyte and xerophyte (both surfaces).
6. To study the phenomenon of seed germination (effect of light).
7. To study the induction of amylase activity in germinating barley grains
8. To demonstrate suction due to transpiration.
9. Measurement of relation between transpiration and transpiring surface.
10. Measurement of cuticular resistance to transpiration.

Course Outcomes:

CO-1 Explore plant physiology by determining osmotic potential and water potential, while studying the influence of environmental factors like wind and light on transpiration rates.

CO-2 Analyze stomatal characteristics in mesophyte and xerophyte leaves to understand adaptation mechanisms to varying climates.

CO-3 Evaluate seed germination under different light conditions and investigate enzymatic activity during germination processes.

CO-4 Demonstrate the physiological mechanisms driving transpiration and its impact on water loss and plant health.

CO-5 Assess cuticular resistance and transpiring surface area to comprehend the plant's ability to regulate water loss.

Text Books:

1. Sinha, R.K. (2015). Modern Plant Physiology, Narosa Publishing House, New Delhi.

Reference Books:

1. Hopkins, W.G. and Huner, A.(2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L. Zeiger, E. MØller, I.M. and Murphy, A(2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Bajracharya D.(1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4. Salisbury, F.B. and Ross, C.W. Plant Physiology Wadsworth Publishing Company, California
5. Sahoo, A.C. (2018). Outlines of Plant Physiology Kalyani Publishers, New Delhi.
6. Srivastava, N.K. (2017). Plant Physiology, Rastogi Publications, Meerut.
7. Pandey and Sinha (2011). Plant Physiology, Vikash Publishing House, New Delhi

+3 THIRD YEAR SIXTH SEMESTER

Core Paper- 13

PLANT METABOLISM

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Concept of metabolism: Introduction, anabolic and catabolic path ways, regulation of metabolism, role of regulatory enzymes (allosteric, covalent modulation and Isozymes).

(ii) Mechanisms of signal transduction: Calcium, phospholipids, cGMP, NO.

Unit - II

Carbon assimilation: Historical background, photosynthetic pigments, role of photosynthetic pigments, Red drop and Emerson Enhancement Effect, antenna molecules and reaction centres, photochemical reactions, photosynthetic electron transport, PSI, PSII, Qcycle, C_3, C_4 path ways; Crassulacean acid metabolism; Factors affecting CO_2 reduction. Photo respiration.

Unit - III

(i) Carbon Oxidation: Glycolysis, fate of pyruvate, regulation of glycolysis, oxidative pentose phosphate path way, oxidative decarboxylation of pyruvate, regulation of PDH, NADH shuttle; TCA cycle, amphibolic role, anaplerotic reactions, regulation of the cycle, mitochondrial electron transport, oxidative phosphorylation, cyanide- resistant respiration, factors affecting respiration.

(ii) ATP- Synthesis: Mechanism of ATP synthesis, substrate level phosphorylation, chemiosmotic mechanism (oxidative and photo- phosphorylation), ATP synthase, Boyers conformational model, Racker's experiment, Jagendorf's experiment; role of uncouplers.

Unit-IV

(i) Lipid metabolism: Synthesis of Triglycerides, Synthesis of fatty acids, glycerols, condensation of fatty acid and Glycerol. Breakdown of Triglycerides: Hydrolysis of TG, Breakdown of Glycerol, Breakdown of fatty acids, α-oxidation, β-oxidation, glyoxylate cycle, gluco- neogenesis and its role in mobilisation of lipids during seed germination.

(ii) Nitrogen metabolism: Free living and symbiotic biological nitrogen fixation (examples of legumes and non- legumes); Physiology and biochemistry of nitrogen fixation; Nitrification, Nitrate assimilation, Ammonia assimilation and transamination.

Course Outcomes:

CO-1 Understand plant metabolism concepts, regulation, and enzyme roles.

CO-2 Explore signal transduction mechanisms using calcium, phospholipids, cGMP, and NO.

CO-3 Study carbon assimilation in photosynthesis and related pathways.

CO-4 Examine carbon oxidation pathways and ATP synthesis mechanisms.

CO-5 Analyse lipid and nitrogen metabolism, including nitrogen assimilation and fixation

PRACTICAL

Credit:**02** **25**Marks

1. Isolation and quantitization of photosynthetic pigments.
2. Experimental demonstration of Hill's reaction.
3. To study the effect of light intensity on the rate of photosynthesis.
4. Effect of carbon dioxide on the rate of photo synthesis.
5. To compare the rate of respiration in different parts of a plant.
6. Demonstration of absorption spectrum of photosynthetic pigments.
7. Assay of the enzyme Catalase.
8. Photoreduction of dye by isolated chloroplasts.

Course Outcomes:

CO-1 Isolate and quantify photosynthetic pigments accurately, understanding their significance in photosynthesis.

CO-2 Experimentally demonstrate Hill's reaction to elucidate the process of photophosphorylation.

CO-3 Investigate the correlation between varying light intensities and the rate of photosynthesis to understand light dependency.

CO-4 Examine the influence of carbon dioxide concentration on photosynthesis rate, crucial for understanding carbon fixation.

CO-5 Compare respiration rates in different plant parts to analyze metabolic activity variations within the plant.

Text Books:

1. Gupta, S.K. (2017). Plant Metabolism, Rastogi Publication, Meerut.

Reference Books:

1. Hopkins, W.G. and Huner, A.(2008). Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.
2. Taiz, L. Zeiger, E. Moller, I.M. and Murphy, A (2015). Plant Physiology and Development. Sinauer Associates Inc. USA. 6th edition.
3. Harborne, J.B.(1973). Phytochemical Methods. John Wiley & Sons. New York.
4. Sahoo, A.C. (2018). Outlines of Plant Metabolism, Kalynai Publishers, New Delhi.

+3 THIRD YEAR SIXTH SEMESTER

Core Paper-14

PLANT BIOTECHNOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit-I

Plant Tissue Culture: Historical perspective; Aseptic tissue culture techniques, Composition of media; Nutrient and hormone requirements (role of vitamins and hormones). Totipotency; Organogenesis; Embryogenesis (somatic and zygotic); Protoplast isolation, culture and fusion; Tissue culture applications (micropropagation, androgenesis, virus elimination, secondary metabolite production, haploids, triploids and hybrids; Cryopreservation; Germplasm Conservation).

Unit-II

Recombinant DNA technology-I: Restriction Endonucleases (History, Types I-IV, biological role and application); Restriction Mapping (Linear and Circular); Cloning Vectors: Prokaryotic (pUC 18 and pUC19, pBR322, Ti plasmid, BAC); Lambda phage, M13 phagemid, Cosmid, Shuttle vector; Eukaryotic Vectors (YAC and briefly PAC, MAC, HAC). Gene Cloning (Recombinant DNA, Bacterial Transformation and selection of recombinant clones, PCR-mediated gene cloning).

Unit-III

Recombinant DNA technology-II: Gene Construct; construction of genomic and cDNA libraries, screening DNA libraries to obtain gene of interest by genetic selection; complementation, colony hybridization; Probes- oligonucleotide, heterologous, Methods of gene transfer- *Agrobacterium*-mediated, Direct gene transfer by Electroporation, Micro injection, Micro projectile bombardment; Selection of transgenics- selectable marker and reporter genes (Luciferase, GUS, GFP).

Unit-IV

Applications of Biotechnology: Pest resistant plants (Bt-cotton); herbicide resistant plants (Round Up Ready soybean); Transgenic crops with improved quality traits (Flavr Savr tomato, Golden rice); Improved horticultural varieties (Moondust carnations); Role of transgenics in bioremediation (Super bug); edible vaccines; Industrial enzymes (Asperaginase, Protease, Lipase); Genetically Engineered Products- Human Growth Hormone; Humulin; Biosafety concerns.

Course Outcomes:

CO-1 Understand plant tissue culture techniques, including aseptic methods, media composition, and applications such as micropropagation and cryopreservation.

CO-2 Explore recombinant DNA technology, covering restriction endonucleases, cloning vectors, and gene cloning processes.

CO-3 Investigate gene library construction, screening, and gene transfer methods in recombinant DNA technology, including Agrobacterium- mediated transfer and electroporation.

CO-4 Analyse biotechnological applications in agriculture, such as pest and herbicide- resistant crops, transgenic crops with improved traits, and horticultural varieties.

CO-5 Examine the role of biotechnology in producing industrial enzymes, genetically engineered products, and addressing biosafety concerns.

PRACTICAL

Credit:**02** **25** Marks

1. (a) Preparation of tissue culture (MS) medium.
   (b) Demonstration of *in vitro* sterilization and inoculation methods using leaf and nodal explants of tobacco, *Datura, Brassica* etc.
2. Study of anther culture through photographs.
3. Preparation of artificial seeds.
4. Study of Bt cotton through photographs.
5. Isolation of DNA by CTAB method from plant tissues.
6. Gel electrophoresis (demonstration).
7. *Agrobacterium* mediated gene transfer.

Course Outcomes:

CO-1 Prepare MS medium for plant tissue culture accurately.

CO-2 Demonstrate *in vitro* sterilization and inoculation techniques using diverse plant explants.

CO-3 Study anther culture visually through photographic documentation.

CO-4 Create artificial seeds using appropriate methods.

CO-5 Examine Bt cotton characteristics and perform plasmid DNA isolation alongside gel electrophoresis demonstration.

Text Books:

1. Chawla, H. S.(2010). Introduction to Plant Biotechnology. Oxford & IBH Publishing Co.Pvt. Ltd. New Delhi.

Reference Books:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
2. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.
3. Stewart, C.N. Jr.(2008). Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
4. Singh, B.D. (2018). Plant Biotechnology Kalynai Publishers, New Delhi.
5. Gupta, P.K. (2017). Plant Biotechnology, Rastogi Publication, Meerut.
6. Dubey, R.C. (2017). Advanced Biotechnology, S. Chand Publication, New Delhi

+3 THIRD YEAR FIFTH SEMESTER

DSE - 1

ANALYTICAL TECNIQUES IN PLANT SCIENCES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit-I

Imaging and related techniques: Principles of microscopy; Light microscopy; Fluorescence microscopy; Flow cytometry (FACS); Transmission and Scanning electron microscopy- sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit-II

Cell fractionation: Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, $CsCl_2$ gradient, analytical centrifugation, ultracentrifugation. Radioisotopes: Use in biological research, auto-radiography, pulse chase experiment. Spectrophotometry: Principle and its application in biological research.

Unit-III

Chromatography: Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion- exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Characterization of proteins and nucleic acids: Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS- PAGE

Unit-IV

Biostatistics: Statistics, data, population, samples, variables, parameters; Representation of Data: Tabular, Graphical; Measures of frequency and central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variance, standard deviation; Chi- square test for goodness of fit. Test of significance: comparison of large, small and paired samples (T-Test)and correlation and regression.

Course outcomes:

CO-1 Learn microscopy principles and electron microscopy sample preparation.

CO-2 Understand cell fractionation via differential and density gradient centrifugation.

CO-3 Explore chromatography techniques including paper chromatography and HPLC.

CO-4 Investigate protein and nucleic acid characterization methods like mass spectrometry and electrophoresis.

CO-5 Gain proficiency in biostatistics, including data representation and statistical tests.

PRACTICAL

Credit:**02** **25** Marks

1. Study of different microscopic techniques for chromosome study
2. Study of PCR Demonstration.

3. To separate pigments by paper chromatography.
4. To separate phytochemicals by thin layer chromatography.
5. To estimate protein through Lowry's methods.
6. To separate proteins using PAGE.
7. To separate DNA (marker) using AGE.
8. Spectrometric estimation of total sugar by Anthrone method.
9. Chi-square analysis of mendelian ratio.
10. T- Test.

Course Outcomes:

CO-1 Study various microscopic techniques for chromosome analysis.

CO-2 Demonstrate PCR for DNA amplification.

CO-3 Separate pigments and phytochemicals using chromatography methods.

CO-4 Estimate protein concentration using Lowry's method and separate proteins using PAGE.

CO-5 Analyse DNA markers using agarose gel electrophoresis and perform statistical tests like chi-square and T-Test.

Text Books:

1. Patil, C.S.(2017). Advanced Analytical Techniques, ABE Books, New Delhi.

Reference Books:

1. Plummer, D.T.(1996). An Introduction to Practical Biochemistry. Tata Mc Graw- Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E.(1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F. Brent, R. Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K.(1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H.(2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.
5. Aneja, K. R.(2014). Laboratory manual of microbiology and biotechnology, Medtech, New Delhi

+3 THIRD YEAR FIFTH SEMESTER

DSE - 2

NATURAL RESOURCE MANAGEMENT

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Natural resources: Definition and types.

(ii) Sustainable utilization: Concept, approaches (economic, ecological and socio- cultural).

(iii) Land: Utilization (agricultural, horticultural, silvicultural); Soil degradation and management.

(iv) Water: Fresh water (rivers, lakes, ground water), water harvesting technology, rain water storage and utilization.

Unit - II

Biological Resources: Biodiversity- definition and types; Significance; Threats; Management strategies: (Bioprospecting; IPR; CBD; National Biodiversity Action Plan). Forests: Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion; Management.

Unit - III

(i) Energy: Renewable and non-renewable sources of energy-solar, wind, tidal, geothermal and bioenergy resources.

(ii) Contemporary practices in resource management: EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint.

Unit - IV

Resource Accounting; Waste management; National and international efforts in resource management and conservation.

Course Outcomes:

CO-1 Define natural resources and explore sustainable utilization concepts.

CO-2 Investigate land utilization, soil degradation, and water management techniques.

CO-3 Analyze biological resources, biodiversity significance, threats, and forest management strategies.

CO-4 Examine renewable and non-renewable energy sources and contemporary resource management practices like EIA and GIS.

CO-5 Discuss resource accounting, waste management, and national/international conservation efforts.

PRACTICAL

Credit:**02** **25**Marks

(i) Estimation of solid waste generated by a domestic system (bio-degradable and non- bio-degradable) and its impact on land degradation.

(ii) Collection of data on forest cover of specific area.

(iii) Measurement of dominance of woody species by DBH (diameter at breast height) method.

(iv) Calculation and analysis of ecological footprint.

(v) Ecological modeling.

(vi) Estimation of soil moisture content and soil texture.

(vii) Estimation of soil porosity.

(viii) Estimation of soil water- holding capacity.

(ix) Estimation of soil organic matter and soil carbon.

Course Outcomes:

CO-1 Estimate domestic solid waste, distinguishing between biodegradable and non-biodegradable components, and assess its impact on land degradation.

CO-2 Investigate land utilization, soil degradation, and water management techniques.

CO-3 Collect data on forest cover in a specific area to analyze forest resources.

CO-4 Measure woody species dominance using the DBH method. Calculate ecological footprint to understand resource consumption.

CO-5 Estimate soil characteristics such as moisture content, texture, porosity, water-holding capacity, organic matter, and carbon levels for soil health assessment.

Text Books:

1. Pandey, B.W.2005. Natural Resource Management. Mittal Publication, New Delhi

Reference Books:

1. Vasudevan, N. (2006). Essentials of Environmental Science. Narosa Publishing House, New Delhi.

2. Singh, J.S.Singh, S.P. and Gupta, S.(2006). Ecology, Environment and Resource Conservation. Anamaya Publications, New Delhi.

3. Rogers, P.P.Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. Prentice Hall of India Private Limited, New Delhi.

+3THIRD YEAR SIXTH SEMESTER

DSE - 3

HORTICULTURAL PRACTICES AND POST- HARVEST TECHNOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Introduction: Scope and importance, Branches of horticulture; Role in rural economy and employment generation; Importance in food and nutritional security; Urban horticulture and ecotourism.

(ii) Ornamental plants: Types, classification (annuals, perennials, climbers and trees); Identification and salient features of some ornamental plants [rose, marigold, gladiolus, carnations, orchids, poppies, gerberas, tuberose, sages, cacti and succulents (*Opuntia, Agave* and spurges)

Unit - II

(i) Fruit and vegetable crops: Production, origin and distribution; Description of plants and their economic products; Management and marketing of vegetable and fruit crops.

(ii) Horticultural techniques: Application of manure, fertilizers, nutrients and PGRs; Weed control; Biofertilizers, biopesticides; Irrigation methods (drip irrigation, surface irrigation, furrow and border irrigation); Hydroponics; Propagation Methods: asexual (grafting, cutting, layering, budding), sexual (seed propagation), Scope and limitations.

(iii) Landscaping and garden design: Planning and layout (parks and avenues); gardening traditions-Ancient Indian, European, Mughal and Japanese Gardens; Urban forestry: policies and practices.

Unit - III

(i) Post- harvest technology: Importance of post harvest technology in horticultural crops; Evaluation of quality traits; Harvesting and handling of fruits, vegetables and cut flowers; Principles, methods of preservation and processing; Methods of minimizing loss during storage and transportation.

(ii) Disease control and management: Field and post- harvest diseases; Identification of deficiency symptoms; remedial measures and nutritional management practices; Crop sanitation; IPM strategies (genetic, biological and chemical methods for pest control); Quarantine practices.

Unit - IV

Horticultural crops - conservation and management: Documentation and conservation of germplasm; Role of micropropagation and tissue culture techniques; Varieties and cultivars of various horticultural crops; IPR issues; National, international and professional societies and sources of information on horticulture.

Course Outcomes:

CO-1 Understand the scope and significance of horticulture, including its role in rural economy, food security, and urban horticulture.

CO-2 Identify and classify ornamental plants, and describe their salient features.

CO-3 Learn about fruit and vegetable crop production, management, and marketing techniques.

CO-4 Explore horticultural techniques such as fertilization, irrigation, propagation methods, and landscaping principles.

CO-5 Study post-harvest technology, disease control, germplasm conservation, and intellectual property rights in horticulture.

PRACTICAL

Credit:**02** **25**Marks

(i) Identification and description of salient features of ornamental plants included in the syllabus.

(ii) Horticultural techniques (Drip irrigation, surface irrigation, furrow and border irrigation).

(iii) Study of practice of asexual propagation methods (grafting, cutting, layering, budding)

(iv) Planning and layout of parks and avenues

(v) Handling of harvested fruits, vegetables and cut flowers.

(vi) Methods of fruit preservation

(vii) Basic tissue cultures technique

Course Outcomes:

CO-1 Identify and describe salient features of ornamental plants specified in the syllabus.

CO-2 Study various horticultural techniques including drip, surface, furrow, and border irrigation.

CO-3 Study asexual propagation methods such as grafting, cutting, layering, and budding.

CO-4 Study Plan and layout of parks and avenues considering principles of landscaping.

CO-5 Learn handling procedures for harvested fruits, vegetables, and cut flowers, including preservation methods and basic tissue culture techniques.

Text Books:

1. Peter, K.V.(2009). Basics of Horticulture, Kalyani Publishers, New Delhi.

Reference Books:

1. Singh, D. & Manivannan, S.(2009). Genetic Resources of Horticultural Crops. Ridhi International, Delhi, India.
2. Swaminathan, M.S. and Kochhar, S.L. (2007). Groves of Beauty and Plenty: An Atlas of Major Flowering Trees in India. Macmillan Publishers, India.
3. NIIR Board (2005). Cultivation of Fruits, Vegetables and Floriculture. National Institute of Industrial Research Board, Delhi.
4. Kader, A.A. (2002). Post- Harvest Technology of Horticultural Crops. UCANR Publications, USA.
5. Capon, B.(2010). Botany for Gardeners. 3rd Edition. Timber Press, Portland, Oregon.
6. Pandey, P.H.(2007). Principles and Practices of Post Harvest Technology, Kalyani Publishers, New Delhi.

+3THIRD YEAR SIXTH SEMESTER

DSE - 4

DISSERTATION/ PROJECT WORK

Introduction, Review & Methodology	Result & Discussion	Viva-Voce	Total
40	40	20	100

+3FIRST YEAR FIRST SEMESTER

GE - 1

BIODIVERSITY (MICROBES, ALGAE, FUNGI AND ARCHEGONIATES)

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

Microbes: Viruses- Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria- Discovery, General characteristics and cell structure; Reproduction- vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit - II

(i) **Algae:** General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Morphology and life-cycles of the following: *Chlamydomonas, Oedogonium, Nostoc* and *Fucus, Vaucheria, Polysiphonia*, Economic importance of algae.

(ii) **Fungi :** Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium* (Ascomycota), *Puccinia, Agaricus* (Basidiomycota); Symbiotic Associations-Lichens.

Unit - III

(i) **Bryophytes:** General characteristics, adaptations to land habit, Classification, Range of thallus organization, morphology, anatomy and reproduction of *Marchantia* and *Funaria* (Developmental details not to be included).

(ii) **Pteridophytes:** General characteristics, classification, Early land plants *(Rhynia)*. Classification (up to family), morphology, anatomy and reproduction of *Selaginella, Equisetum* and *Pteris* (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economic importance of Pteridophytes.

Unit - IV

Gymnosperms: General characteristics. Classification (upto family), morphology, anatomy and reproduction of *Cycas, Pinus* and *Gnetum*. (Developmental details not to be included). Ecological and economic importance.

Course Outcomes:

CO-1 Understand the structure, replication cycles, and economic significance of viruses, along with the characteristics and reproduction methods of bacteria.

CO-2 Explore the characteristics, ecology, reproduction, and economic importance of algae and fungi.

CO-3 Study the characteristics, adaptations, classification, morphology, and reproduction of bryophytes and pteridophytes.

CO-4 Learn about gymnosperms, including their characteristics, classification, morphology, reproduction, and ecological/economic importance.

CO-5 Gain comprehensive knowledge of microbes, algae, fungi, and archegoniates, focusing on their diversity, ecological roles, and economic relevance.

PRACTICAL

Credit:**02** **25** Marks

1. Gram staining
2. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Fucus* and *Polysiphonia* through temporary preparations and permanent slides.
3. *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
4. *Puccinia* and *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus.*
5. *Marchantia* and *Funaria*- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, L.S. sporophyte (all permanent slides).
6. *Selaginella*- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m.microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
7. *Equisetum*- morphology, T.S. internode, L.S. strobilus, T.S. strobilus, w.m. sporangiophore, w.m. spores (wet and dry) (temporary slides); t.s rhizome (permanent slide).
8. *Cycas*- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).
9. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophy ll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

Course Outcomes:

CO-1 Conduct Gram staining for bacterial cell wall differentiation.

CO-2 Study vegetative and reproductive structures of various algae, fungi, bryophytes, pteridophytes, and gymnosperms using slides.

CO-3 Examine asexual and sexual stages of selected fungi.

CO-4 Analyze specimens of different fungi and plants at various growth stages, including sectioning.

CO-5 Investigate the morphology of selected plants, including thallus, leaves, stems, cones, and reproductive structures using slides

Text Books:

1. Mitra, J.N. Mitra, D. and Choudhury, S.K. Studies in Botany Volume 1. Moulik Publisher, Kolkata. Ninth Revised Edition

Reference Books:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
2. Tortora, G.J. Funke, B.R. Case, C.L.(2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
3. Sethi, I.K. and Walia, S.K.(2011). Text book of Fungi & Their Allies, Mac Millan Publishers Pvt. Ltd. Delhi.

4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, JohnWiley and Sons (Asia), Singapore. 4th edition.

5. Raven, P.H. Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata Mc Graw Hill, Delhi, India.

6. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S.Chand. Delhi, India.

7. Bhatnagar, S.P. and Moitra, A.(1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.

8. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.

9. Pandey, B.P. (2017), Botany for degree studies (asper CBCS). S.Chand

10. Acharya, B.S. and Mishra, B.K. (2018). Plant Biodiversity, Kalyani Publishers, New Delhi.

+3FIRST YEAR SECOND SEMESTER

GE - 2

PLANT PHYSIOLOGY AND METABOLISM

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit - I

(i) Plant- water relations : Importance of water, water- potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

(ii) Mineral nutrition: Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

(iii) Translocation in phloem: Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit - II

(i) Photosynthesis : Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C_3, C_4 and CAM pathways of carbon fixation.

(ii) Respiration: Glycolysis, anaerobic respiration, TCA cycle; Oxidative Phosphorylation.

Unit-III

(i) Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

(ii) Nitrogen metabolism: Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit-IV

(i) Plant growth regulators: Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

(ii) Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

Course Outcomes:

CO-1 Understand plant-water relations, including water potential components, transpiration significance, and factors affecting transpiration.

CO-2 Explore mineral nutrition, essential elements, and mechanisms of ion transport across membranes.

CO-3 Study photosynthesis, focusing on photosynthetic pigments, photosystems, and carbon fixation pathways.

CO-4 Investigate respiration processes, including glycolysis and oxidative phosphorylation.

CO-5 Learn about enzymes, nitrogen metabolism, plant growth regulators, and plant responses to light and temperature.

PRACTICAL

Credit:**02** **25**Marks

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomata lindex and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of Hill reaction.
5. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
6. To study the effect of light intensity and bicarbonate concentration on O_2 evolution in photosynthesis.
7. Comparison of the rate of respiration in any two parts of a plant.
8. Determination of water potential of given tissue (potato tuber) by weight method.
9. Measurement of cuticular resistance to transpiration.
10. Measurement of relation between transpiration and transpiring surface.

Course outcomes:

CO-1 Assess various physiological aspects of plant function and response mechanisms.

CO-2 Explore environmental influences on plant transpiration and photosynthetic processes.

CO-3 Analyze anatomical features such as stomatal index and frequency in different plant types.

CO-4 Understand key biochemical reactions like the Hill reaction and catalase activity.

CO-5 Investigate plant water potential, resistance to transpiration, and relationships between transpiration and surface area.

Text Books:

1. A.C. Sahu (2018), Plant Physiology and Metabolism, Kalyani Publishers, New Delhi.

Reference Books:

1. Taiz, L., Zeiger, E., Moller, I.M. and Murphy, A (2015), Plant Physiology and Development, Sinauer Associates Inc. USA, 6th edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology, John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1990). Experiments in Plant Physiology. AL aboratory manual Narosa Publishing House, New Delhi.
4. H.S. Srivatava. Plant Physiology, Rastogi Publications, New Delhi.

COURSES OF STUDIES
UG CHEMISTRY

Programme Outcomes

After successful completion of the three-year degree program in Chemistry, a student should be able to :

PO-1 acquire knowledge in all disciplines of chemistry and understand the theories, essential facts, core concepts, principles, and postulates relating to chemistry **(Domain Knowledge).**

PO-2 Developing skills to effectively communicate the concepts of chemistry both orally and in writing. **(Communication Skill)**

PO-3 Employ critical thinking and scientific knowledge to design, carry out, record, and analyze the results of chemical reactions. **(Critical thinking)**

PO-4 Identify the problem and think methodically and independently to draw and logical conclusion. **(Problem-solving)**

PO-5 To acquire technical skills in chemistry through different lab experiments in each course and project for better prospects in jobs and research. **(Teachnical/Research Skill)**

PO-6 To develop ICT-based competency for e-learning, literature search, project report writing and presentation. **(Digital skill)**

PO-7 Create an awareness of the impact of chemistry on the environment, society, and development outside the scintific community. **(moral/ethical/societal awareness)**

PO-8 Developing cooperatin, teamwork and leadership qualities of the students. **(Teamwork/ Leadership)**

PO-9 Acquire expertise in the role of chemistry in Industries and become an entrepreneur. **(Self-directing learning)**

PROGRAMME SPECIFIC OUTCOMES

PSO-1 Acquire a solid foundation in chemistry fundamentals required to solve chemical, technical and environmental problems.

PSO-2 Develop the analytical skills to design, choose and perform experiments with the precaustions and protocols.

PSO-3 Express their thoughts and ideas through effective communication using scientific knowldge.

PSO-4 Act as an individual and team member relevant to the professional practice.

CHEMISTRY

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 1
INORGANIC CHEMISTRY - I

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand the atomic theory, structure of atom, Schrodinger's wave equation and its significance, the theories of bonding and predict the structure of molecules. To learn the similarities and differences of properties of elements and their reactivity by using the periodic table. T o know the variation in properties of molecules on the basis of the type of bonding. Understand the basic concepts of redox reactions and its applications.

Unit-I

Atomic structure

Bohr's theory, its limitations and atomic spectrum of hydrogen atom, Sommerfeld's modification. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle (time independent) and its significance, Derivation of Schrödinger's wave equation (for hydrogen atom) in Cartesian coordinate,significance of ψ and ψ^2. Normalized and orthogonal wave functions. Sign of wave functions; Setting of Schrödinger's equation in polar coordinates (derivation not required), radial and angular wave functions for hydrogen atom. Radial and angular distribution curves; Shapes of s, p, d and f orbitals; Quantum numbers and their significance. Pauli's Exclusion principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations. Electron configuration of atoms.

Unit-II

Periodicity of elements

Periodicity of Elements: s, p, d, f block elements, the long form of periodic table. Detailed discussion of the following properties of the elements, with reference to s & p-blocks. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table, (b) Atomic radii (van der Waals) (c) Ionic and crystal radii, (d) Covalent radii (octahedral and tetrahedral) (e) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy, (f) Electron gain enthalpy, trends of electron gain enthalpy, (g) Electronegativity, Pauling's/ Muiliken's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization. Sanderson's electron density ratio.

Unit-III

Chemical bonding-I

Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Lande equation with derivation. Madelung constant, Born-Haber cycle and its application, Solvation energy, (ii) Covalent bond: Valence Bond theory (Heitler-

London approach). Hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements, equivalent and non-equivalent hybrid orbitals, Resonance and resonance energy.

Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions (CO^+, NO^+, NO^-).

Unit - IV

Chemical bonding-II

VSEPR theory, shapes of simple molecules and ions containing lone and bond pairs of electrons, multiple bonding (σ – and π - bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability. Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipole moment. Percentage ionic character from dipole moment and electronegativity difference Values.

Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, (ii) *Weak Chemical Forces:* van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Oxidation-reduction: Redox equations, standard electrode potential and its applications to inorganic reactions. Principles involved in some volumetric analysis like permanganometry & Iodometry (Estimation of Iron and Copper)

Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry Wiley India, 5th Edn., 2008.
2. Huheey J. E., Keiter E. A. and Keiter R. L, Inorganic Chemistry - Principles of structure and reactivity,, Pearson Education, 4th Ed. 2002.
3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017
4. Selected Topic in Inorganic Chemistry, S. Chand, New Delhi, 17th Ed., 2010.

Reference books

5. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
6. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To estimate ions/acids/bases by acid-base titration method and oxidation-reduction titration method.

Students are required to learn the followings:

i. Calibration and use of apparatus

ii. Preparation of solutions of different Molarity/Normality of titrants.

List of experiments

(A) Acid-Base Titrations

i. Estimation of carbonate and hydroxide present together in mixture.

ii. Estimation of carbonate and bicarbonate present together in a mixture.

iii. Estimation of free alkali present in different soaps/detergents.

(B) Oxidation-Reduction Titrimetry

i. Standardization of $KMnO_4$ with standard sodium oxalate and estimation of Fe(II) using standardized $KMnO_4$ solution.

ii. Estimation of percentage of oxalic acid and sodium oxalate in a given mixture.

iii. Estimation of Fe(II) and Fe(III) in a mixture by standard $K_2Cr_2O_{7'}$ solution.

Reference text:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. Gulati Shikha, Sharma Gulati JL and ManochaShagun, Practical Inorganic Chemistry, 1st Edn., CBS Publishers & Distributors Pvt Ltd., (2017).

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 2

PHYSICAL CHEMISTRY - 1

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To differentiate the physical properties of each state of matter and understand Kinetic theory of gas and its applications. To explain electrolytes, degree of ionization and dissociation constant, pH.To understand lattice parameters of solids, symmetry elements and symmetry operations, theories of acid-base indicators and its applications.

Unit-I

Gaseous state-I

Kinetic molecular model of a gas: postulates and derivation of the kinetic gas equation; collision frequency; collision diameter; mean free path and viscosity of gases, including their temperature and pressure dependence, relation between mean free path and coefficient of viscosity, calculation of σ from η; variation of viscosity with temperature and pressure.

Maxwell distribution and its use in evaluating molecular velocities (average, root mean square and most probable) and average kinetic energy, law of equipartition of energy, degrees of freedom and molecular basis of heat capacities.

Behaviour of real gases: Deviations from ideal gas behaviour, compressibility factor, Z, and its variation with pressure for different gases. Causes of deviation from ideal behaviour, van der Waal's equation of state, its derivation and application in explaining real gas behaviour. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waal's constants, law of corresponding states.

Unit-II

Liquid state

Qualitative treatment of the structure of the liquid state; physical properties of liquids; vapour pressure, surface tension and coefficient of viscosity, and their determination. Effect of addition of various solutes on surface tension and viscosity. Explanation of cleansing action of detergents. Temperature variation of viscosity of liquids and comparison with that of gases. Qualitative discussion of structure of water.

Ionic equilibria-1

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect; dissociation constants of mono- and diprotic acids.

Unit- III:

Solid state

Nature of the solid state, law of constancy of interfacial angles, law of rational indices, Miller indices, elementary ideas of symmetry, symmetry elements and symmetry operations, seven crystal systems and fourteen Bravais lattices; X-ray diffraction, Bragg's law, a simple account of rotating crystal method and powder pattern method. Analysis of powder diffraction patterns of NaCl, CsCl and KCl. Defects in crystals (stoichiometric and non- stoichiometric). Glasses and liquid crystals.

Unit-IV

Ionic equilibria - II

Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions; derivation of Henderson equation and its applications, buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry and biochemical processes in the human body. Solubility and solubility product of sparingly soluble salts - applications of solubility product principle. Qualitative treatment of acid - base titration curves (calculation of pH at various stages). Theory of acid-base indicators; selection of indicators and their limitations. Multistage equilibria in polyelectrolyte systems.

Recommended Text Books :

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn., 2017.
3. Kapoor K. L, Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017
4. Castellan G. W. Physical Chemistry 4thEdn. Narosa (2004).

Reference Books:

1. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications
2. Mortimer R. G., Physical Chemistry, Elsevier (Academic Press), 3rd Ed (2008).

3. Ball D. W. Physical Chemistry Thomson Press, India (2007).

4. Engel T. & Reid P., Physical Chemistry, 3rd Ed. Pearson (2013)

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To find out surface tension and viscosity of solutions of different concentrations and to prepare solutions of different pH.

Surface tension measurements.

a. Determine the surface tension by (i) drop number (ii) drop weight method.

b. Study the variation of surface tension of detergent solutions with concentration.

Viscosity measurement using Ostwald's viscometer.

a. Determination of viscosity of aqueous solutions of (i) polymer (ii) ethanol and (iii) sugar at room temperature.

b. Study the variation of viscosity of sucrose solution with the concentration of solute.

pH-metry

a. Study the effect on pH of addition of HCl/NaOH to solutions of acetic acid, sodium acetate and their mixtures.

b. Preparation of buffer solutions of different pH (i) Sodium acetate-acetic acid (ii) Ammonium chloride-ammonium hydroxide

c. pH metric titration of (i) strong acid vs. strong base, (ii) weak acid vs. strong base.

d. Determination of dissociation constant of a weak acid.

Ionic equilibria

a. Determination of solubility product of PbI_2 by titrimetric method.

Reference Books

1. Khosia, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry, 8th Ed.; McGraw-Hill, New York (2003).

3. Viswanathan, B., Raghavan, P.S. Practical Physical Chemistry, Viva Books (2009).

4. Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co., New York (2003).

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 3

ORGANIC CHEMISTRY-I

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand the formation and stability of reaction intermediates, mechanism of elimination and addition reaction and compare the relative strength of organic acids and bases.

To distinguish between different types of isomerism, enantiomers and diastereomers, chair and boat form of cyclohexane and to describe aromaticity and Electrophilic aromatic substitution reactions.

Unit-1:

Basics of organic chemistry
Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength.

Homolytic and heterolytic fission with suitable examples. Curly arrow rules, Electrophiles and Nucleophiles, Nucleophilicity and basicity, Types, shape and relative stability of carbocations, carbanions, free radicals and carbenes.

Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Carbon-carbon sigma bonds
Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation-relative reactivity and selectivity.

Unit-II

Stereochemistry
Fischer Projection, Newmann and Sawhorse Projection formula and their interconversions Geometrical isomerism: cis-trans and, syn-anti isomerism E/Z notations with C.I.P rules.

Optical Isomerism: Optical Activity, Specific Rotation, Chirality/Asymmetry, Enantiomers, Molecules with one and two chiral-centres, Distereoisomers, meso-structures, Racemic mixture and resolution, inversion. Relative and absolute configuration: D/L and R/S designations.

Unit-III:

Chemistry of aliphatic hydrocarbons
Carbon-Carbon pi bonds:
Formation of alkenes and alkynes by elimination reactions, Mechanism of El, E2, E1cB reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroboration oxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2- and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction. Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Cycloalkanes and Conformational Analysis
Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformational analysis of alkanes (ethane and n-butane): Relative stability with energy diagrams. Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms.

Unit-IV:

Aromatic hydrocarbons
Aromaticity: Hückel's rule, aromatic & non aromatic, anti aromatic character of arenes, cyclic carbocations and carbanions, heterocyclic compounds. Annulenes & Azulenes with examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups

Recommended Text Books:

1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
3. Kalsi, P. S., Stereochemistry Conformation and Mechanism; 8thEdn, New Age International, 2015.

Reference Books:

1. Graham Solomons T. W., Fryhle, Craig B., Snyder Scott A, Organic Chemistry, Wiley Student Ed, 11th Edition (2013)
2. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, 2nd Edition, Oxford Publisher, 2014.
3. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To determine the functional group of organic compounds, melting points and boiling points of organic compounds and to know separation of amino acids by chromatography.

Students are required to learn the fallowings:

- Checking the calibration of the thermometer
- Determination of melting point, effect of impurities on the melting point - mixed melting point of two unknown organic compounds
- Determination of boiling point of liquid compounds [boiling point lower than and more than 100°C (up to 160°C) by distillation and capillary method, respectively](e.g., ethanol, cyclohexane, ethyl methyl ketone, cyclohexanone, acetylacetone, anisole, crotonaldehyde, mesityl oxide etc.).

List of experiments

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid groups and identification of unknown organic compounds of CHO system (without element detection).
2. Separation and purification of any one component of following binary solid mixture based on the solubility in common laboratory reagents like water (cold, hot), dil. HCl, dil. NaOH, $NaHCO_3$, etc. and determination of melting point.

   Benzoic acid/p-Toluidine; p-Nitrobenzoic acid/p-Aminobenzoic acid; p-Nitrotoluene/p-Anisidine etc.
3. Chromatography
   - Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
   - Separation of a mixture of two sugars by ascending paper chromatography
   - Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 4

PHYSICAL CHEMISTRY-II

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To explain enthalpy, entropy, internal energy, free energy, the laws of Chemical Thermodynamics, partial molar quantities and colligative properties and to describe Carnot cycle and efficiency of heat engine. To understand the significance of equilibrium constant. Predict spontaneity of reaction.

Unit-I:

Chemical thermodynamics
Intensive and extensive variables state and path functions isolated, closed and open systems, zeroth law of thermodynamics.

First law: Concept of heat, q, work, w, internal energy, U, and statement of first law; enthalpy, H, relation between heat capacities, calculations of q, w, U and H for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions. Joule's law, Joule-Thomson coefficient and inversion temperature.

Thermochemistry: Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications, calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions.

Unit-II

Second law of thermodynamics: Statement of the law; Carnot cycle, efficiency of heat engine, Carnot theorem. Thermodynamic scale of temperature.

Concept of entropy, molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law of thermodynamics: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters, Gibbs-Helmholtz equation, Maxwell relations, thermodynamic equation of state.

Unit-III

Systems of variable composition

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Chemical equilibrium

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, concept of fugacity. Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient, vant Hoff's equations (isotherms & isochores). Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p, K_c and K_x. Le Chatelier principle (quantitative treatment) and its applications.

Unit-IV

Solutions and Colligative Properties

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties: (i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Recommended Text Books :

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Principles of Physical Chemistry, Puri, Sharma &Pathania, Vishal Publishing Co, 47th Edn., 2017.

3. Text Book of Physical Chemistry, K. L Kapoor, Mac Grow Hill, 3rd Edn. 2017
4. Castellan G. W. Physical Chemistry 4th Ed. Narosa (2004).

Reference Books :

1. Engel T. & Reid P., Physical Chemistry 3rd Ed. Pearson (2013).
2. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
3. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications.

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To measure the heat capacity of a calorimeter and enthalpy of solutions.

THERMOCHEMISTRY

a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

c) Calculation of the enthalpy of ionization of ethanoic acid.

d) Determination of heat capacity of the calorimeter and integral enthalpy of (endothermic and exothermic) solution of salts.

e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

f) Determination of enthalpy of hydration of copper sulphate.

g) Determination of heat of solution (ΔH) of oxalic acid/benzoic acid from solubility measurement.

Reference Books

1. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
2. Athawale, V. D. & Mathur, P. Experimental Physical Chemistry, New Age International: New Delhi (2001).
3. Viswanathan, B., Raghavan, P.S. Practical Physical Chemistry, Viva Books (2009)

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 5

INORGANIC CHEMISTRY - II

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand the basic principles of extraction of metals from its ore and its purification. Explain the concept of acid and base, Hard and soft acids and bases and describe the variation of properties of s and p block elements in the periodic table. Analyze the chemistry of s and p block elements, noble gases and their compounds. Distinguish between inorganic and organic polymers.

UNIT-I

General Principles of Metallurgy

Chief modes of occurrence of metals based on standard electrode potentials. Ellingham diagrams for reduction of metal oxides using carbon and carbon monoxide as reducing agent. Electrolytic Reduction, Hydrometallurgy. Methods of purification of metals: Electrolytic process, Parting process, van Arkel-de Boer process and Mond's process, Zone refining.

Acids and Bases

Archenius and Bronsted-Lowry concept of acid-base reactions, solvated proton, relative strength of acids, types of acid-base reactions, Lewis acid-base concept, Classification of Lewis acids, Hard and Soft Acids and Bases (HSAB), Application of HSAB principle.

UNIT-II

Chemistry of s and *p* Block Elements - I

Inert pair effect, Relative stability of different oxidation states, diagonal relationship and anomalous behaviour of first member of each group. Allotropy and catenation. Complex formation tendency of s and *p* block elements.

Hydrides and their classification ionic, covalent and interstitial. Basic beryllium acetate and nitrate.

UNIT-III

Chemistry of s and *p* Block Elements - II

Study of the following compounds with emphasis on structure, bonding, preparation, properties and uses. Boric acid and borates, boron nitrides, borohydrides (diborane), carboranes and graphitic compounds, silanes. Oxides and oxoacids of nitrogen, phosphorus and chlorine. Peroxo acids of sulphur, interhalogen compounds, polyhalide ions, pseudohalogens and basic properties of halogens.

UNIT-IV

Noble Gases

Occurrence and uses, rationalization of inertness of noble gases, clathrates; preparation and properties of XeF_2, XeF_4 and XeF_6; Nature of bonding in noble gas compounds (Valence bond treatment and MO treatment for XeF_2). Molecular shapes of noble gas compounds (VSEPR theory).

Inorganic Polymers :

Types of inorganic polymers, comparison with organic polymers, synthesis, structural aspects and applications of silicones and siloxanes. Borazines, silicates and phosphazenes, and polysulphates.

Recommended Text Books :

1. Lee J. D., Concise Inorganic Chemistry Wiley India, 5thEdn., 2008.
2. Huheey J. E., Keiter E. A. and Keiter R. L, Inorganic Chemistry - Principles of structure and reactivity,, Pearson Education, 4th Ed. 2002.
3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017.
4. ShriverD. E.,Atkins P. W., InorganicChemistry, Oxford University Press,5thEdn.(2010).

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. I, CBS Publications, 2nd Ed. 2010.
2. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Preparation of some inorganic salts. To Perform iodometric titration for estimation of chemicals.

Iodometric / Iodimetric titrations

(i) Standardization of sodium thiosulphate solution by standard of $K_2Cr_2O_7$solution.

(ii) Estimation of Cu(M) using standard sodium thiosulphate solution (Iodimetrically).

(iii) Estimation of available chlorine in bleaching powder iodometrically.

Inorganic preparations

(i) Cuprous oxide (Cu_2O)

(ii) Cuprous chloride, Cu_2Cl_2

(iii) Manganese(lll) phosphate, $MnPO_4.H_20$

(iv) Aluminium potassium sulphate $K_2SO_4.Al_2(SO_4)_2.24H_2O$ (Potash alum).

(v) Lead chromate ($PbCrO_4$)

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis, 6th Ed., Pearson, 2009.
2. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).
3. Gulati Shikha, Sharma Gulati JL and Manocha Shagun, Practical Inorganic Chemistry, 1stEdn., CBS Publishers & Distributors Pvt. Ltd., (2017).

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 6

ORGANIC CHEMISTRY - II

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand nucleophilic substitution reaction and its mechanism and to describe method of preparation and reactions of alkyl and aryl halides, alcohols, phenols, ethers, carbonyl compounds, carboxylic acids and their derivatives, explain the use of organometallic compounds of Mg and Li. Compare the reactivity of different types of alcohols.

UNIT-I Chemistry of Halogenated Hydrocarbons

Alkylhalides: Methods of preparation, nucleophilic substitution reactions -S_N1, S_N2 and S_Ni mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

Aryl halides: Preparation, including preparation from diazonium salts, nucleophilic aromaticsubstitution; S_NAr, Benzyne mechanism.

Relative reactivity of alkyl, allyl/benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

Organometallic compounds of Mg and Li - Use in synthesis of organic compounds.

UNIT-II Alcohols, Phenols, Ethers and Epoxides

Alcohols: preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Oppenauer Oxidation Bouveault-BlancReduction; Preparation and properties of glycols: Oxidation by periodic acid and lead tetraacetate, **Pinacol-**Pinacolone rearrangement;

Phenols: Preparation by use of cumene-hydroperoxide method and properties; Acidity and factors affecting it, Ring substitution reactions, Reimer-Tiemann and Kolbe's-Schmidt Reactions, Fries and Claisen rearrangements with mechanism;

Ethers and Epoxides: Preparation and reactions with acids. Reactions of epoxides withalcohols, ammonia derivatives and $LiAlH_4$.

UNIT-III Carbonyl Compounds

Structure, reactivity and preparation: by Gattermann Koch reaction method:

Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Perkin, Cannizzaro and Wittig reaction, Beckmann rearrangements, haloform reaction and Baeyer Villiger oxidation, - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, $LiAlH_4$, $NaBH_4$, MPV. Addition reactions of unsaturated carbonyl compounds: Michael addition.

Active methylene compounds: Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate and ethyl acetoacetate.

UNIT-IV

Carboxylic Acids and their Derivatives

Preparation, physical properties and reactions of monocarboxylic acids: Typical reactions-of dicarboxylic acids, hydroxy acids and unsaturated acids: succinic, lactic, malic, tartaric, citric, maleic and fumaric acids; citric acids.

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic sustitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann-bromamide degradation and Curtius rearrangement.

Sulphur containing compounds:

Preparation and reactions of thiols and thioethers.

Recommended Text Books:

1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Bhal and Bhal, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
3. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009..

Reference Books:

1. Graham Solomons T. W., Fryhle, Craig B., Snyder Scott A, Organic Chemistry, Wiley Student Ed, llth Edition (2013)
2. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, 2nd Edition, Oxford Publisher, 2014.
3. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Prepare acetyl and benzoyl derivative of amines and phenols.

Organic preparations:

i. Acetylation of one of the following compounds : amines (aniline, *o-, m-,* p-toluidines and o, *m,* p-anisidine) and phenols (α-naphthol, vanillin, salicylic acid) by any one method
   a. Using conventional method.
   b. Using green approach
ii. Benzoylation of one of the following amines (aniline, *o-,* m-, p-toluidinesand *o-,* m-, p-anisidine) and one of the following phenols (α-naphthol, resorcinol, p-cresol) by Schotten-Baumann reaction.
iii. Bromination of any one of the following:
   a. Acetanilide by conventional methods
   b. Acetanilide using green approach (Bromate-bromide method)

iv. Nitration of any one of the following:

a. Acetanilide/nitrobenzene by conventional

b. Salicylic acid by green approach (using ceric ammonium nitrate).

The above derivatives should be prepared using 0.5-1g of the organic compound. Calculate percentage yield, based upon isolated yield (crude) and theoretical yield.

Purification of the crude product by recrystallisation from water/alcohol, or sublimation, whichever is applicable and determination of melting point.

Reference Books

1. Vogel, A. I. Elementary Practical Organic Chemistry, Part 1: Small scale Preparations, Pearson (2011)
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.,* Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis,* University Press (2000).
5. Analysis Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry: QualitativeAnalysis,* University Press (2000).

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 7

PHYSICAL CHEMISTRY - III

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand phase, component, degree of freedom and Gibbs phase rule and to draw and analyze phase diagram of one component system, three component system and eutectic system. Describe Nernst distribution law and its applications, experimental methods of determining order of a reaction and theories of rate of reactions, physical adsorption and chemisorption Discuss acid-base catalysis and enzyme catalysis with mechanism and adsorption isotherms.

UNIT-I

Phase Equilibria-I

Concept of phases, components and degrees of freedom, derivation of Gibbs Phase Rule for nonreactive and reactive systems; Clausius-Clapeyron equation and its applications to solid-liquid, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, with applications (H_20 and sulphur system).

Phase diagrams for systems of solid-liquid equilibria involving eutectic (Pb-Ag system, desilverisation of lead), congruent (ferric chloride-water) and incongruent (sodium sulphate-water) melting points, completely miscible solid solutions (intermediate, medium, maximum freezing points).

UNIT-II

Phase Equilibria-II

Three component systems, water-chloroform-acetic acid system, triangular plots.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications tofractional distillation of binary miscible liquids (ideal and non-ideal), azeotropes, partial miscibility of liquids, CST, miscible pairs, steam distillation.

Nernst distribution law: its derivation and applications.

UNIT-III

Chemical Kinetics

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of orders.

Kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, qualitative treatment of the theory of absolute reaction rates.

UNIT-IV

Catalysis

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Surface chemistry:

Physical adsorption, chemisorption, adsorption isotherms (Langmuir, Freundlich and Gibb's isotherms), nature of adsorbed state.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn., 2017.
3. Kapoor K. L, Text Book of Physical Chemistry, McGraw Hill, 3rd Edn. 2017
4. Castellan G. W. Physical Chemistry 4thEdn. Narosa (2004).

Reference Books:

1. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications
2. Levine, I. N. *Physical Chemistry 6thEd.,* Tata McGraw-Hill (2011).
3. Ball D. W. Physical Chemistry Thomson Press, India (2007).
4. EngelT. & Reid P., Physical Chemistry 3rd Ed. Pearson (2013)

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Verify Freundlich and Langmuir isotherm. Study the kinetics of reactions. Determine the distribution coefficient of a solute.

1. Determination of distribution coefficients of:

   (a) Iodine between water and carbon tetrachloride.
   (b) Acetic/ benzoic acid between water and cyclohexane.

2. Study the equilibrium of at least one of the following reactions by the distribution method:

   - $I_2(aq) + \overline{I}_3(aq)$
   - $Cu^{2+}(aq) + nNH_3$'! $Cu(NH_3)_{,}$

3. Study the kinetics of the following reactions,

   (i) Integrated rate method:

      a) Acid hydrolysis of methyl acetate with hydrochloric acid.
      b) Saponification of ethyl acetate.

   (ii) Compare the strengths of HCI and H_2S0_4 by studying kinetics of hydrolysis of methyl acetate.

4. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Reference Books :

1. Khosla, B. D.; Garg, V. C. & Gulati, A. *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in Physical Chemistry8th Ed.;* McGraw-Hill: New York (2003).

3. Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York (2003).

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 8
INORGANIC CHEMISTRY - III

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To describe Werner's theory, Valence Bond theory, Crystal field theory and Molecular Orbital theory of formation of complexes and to calculate CFSE in weak and strong fields. Explain the properties of Transition elements, Lanthanoids and Actinoids. To draw and analyze Latimer and Ebsworth diagrams. Understand the role of metal ions present in biological systems.

UNIT-I

Coordination Chemistry

IUPAC nomenclature of coordination compounds, isomerism in coordination compounds. Stereochemistry of complexes with 4 and 6 coordination numbers.

Werner's theory, EAN rule and its applications, valence bond theory (inner and outer orbital complexes), electro neutrality principle and back bonding.

Crystal field theory, measurement of CFSE in weak and strong crystal fields in Octahedral and tetrahedral complexes, pairing energies, Effects of crustal field spliting, Factors affecting the magnitude of 10 Dq, Electronic spectrum of $[Ti(H_2O)]^{3+}$ complex, spetrochemical series, Octahedral vs. Tetrahedral Co-ordination, Tetragonal distortions from Octahedral geometry, Jahn- Teller theorem, square planar geometry.

Types of electronic transitions, selection rules for d-d transitions, spectroscopic term symbols. Orgel energy level diagrams for d^1 and d^9 states; Qualitative aspect of Ligand field Theory.

UNIT-II

Transition Elements-I

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, and ability to form complexes. Stability of various oxidation states, electromotive force (E.M.F.), Latimer and Frost (Ebsworth) diagrams. Difference between the first, second and third transition series.

UNIT-III

Transition Elements-II

Chemistry of Ti, V, Cr Mn, Fe and Co in various oxidation states (excluding their metallurgy).

Lanthanoids and Actinoids

Electronic configuration, oxidation states, colour, spectral and magnetic properties Lanthanide contraction and its consequences. Different methods of separation of lanthanides.

General features of actinoids, separation of Np, Pm, Am from U.

UNIT-IV

Bioinorganic Chemistry

Metal ions present in biological systems, classification of elements according to their action in biological system. Na/K-pump, carbonic anhydrase and carboxypeptidase. Excess and deficiency of some trace metals. Toxicity of metal ions (Hg, Pb, Cd and As), reasons for toxicity, Use of chelating agents in medicine.

Iron and its application in bio-systems, Haemoglobin and *myoglobin.*

Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry, Wiley India, 5^{th} Edn., 2008.
2. Huheey J. E., Keiter E. A. and Keiter R. L, Inorganic Chemistry - Principles of structure and reactivity,, Pearson Education, 4^{th} Ed. 2002.
3. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33^{rd} ed., 2017.
4. ShriverD. E.,Atkins P. W., InorganicChemistry, Oxford University Press,5^{th}Edn

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2^{nd} Ed. 2010.
2. Bioinorganic Chemistry, Asim Kumar Das, Books & Allied (P) Ltd. 1^{st} ed. 2015.
3. Selected Topic in Inorganic Chemistry, Mallick, Madan and Tuli, S. Chand Publisher. 17^{th} Ed. 2010.
4. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14^{th} Ed. 2017.

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Preparation of simple inorganic complexes. Estimation of different metal ions by complexometric, gravimetric and paper chromatographic methods.

Inorganic preparations

Preparation of complexes:

i. Hexamine nickel(II), $[Ni(NH_3)_6]Cl_2$
ii. Potassium trioxalatoferrate(III) trihydrate
iii. Tetraamminecopper(II) sulphate, $[Cu(NH_3)_4]SO_4.H_2O$
iv. Tetraamminecarbonatocobalt(III) nitrate

Complexometric titration

i. Estimation of Ca by EDTA
ii. Estimation of Mg by EDTA

Gravimetric Analysis:

i. Estimation of nickel(II) using dimethylglyoxime (DMG).
ii. Estimation of copper as CuSCN

iii. Estimation of iron as Fe_2O by precipitating iron as $Fe(OH)_3$.

iv. Estimation of Al(III) by precipitating with oxine and weighing as $Al(oxine)_3$ (aluminiumoxinate).

Chromatography of metal ions

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

i. Ni(II) and Co(II) ii. Fe(III)and Al(III)

Reference Books :

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS (1978).
2. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).
3. Gulati Shikha, Sharma Gulati JL and ManochaShagun, Practical Inorganic Chemistry, IstEdn., CBS Publishers & Distributors Pvt Ltd., (2017).

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 9

ORGANIC CHEMISTRY - III

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand the methods of preparation of nitro compounds, nitriles, amines and diazonium salts. To learn the structure, method of preparation and reactions of naphthalene and anthracene and todescribe classification, nomenclature, structure, aromaticity, synthesis and reactions of Heterocyclic compounds.

UNIT- I

Nitrogen Containing Functional Groups

Preparation and important reactions of nitro compounds, nitriles.

Amines: Effect of substituent and solvent on basicity; Preparation and properties: Gabriel phthalimide synthesis, Carbylamine reaction, Mannich reaction, Hoffmann's exhaustive methylation, Hofmann-elimination reaction; Distinction between 1°, 2° and 3° amines with Hinsberg reagent and nitrous acid.

UNIT-II

Diazonium Salts

Preparation and their synthetic applications.

Polynuclear Hydrocarbons

Reactions of naphthalene and anthracene Structure, Preparation and structure elucidation and important derivatives of naphthalene and anthracene. Polynuclear hydrocarbons.

Unit -III

Heterocyclic Compounds

Classification and nomenclature, Structure, aromaticity in 5-numbered and 6-membered rings containing one heteroatom; Synthesis, reactions and mechanism of substitution reactions of: Furan, Pyrrole (Paal-Knorr synthesis, Knorr pyrrole synthesis Hantzsch synthesis of pyrrole), Thiophene, (Pall- Knorr synthesis) Pyridine (Hantzsch synthesis). Indole (Fischer indole synthesis and Madelung synthesis); Derivaties of furan: Furfural and furoic acid (preparation only).

UNIT-IV

Alkaloids

Natural occurrence, General structural features, Isolation and their physiological action. Hoffmann's exhaustive methylation, Emde's modification, Structure elucidation and synthesis of Hygrine and Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine, and Reserpine.

Terpenes

Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral, Neral and α-terpineol.

Recommended Text Books:

1. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
2. Advanced Organic Chemistry, 2nd Edition, Arun Bahl & B S Bahl, S. Chand Publisher, 2012.

Reference Books :

1. Graham Solomons T. W., Fryhle, Craig B., Snyder Scott A, Organic Chemistry, Wiley Student Ed, llth Edition (2013)
2. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, 2nd Edition, Oxford Publisher, 2014.
3. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

LAB

Credit : **02** | **25** Marks

COURSE OUTCOME

To learn the synthesis, psychological properties, isolation medicinal importance and other synthetic use of terpenes and alkaloids. To learn the techniques of qualitative analysis of organic compounds containing extra elements.

Qualitative organic analysis of organic compounds

1. Detection of extra elements (N, X, S) in organic compounds by Lassaigne's test.
2. Qualitative analysis of unknown organic compounds containing simple functional groups under C, H, N system (amine, nitro, amide and imide), determination of melting/boiling point, and preparation of their derivative.

Reference Books

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
2. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical OrganicChemistry, 5th Ed., Pearson (2012)
3. Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry:Qualitative Analysis, University Press (2000).
4. Ghoshal, A., Mahapatra, B., Nad, A. K. An Advanced Course in Practical Chemistry, New Central Book Agency (2007).

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 10

PHYSICAL CHEMISTRY - IV

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To learn the theory of electrolytic dissociation, concept of conductance and their associated laws and tounderstand the concept of ionic mobilities, applications of conductance measurement Quantitative aspects of Faraday's laws of electrolysis, chemistry of different types of cells and application of emf measurements Understand the concept of concentration cells and Electrical properties of atoms and molecules.

UNIT-I

Conductance -1

Arrhenius theory of electrolytic dissociation. Conductivity, equivalent and molar conductivity and their variation with dilution for weak and strong electrolytes. Molar conductivity at infinite dilution. Kohlrausch law of independent migration of ions. Debye-Huckel-Onsager equation, Wien effect, Debye-Falkenhagen effect, Walden's rules.

UNIT-II

Conductance-II

Ionic velocities, mobilities and their determinations, transference numbers and their relation to ionic mobilities, determination of transference numbers using Hittorf and Moving Boundary methods. Applications of conductance measurement: (i) degree of dissociation of weak electrolytes, (ii) ionic product of water (iii) solubility and solubility product of sparingly soluble salts, (iv) conductometric titrations, and (v) hydrolysis constants of salts.

UNIT-III

Electrochemistry-I

Quantitative aspects of Faraday's laws of electrolysis, rules of oxidation/reduction of ions based on half-cell potentials, applications of electrolysis in metallurgy and industry. Chemical cells, reversible and irreversible cells with examples. Electromotive force of a cell and its measurement, Nernst equation; Standard electrode (reduction) potential and its application to different kinds of half-cells. Application of EMF measurements in determining free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values, using hydrogen, quinone-hydroquinone, glass electrodes.

UNIT-IV

Electrochemistry-II

Concentration cells with and without transference, liquid junction potential; determination of activity coefficients and transference numbers. Qualitative discussion of potentiometric titrations (acid-base, redox, precipitation).

Electrical properties of atoms and molecules

Basic ideas of electrostatics, Electrostatics of dielectric media. Clausius-Mosotti equation and Lorenz-Laurentz equation (no derivation), Dipole moment and molecular polarizabilities and their measurements.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn., 2017.
3. Kapoor, K. L, Text Book of Physical Chemistry, Mac Grow Hill, 3rdEdn., 2017
4. Castellan G. W. Physical Chemistry 4th Ed. Narosa (2004).

Reference Books:

1. EngelT. & Reid P., Physical Chemistry 3rd Ed. Pearson (2013).
2. Levine, I. N. Physical Chemistry 6thEd., Tata McGraw-Hill (2011).
3. McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
4. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To know how to experimentally estimate the strength of acid/base by conductometric and potentiometric titrations.

Conductometry

I. Determination of cell constant.

II. Determination of equivalent conductance, degree of dissociation and dissociation constant of a weak acid.

III. Perform the following conductometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Strong acid vs. weak base

Potentiometry

I. Perform the following potentiometric titrations:

i. Strong acid vs. strong base

ii. Weak acid vs. strong base

iii. Dibasic acid vs. strong base

Reference Books :

1. Khosia, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand &Co.,New Delhi (2011).

2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P., Experiments in Physical Chemistry8th Ed.; McGraw-Hill: New York (2003).

3. Halpern, A. M. &McBane, G. C., Experimental Physical Chemistry 3rdEd.; W.H. Freeman & Co., New York (2003).

4. Viswanathan, B., Raghavan, P.S., Practical Physical Chemistry, Viva Books (2009).

β

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 11

ORGANIC CHEMISTRY - IV

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand the basic principles of UV spectroscopy and use of Woodward rules to calculate ëmax of organic compounds and to understand the concept of IR spectroscopy and its applications for identifying different functional groups. Understand the principle of NMR spectroscopy, interpretation of NMR spectra of simple organic compounds, the principle, instrumentation and applications of mass spectroscopy.

UNIT-I

Organic Spectroscopy - 1

UV Spectroscopy: Types of electronic transitions, ε_{max}, Lambert-Beer's law and its limitations, Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward rules for calculation of λ_{max} for the following systems: α : unsaturated aldehydes: ketones, carboxylic acids and esters; Conjugated dienes: alicyclic, homoannular and heteroannular; Extended conjugated systems (aldehydes, ketones and dienes); distinction between cis and trans isomers.

UNIT-II

Organic Spectroscopy-II

IR Spectroscopy: Fundamental and non-fundamental molecular vibrations; IR absorption positions of O and N containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in simple functional group analysis.

UNIT- III

Organic Spectroscopy-III

NMR Spectroscopy: Basic principles of Proton Magnetic Resonance, chemical shift and factors influencing it; Spin-spin coupling and coupling constant; Anisotropic effects in alkene, alkyne, aldehydes and aromatics; Interpretation of NMR spectra of simple compounds.

Mass Spectroscopy-Basic principle, Fragmentation pattern, instrumentation, determination of m/e ratio. Mc Lafferty rearrangement, Nitrogen rule, Application of mass Spectroscopy on CH_4, C_2H_6, n-butane and neo-pentane.

Applications of IR, UV & NMR for identification of simple organic molecules.

UINIT-IV

Carbohydrates

Occurrence, classification and their biological importance.

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, Osazone formation, determination of ring size of glucose and fructose, Haworth projections and conformational structures; Interconversions of aldoses and ketoses; Killiani-Fischer synthesis and Ruff degradation;

Disaccharides - Structure elucidation of Sucrose; Polysaccharides - Elementary treatment of starch, cellulose.

Recommended Text Books:

1. Kemp William, Organic Spectroscopy, 3rd Edition, Palgrave Publisher, 1991.
2. Davis, B. G_v Fairbanks, A. J., Carbohydrate Chemistry, Oxford Chemistry Primer, Oxford University Press.
3. J Kalsi P. S., Spectroscopy of Organic Compounds, 5th Edition,, New Age International Publishers, 2016.
4. Advanced Organic Chemistry, 2nd Edition, Arun Bahl & B S Bahl, S. Chand Publisher, 2012.

Reference Books:

1. Y R Sharma, Elementary Organic Spectroscopy, 5th Edition, S. Chand & Company, 2013.
2. Jag Mohan, Organic Spectroscopy and Applications, NarosaPublishrs, **2012.**
3. Graham Solomons T. W., Fryhle, Craig B., Snyder Scott A, Organic Chemistry, Wiley Student Ed, llth Edition (2013).
4. Jonathan Clayden, Nick Greeves, Stuart Warren, Organic Chemistry, 2nd Edition, Oxford Publisher, 2014.
5. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Help to know experimentally the qualitative and quantitative analysis of different carbohydrates. Qualitative analysis of unknown organic compounds containing simple bifunctional groups.

1. Qualitative analysis of carbohydrate: aldoses and ketoses, reducing and non-reducing sugars.
2. Qualitative analysis of unknown organic compounds containing simple bifunctional groups, for e.g. salicylic acid, cinnamic acid, nitrophenols etc.
3. Quantitative estimation of sugars:
   (c) Estimation glucose by titration with Fehling's solution.
   (d) Estimation of sucrose by titration with Fehling's solution.
   (e) Estimation glucose and sucrose in a given mixture.
4. Identification of labelled peaks in the ^{1}H NMR spectra of the known organic compounds explaining the relative a-values and splitting pattern.
5. Identification of labelled peaks in the IR spectrum of the same compound explaining the relative frequencies of the absorptions (C-H, O-H, N-H, C-O, C - X, C = C, C = O, N = O, C C, C N stretching frequencies; characteristic bending vibrations are included).

Reference Books :

1. Vogel, A.I. *Quantitative Organic Analysis,* Part 3, Pearson (2012).
2. Mann, F.G. & Saunders, B.C. *Practical Organic Chemistry,* Pearson Education (2009)
3. Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. *Practical OrganicChemistry, 5th Ed.,* Pearson (2012)
4. Ahluwalia, V.K. & Aggarwal, R. *Comprehensive Practical Organic Chemistry:Preparation and Quantitative Analysis,* University Press (2000).
5. Ahluwalia, V.K. & Dhingra, S. *Comprehensive Practical Organic Chemistry:Qualitative Analysis,* University Press (2000).

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 12
PHYSICAL CHEMISTRY - V

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand quantum mechanical operators, postulates of quantum mechanics, application of Schrodinger equation to particle in one dimensional box, simple harmonic oscillator and rigid rotator. Illustrate valence bond and molecular orbital approach of chemical bonding. To learn the basic principles of electronic, vibrational, Rotational and Raman spectroscopy. Explain the laws of photochemistry, quantum yield and chemiluminescence.

UNIT-I

Quantum Chemistry-I

Plank's black body radiation, photoelectric effect, Bohr's theory, de Broglie postulates. Heisenberg's uncertainly Principle, Schrodinger's wave equation (including mathematical treatment). Postulates of quantum mechanics, normalized and orthogonal wave functions, its complex conjugate (idea of complex numbers) and significance of ψ^2, Operators.

Free particle and particle-in-a-box (rigorous treatment), quantization of energy levels, zero-point energy, wave fuctions, probability distribution functions, nodal properties, extension to two and three dimensional boxes, separation of variables, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion: Setting up of Schrodinger equation and discussion of solution and wave functions. Vibrational energy of diatomic molecules and zero-point energy.

Rigid rotator model of rotation of diatomic molecule: SchrodInger equation, transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Qualitative treatment of hydrogen atom and hydrogen-like ions, setting up of Schrodinger equation in spherical polar coordinates, radial part, quantization of energy (only final energy expression). Average and most probable distances of electron from nucleus.

UNIT-II

Chemical Bonding

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+ ion. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wave functions, detailed solution not required) and their limitations. Localized and non-localized molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

UNIT-III

Molecular Spectroscopy-I

Interaction of electromagnetic radiation with molecules and various types of spectra; Born-Oppenheimer approximation.

Rotation spectroscopy: Rotational Energy levels (Rigid rotator) Selection rules, intensities of spectral lines, determination of bond lengths of diatomic and linear triatomic molecules, isotopic substitution.

Vibrational spectroscopy: Classical equation of vibration, computation of force constant, amplitude of diatomic molecular vibrations, anharmonicity, Morse potential, dissociation energies, fundamental frequencies, overtones, hot bands, degrees of freedom for polyatomic molecules, modes of vibration. Vibration-rotation spectroscopy: diatomic vibrating rotator, P, Q, R branches.

UNIT-IV

Molecular Spectroscopy-II

Raman spectroscopy: Qualitative treatment of Rotational Raman effect; Effect of nuclear spin, Vibrational Raman spectra, Stokes and anti-Stokes lines; their intensity difference, rule of mutual exclusion.

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation.

Photochemistry

Characteristics of electromagnetic radiation, physical significance of absorption coefficients. Laws of photochemistry, quantum yield, actinometry, examples of low and high quantum yields, photochemical equilibrium and the differential rate of photochemical reactions, photosensitised reactions, quenching, chemiluminescence.

Recommended Text Books:

1. McQuarie D., Quantum Chemistry, University Science Publishers, 2007
2. Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001).
3. Banwell, C. N. &McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2010).
4. Prasad R K., Quantum Chemistry, New Age International Publishers, 4thEdn, 2010.
5. Rohatagi Mukherjee K K., Fundamentals of Photochemistry, Wiley Eastern Ltd., 1992.

Reference Books:

1. Puri, Sharma &Pathania, Principles of Physical Chemistry, Vishal Publishing Co, 47th Edn., 2017.
2. Kapoor, K. L, Text Book of Physical Chemistry, McGraw Hill, Vol. II, IV
3. Levine, I. N. Quantum Chemistry, PHI.

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Verification of Lambert-Beer's law and determine the concentrations of a different solution. Determine the strength of acid and metal ions by spectrophotometric titration.

Spectroscopy/Colorimetry

1. Study of absorption spectra (visible range) of $KMnO_4$and determine the $\in_{max}$ value. Calculate the energies of the transitions in kJ mol’^{1}, cm”^{1}, and eV.

2. Verify Lambert-Beer's law and determine the concentration of $CuS0_4$/$KMn0_4$/$K_2Cr_20_7$ in a solution of unknown concentration.
3. Determine the dissociation constant of an indicator (phenolphthalein).

Spectrophotometric titration

1. Determine the concentration of HCl against 0.1 N NaOH spectrophotometrically.
2. To find the strength of given ferric ammonium sulfate solution of (0.05 M) by using EDTA spectrophotometrically.
3. To find out the strength of $CuS0_4$ solution by titrating with EDTA spectrophotometrically.
4. To determine the concentration of Cu(II) and Fe(III) solution photometrically by titrating with EDTA.

Reference Books:

1. Khosla, B. D.; Garg, V. C. & Gulati, A., *Senior Practical Physical Chemistry,* R. Chand & Co.: New Delhi (2011).
2. Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. *Experiments in PhysicalChemistry 8th Ed.;* McGraw-Hill: New York (2003).
3. Halpern, A. M. &McBane, G. C. *Experimental Physical Chemistry 3rdEd.;* W.H. Freeman & Co.: New York (2003).
4. J. N. Gurtu, R. Kapoor, Experimental Physical Chemistry.

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 13

INORGANIC CHEMISTRY - IV

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand the classification of organometallic compounds. Synthesis, structures and bonding of metal carbonyls and to study of some industrially important processes catalysis by organometallic compounds. Understand the theoretical principles of qualitative Analysis by H_2S Scheme. Understand the thermodynamic & kinetic stability and reaction mechanisms of metal complexes.

UNIT-I

Organometallic Compounds-I

Definition and classification of organometallic compounds on the basis of bond type. Concept of hapticity of organic ligands.

Metal carbonyls: 18 electron rule, electron count of mononuclear, polynuclear and substituted metal carbonyls of 3d series. General methods of preparation (direct combination, reductive carbonylation, thermal and photochemical decomposition) of mono and binuclear carbonyls of 3d series π-acceptor behaviour of CO (MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT.

Zeise's salt: Preparation and structure, evidences of synergic effect and comparison of synergic effect with that in carbonyls.

UNIT-II

Organometallic Compounds-II

Metal Alkyls: Important structural features of methyl lithium (tetramer)and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds. Role of triethylaluminium in polymerisation of ethene (Ziegler - Natta Catalyst). Species present in ether solution of Grignard reagent and their structures.

Ferrocene: Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation), structure and aromaticity, comparison of aromaticity and reactivity with that of benzene.

UNIT-III

Catalysis by Organometallic Compounds

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Hydroformylation (Co salts)
3. Wacker Process
4. Synthetic gasoline (Fischer Tropsch reaction)

Theoretical Principles in Qualitative Analysis (H_2S Scheme)

Basic principles involved in analysis of cations and anions and solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Removal of Interfering anions (fluoride and phosphate) and need to remove them after Group II.

UNIT-IV

Thermodynamic & kinetic aspects and reaction mechanism of metal complexes

Thermodynamic and kinetic stability, Labile and inert complexes. Stepwise and overall formation constants and their relationship between them. Factors affecting stability of complexes and chelate effect.

Introduction to inorganic reaction mechanisms-types of reaction and classification of substitution reaction. Substitution reaction of square planar complexes, Trans effect and its applications, theories of trans-effect (electrostatic polarization and Static π-Bonding Theory). Kinetics of octahedral substitution (classification of metal ions based on water exchange rate), General mechanism of ligand substitution reactions in octahedral complexes (D, I, I_d, I_a).

Recommended Text Books:

1. Huheey J. E., Keiter E. A. and Keiter R. L, Inorganic Chemistry - Principles of structure and reactivity,, Pearson Education, 4th Ed. 2002.
2. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017.
3. Shriver D. E.,Atkins P. W., InorganicChemistry, Oxford University Press,5th Edn..
4. Svehla, G. *Vogel's Qualitative Inorganic Analysis,* 7th Edition, Prentice Hall, 1996-0307.

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.

2. Selected Topic in Inorganic Chemistry, Mallick, Madan and Tuli, S. Chand Publisher. 17th Ed. 2010.

3. Mehrotra R.C. and Singh, A. *Organometallic Chemistry,* New Age International Publishers, 2nd Edn, 2000.

4. Gupta B. D. and Elias A. J., Basic organometallic Chemistry, 2nd Edn., University Press (2013).

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To learn the qualitative analysis of cations, anions, and insoluble in an inorganic salt mixture

- Qualitative analysis of mixtures containing 4 radicals (2 anions and 2 cations). Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:

  $C0_3^{2-}$, NO_2^-, S^{2-}, SO_3^{2-}, F^-, Cl^-, Br^-, I^-, NO^-, PO_4^{3-}, NH_4^+, K^+, Pb^{2+}, Cu^{2+}, Cd^{2+}, Bi^{3+}, Sn^{2+}, Sb^{3+}, Fe^{3+}, Al^{3+}, Cr^{3+}, Zn^{2+}, Mn^{2+}, Co^{2+}, Ni^{2+}, Ca^{2+}, Mg^{2+}.
- Mixtures may contain one insoluble component ($BaS0_4$, $SrS0_4$, $PbS0_4$, CaF_2 or Al_20_3) orcombination of interfering anions e.g. CO_3^{2-} and SO_3^{2-}, NO_2^- and NO_3^-, Cl and Br^-, Cl^- and I , Br^- and I^-, NO_3^-; and Br^-, NO_3^-; and I.
- Spot tests should be done whenever possible.

Reference Books

1. Vogel's Qualitative Inorganic Analysis, 7th Ed, Revised by G. Svehela, 4th Ed., Person (2007).

2. Gulati Shikha, Sharma Gulati JL and ManochaShagun, Practical Inorganic Chemistry, Ist Edn., CBS Publishers & Distributors Pvt Ltd., (2017).

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 14

ORGANIC CHEMISTRY - V

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To know the classification, synthesis and properties of amino acids and peptides, structure of proteins, protein denaturation and renaturation and to explain the characteristics of enzymes and the mechanism of enzyme action. Illustrate the structure, synthesis, and reactions of some nucleic acids. Explain hydrogenation, saponification value, acid value, and iodine number. reversion and rancidity of fats and oils. Understand the concept of Energy in Biosystems - catabolism and anabolism. Structure and Importance of some pharmaceutical compounds. Classification of dyes. Synthesis and applications of Azo, Triphenylmethane, and Phthalein dyes.

UNIT-I

Amino Acids, Peptides and Proteins

Amino acids: Classification; α - Amino acids - Synthesis, ionic properties and reactions. Zwitterions, pK_a values, isoelectric point and electrophoresis.

Peptides: Classification, determination of their primary structures-end group analysis, methods of peptide synthesis. Synthesis of peptides using N-protecting, C-protecting and C-activating groups -Solid-phase synthesis.

Proteins: Structure of proteins, protein denaturation and renaturation

UNIT-II

Enzymes

Introduction, classification and characteristics of enzymes. Salient features of active site of enzymes. Mechanism of enzyme action (taking trypsin as example), factors affecting enzyme action, coenzymes and cofactors and their role in biological reactions, specificity of enzyme action (including stereo specificity), enzyme inhibitors and their importance, phenomenon of inhibition (competitive, uncompetitive and non-competitive inhibition including allosteric inhibition).

Nucleic Acids

Components of nucleic acids, Nucleosides and nucleotides;

Structure, synthesis and reactions of: Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides.

UNIT-III

Lipids

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenntion of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

Concept of Energy in Biosystems

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism and anabolism).

Overview of catabolic pathways of fat and protein.

Interrelationship in the metabolic pathways of protein, fat and carbohydrate. Caloric value of food, standard caloric content of food types.

UNIT-IV

Pharmaceutical Compounds: Structure and Importance

Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis). An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

Dyes

Classification, colour and constitution; Mordant and Vat dyes; Chemistry of dyeing. Synthesis and applications of: *Azo dyes* - Methyl orange and Congo red (mechanism of Diazo Coupling); *Triphenylmethane dyes* - Malachite Green, and crystal violet; *Phthalein dyes* - Phenolphthalein and Fluorescein.

Recommended Text books

1. Nelson, D.L., Cox, M.M. and Lehninger, A.L. Principles of Biochemistry. 6thEdn. W.H. Freeman and Co. (2013).
2. Kar Ashutosh, Medicinal chemistry, New Age International (P) Ltd., (2007)
3. Debojyoti Das, Biochemistry, (part-I) Academic Publishers (1979)

Reference Books:

1. Talwar, G.P. & Srivastava, M. Textbook of Biochemistry and Human Biology, 3rd Ed. PHI Learning.
2. Berg, J.M., Tymoczko, J.L &Stryer, L. Biochemistry, W.H. Freeman, 2002.
4. Murray, R.K., Granner, O.K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/ McGraw-Hill.
5. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry, 6th Edition. W.H. Freeman and Co. (2002).
6. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).
7. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Preparations of Aspirin/ Methyl orange. Estimation of different organic compounds such as phenol/ aniline/ glycine/ formaldehyde/ascorbic acid. Determination of saponification value and iodine number of oil/ fat.

1. Preparations of the following compounds
   i. Aspirin ii. Methyl orange
2. Estimation of phenol and aniline by bromination method.
3. Saponification value of an oil/fat/ester.
4. Estimation of glycine by Sorenson's formalin method.
5. Estimation of formaldehyde (formalin).
6. Estimation of ascorbic acid in fruit juices/Vitamin C tablet (Iodometric method)
7. Determination of Iodine number of an oil/ fat.

Reference Books:

1. Arthur, I. Vogel, Elementary Practical Organic Chemistry, Part-1 Small scale preparations, Indian Edition, Pearson (2011).

2. Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
3. Arthur, I. Vogel, *Quantitative Organic Analysis,* Pearson.
4. Wilson, K. & Walker, J. Practical Biochemistry. Cambridge University Press (2009).

+3 THIRD YEAR FIFTH SEMESTER

DSE - 1

POLYMER CHEMISTRY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To learn about the history, classification and functionality of polymeric materials. To know about the kinetics of polymerization, details on crystallization and morphology of crystalline polymers, determination of crystalline melting point of a crystalline material and the factors effecting crystalline melting point. To understand the nature and structure of polymers, determination of molecular weight of polymers and thermodynamics of polymer solution. To study the preparation, structure, properties and application of different types of addition and condensation polymers

UNIT-I

$\overline{M}_n$

Introduction and history of polymeric materials:

Different schemes of classification of polymers, Polymer nomenclature, Molecular forces and chemical bonding in polymers, Texture of Polymers.

Functionality and its importance:

Criteria for synthetic polymer formation, classification of polymerization processes, Relationships between functionality, extent of reaction and degree of polymerization. Bi-functional systems, Poly-functional systems.

UNIT-II

Mechanism & Kinetics of Polymerization:

Polymerization reactions-addition and condensation, mechanism and kinetics of step growth, radical chain growth, ionic chain (both cationic and anionic) and coordination polymerizations, Mechanism and kinetics of copolymerization, polymerization techniques.

Crystallization and crystallinity:

Determination of crystalline melting point and degree of crystallinity, Morphology of crystalline polymers, Factors affecting crystalline melting point.

UNIT-III

Molecular weight of polymers and their determination ($,\overline{M}_w$, $\overline{M}_v$, $\overline{M}_z$) by end group analysis,viscometry and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

Glass transition temperature (T_g) and it determination: WLFequation, Outlines of factors affecting glass transition temperature (T_g).

UNIT-IV

Properties of polymers (physical, thermal and mechanical properties).

Preparation, structure, properties and applications of the following polymers: polyolefins (polyethylene, polypropylene), polystyrene, polyvinyl chloride, polyvinyl acetate, polyacrylamide, fluoro polymers (Teflon), polyamides (nylon-6 and nylon 6,6). Thermosetting polymers - phenol formaldehyde resins (Bakelite, Novolac), polyurethanes, conducting polymers (polyacetylene, polyaniline). Brief outline of biodegradable polymers.

Recommended Text Books :

1. V. R. Gowarikar, Jayadev Sreedhar, N. V. Viswanathan, Polymer Science 1st Edition, New Age International Publishers, 1986.
2. Premamoy Ghosh, Polymer Science and Technology: Plastics, Rubber, Blends and Composites, 3rdEdition, McGraw Hill Education, 2010.
3. P. Bahadur &N.V.Sastry, Principles of polymer science, Narosa Publishing house, New Delhi 2002.
4. Fred W. Billmeyer, Textbook of Polymer Science, 3rd ed. Wiley-Interscience (1984)

Reference books

1. L.H. Sperling, Introduction to Physical Polymer Science, 4th ed. John Wiley & Sons (2005)
2. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)
3. Seymour/Carraher's Polymer Chemistry, 9th ed. by Charles E. Carraher, Jr. (2013).
4. Nayak P.L, Polymer Chemistry, Kalyani Publisher (2017).

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To know how to prepare polymers by using free radical polymerization, redox polymerization, interfacial polymerization, precipitation polymerization, addition polymerization and condensation polymerization process. To learn experimentally how to characterize and analyze a polymeric compound or material.

Polymer synthesis (At least three experiment)

1. Preparation of nylon-6,6 / Polyaniline
2. Preparations of phenol-formaldehyde resin-novalac / phenol-formaldehyde resin resol.
3. Preparation of urea-formaldehyde resin
4. Free radical solution polymerization of styrene (St) / Methyl Methacrylate (MMA) / Methyl Acrylate (MA) / Acrylic acid (AA).
   a. Purification of monomer
   b. Polymerization using benzoyl peroxide (BPO) / 2,2'-azo-bis-isobutylonitrile (AIBN)

5. Redox polymerization of acrylamide
6. Precipitation polymerization of acrylonitrile

Polymer characterization/analysis (At least two different experiemtn)

1. Determination of molecular weight by viscometry:
   a. Polyacrylamide/Polystyrene
   b. (Polyvinyl pyrolidine (PVP)
2. Determination of acid value/saponification value of a resin.
3. Determination of hydroxyl number of a polymer using colorimetric method.
4. Estimation of the amount of HCHO in the given solution by sodium sulphite method
5. Analysis of some IR spectra of polymers - Identification of labelled peaks in IR spectra of known polymer.

Reference Books:

1. Hundiwale G.D., Athawale V.D., Kapadi U.R. and Gite V. V., Experiments in Polymer Science, New Age Publications (2009)
2. Malcohm P. Stevens, Polymer Chemistry: An Introduction, 3rd Ed.
3. Joel R. Fried, Polymer Science and Technology, 2nd ed. Prentice-Hall (2003)
4. Petr MunkandTejraj M. Aminabhavi, Introduction to Macromolecular Science, 2nd ed. John Wiley & Sons(2002)
5. Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3rd ed. Oxford University Press (2005)

+3 THIRD YEAR FIFTH SEMESTER

DSE - 2

GREEN CHEMISTRY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

Understanding of the concepts and principles of Green Chemistry and its importance Designing chemical synthesis of compounds by greener methods and using alternative energy sources like microwaves and ultrasound waves. To know about the examples of green synthesis/ reactions with some real-world cases. Understanding the future trends of green chemistry

UNIT-I

Introduction to Green Chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry. Limitations/ Obstacles in the pursuit of the goals of Green Chemistry.

Principles of Green Chemistry and Designing a Chemical synthesis-I

Twelve principles of Green Chemistry. Explanations of principle with special emphasis on - Designing green synthesis processes: Prevention of Waste/ by-products; maximize the incorporation of the materials used in the process into the final products (Atom Economy) with reference to rearrangement, addition, substitution and elimination reactions; Prevention/ minimization of hazardous/ toxic products; Designing safer chemicals; Use of safer solvents and auxiliaries (e.g. separating agent) -green solvents (supercritical $C0_2$, water, ionic liquids), solventless processes, immobilized solvents.

UNIT-II

Principles of Green Chemistry and Designing a Chemical synthesis-II
Explanation of green chemistry principles with special emphasis on:

Energy efficient processes for synthesis - use of microwaves and ultrasonic energy. Selection of starting materials (use of renewable feedstock); avoidance of unnecessary derivatization (e.g. blocking group, protection groups, deprotection); Use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products use of chemically safer substances for prevention of chemical accidents, inherent safer design greener - alternative to Bhopal Gas Tragedy (safer route to carcarbaryl) and Flixiborough accident (safer route to cyclohexanol); real-time, in-process monitoring and control to prevent the formation of hazardous substances; development of green analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes;

UNIT-III

Examples of Green Synthesis/ Reactions and some real world cases-I

Green Synthesis of the following compounds: adipic acid, catechol, methyl methacrylate, urethane, disodium iminodiacetate (alternative to Strecker synthesis), paracetamol, and furfural. *Microwave assisted reactions:* Applications to reactions (i) in water: Hofmann Elimination, hydrolysis (of benzyl chloride, methyl benzoate to benzoic acid), Oxidation (of toluene, alcohols); (ii) reactions in organic solvents: Diels-Alder reaction and Decarboxylation reaction.

Ultrasound assisted reactions: Applications to esterification, saponification, Simmons-Smith Reaction (Ultrasonic alternative to Iodine).

UNIT-IV

Examples of Green Synthesis/ Reactions and some real world cases-II

Surfactants for carbon dioxide - replacing smog producing and ozone depleting solvents with CO_2 for precision cleaning and dry cleaning of garments; Designing of Environmentally safe marine antifoulant; Rightfit pigment: synthetic azopigments to replace toxic organic and inorganic pigments; Synthesis of a compostable and widely applicable plastic (poly lactic acid) from corn; Development of Fully Recyclable Carpet: Cradle to Cradle Carpeting

Future Trends in Green Chemistry

Oxidizing and reducing reagents and catalysts, multifunctional reagents; Combinatorial green chemistry, Proliferation of solventless reactions; Green chemistry in sustainable development. (Bio-diesel, bio-ethanol and biogas)

Recommended Text Books:

1. Anastas P.T. & WarnerJ.K.: Green Chemistry-Theory and Practical, Oxford University Press (2000).
2. Ahluwalia V.K. & Kidwai M.: New Trends in Green Chemistry, Anamalaya Publishers, New Delhi (2004).
3. Kumar V., An Introduction to Green Chemistry, Vishal Publishing Co., (2015).

Reference Books:

1. Matlack A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
2. Das Asim K. amd Das Mahua , Environment Chemistry with Green Chemistry, Books and Allied (P) Ltd. (2010)

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To learn the synthesis of different organic compounds/nanoparticles by eco-friendly green methods.

At least five experiments should be done:

1. Acetylation of primary amine (Aniline to N-phenylacetamide) using Zn dust.
2. Nitration of salicylic acid by green method (Using calcium nitrate and acetic acid).
3. Bromination of acetanilide using eerie ammonium nitrate/KBr.
4. Microwave assisted nitration of Phenols using $Cu(N0_3)_2$.
5. Detection of elements in organic compounds by green method (Sodium carbonate fusion)
6. Base catalyzed Aldol condensation (Synthesis of dibenzalpropanone)
7. Vitamin C clock reaction using vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch. Effect of concentration on clock reaction.
8. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.
9. Diels Alder reaction in water: Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.
10. Preparation and characterization of nanoparticles (Cu, Ag) using plant extract.
11. Preparation of propene by following two methods or any other reactions like addition, elimination, substitution showing atomic economy can be studied
    (i) Triethylamine ion + OH^{-}'! propene + trimethylpropene + water
    (ii) 1-propanol $\xrightarrow{H_2S0_4/Ä}$ propene + water

Reference Books:

1. Monograph on Green Chemistry Laboratory Experiments, edited and published by Green Chemistry Task Force Committee, DST Govt. of India, p. 1-79.

2. Kirchoff, M. & Ryan, M.A. *Greener approaches to undergraduate chemistryexperiment.* American Chemical Society, Washington DC (2002).

3. Sharma, R.K.; Sidhwani, I.T. & Chaudhari, M.K. I.K. *Green Chemistry Experiment^ monograph International Publishing House Pvt Ltd. New Delhi.* Bangalore CISBN978-93-81141-55-7 (2013).

+3 THIRD YEAR SIXTH SEMESTER

DSE - 3

INDUSTRIAL CHEMICALS AND ENVIRONMENT

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To study the production/manufacturing process, handling, and uses of some industrial gases and inorganic chemicals. Preparation of metals and ultrapure metals for semiconductor technology and to understand the environment ecosystems; air pollution – types, sources and harmful effects; water pollution – Sources, nature and impact of water pollutants and purification methods. Conventional/Non-conventional sources of energy, nuclear pollution. Concept of bio-catalysis.

UNIT-I

Industrial Gases and Inorganic Chemicals

Industrial Gases: Large scale production, uses, storage and hazards in handling of the following gases: oxygen, nitrogen, argon, hydrogen, acetylene, carbon monoxide, chlorine, sulphur dioxide.

Inorganic Chemicals: Manufacture, application and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, potassium dichromate and potassium permanganate.

Industrial Metallurgy

Preparation of metals (ferrous and nonferrous) and ultrapure metals for semiconductor technology.

UNIT-II

Environment and its segments

Ecosystems. Biogeochemical cycles of carbon, nitrogen and sulphur.

Air Pollution: Major regions of atmosphere. Chemical and photochemical reactions in atmosphere. Air pollutants: types, sources, particle size and chemical nature; Photochemical smog: its constituents and photochemistry. Environmental effects of ozone. Major sources of air pollution.

Pollution by SO_2, CO_2, CO, NO_x, and H_2S and control procedures.

Effects of air pollution on living organisms and vegetation. Greenhouse effect and global warming, Ozone depletion by oxides of nitrogen, chlorofluorocarbons and halogens, removal of sulphur from coal.

UNIT-III

Water Pollution: Hydrological cycle, water resources, aquatic ecosystems, Sources and nature of water pollutants, Techniques for measuring water pollution, Impacts of water pollution on hydrological and ecosystems.

Water purification methods. Effluent treatment plants (primary, secondary and tertiary treatment). Industrial effluents from the following industries and their treatment: electroplating, textile, tannery, dairy, petroleum and petrochemicals, fertilizer. Sludge disposal.

Industrial waste management: incineration of waste. Water treatment and purification (reverse osmosis, ion exchange). Water quality parameters for wastewater, industrial water and domestic water.

UIMIT-IV

Energy and Environment

Sources of energy: Coal, petrol and natural gas. Nuclear fusion/fission, solar energy, hydrogen, geothermal, tidal and hydel.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

Biocatalysis

Introduction to biocatalysis: Importance in green chemistry and chemical industry.

Recommended Text Books:

1. De, A. K. *Environmental Chemistry:* New Age International Pvt., Ltd, New Delhi, 2010.
2. Stocchi E., *Industrial Chemistry,* Vol-I, Eilis Norwood Ltd. UK.
3. Sharma, B.K. & Gaur, H. Industrial Chemistry, Goel Publishing House, Meerut (1996).

Reference Books:

4. Felder R.M. and Rousseau R.W., *Elementary Principles of Chemical Processes,* Wiley Publishers, New Delhi.
5. Dara S. S., *A Textbook of Engineering Chemistry,* S. Chand & Company Ltd. New Delhi.
6. Miller G.T., Environmental Science, 11^{th} edition. Brooks/ Cole (2006).
7. Mishra, Environmental Studies, Selective and Scientific Books, New Delhi (2005).

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Determination of different water parameters such as DO, COD, BOD, chloride, sulphate, salinity, total alkalinity, and dissolved carbon dioxide. Estimation of SPM in air samples and preparation of borax/ boric acid.

1. Determination of Dissolved Oxygen (DO) in water.
2. Determination of Chemical Oxygen Demand (COD)
3. Determination of Biological Oxygen Demand (BOD)
4. Percentage of available chlorine in bleaching powder.

5. Measurement of chloride, sulphate and salinity of water samples by simple titration method ($AgNO_3$ and potassium chromate).
6. Estimation of total alkalinity of water samples (CO_3^{2-}, HCO_3) using double titration method.
7. Measurement of dissolved CO_2
8. Study of some of the common bio-indicators of pollution.
9. Estimation of SPM in air samples.
10. Preparation of borax/ boric acid.

Reference Books:

1. Dara S. S., A Textbook on Experiments and Calculations in Engineering Chemistry S Chand & Company; 9th Revised edition (2015).
2. E. Stocchi: *Industrial Chemistry,* Vol-I, Ellis Horwood Ltd. UK.
3. R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes,* Wiley Publishers, New Delhi.
4. A. Kent: Riegel's *Handbook of Industrial Chemistry,* CBS Publishers, New Delhi.
5. S. M. Khopkar, *Environmental Pollution Analysis:* Wiley Eastern Ltd, New Delhi.

+3 THIRD YEAR SIXTH SEMESTER

DSE - 4

Project Work

Furl Mark : 80+20

COURSE OUTCOME

Students express their creativity and develop higher-order thinking skills. To know how to carry out research work and write a review article on a particular field or topic as assigned by the teacher. Develops an aptitude for doing research. To know how to handle the technical devices for presenting research works.

+3 FIRST YEAR FIRST SEMESTER

GE - 1

GENERIC ELECTIVE PAPER I (THEORY)

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

SECTION A: INORGANIC CHEMISTRY-1

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To understand the atomic theory, structure of the atom, Schrodinger's wave equation and its significance and to describe the theories of bonding and predict the structure of molecules. Explain the formation and stability of reaction intermediates, nucleophiles and electrophiles. Illustrate the types of isomerism, aromaticity, methods of preparation and reactions of alkanes, alkenes and alkynes.

Unit-I

Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrodinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for Is, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Quantum numbers and their significance, shapes of s, p and d atomic orbitals, nodal planes.

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit-II

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics, energy considerations.Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules and its applications.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for S-S, S-P and P-P combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules (N_2, 0_2) and heteronuclear diatomic molecules (CO, NO). Comparison of VB and MO approaches

Section B: Organic Chemistry-1

Unit-III

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive effect, Electromeric effect, Resonance and hyperconjugation. Cleavage of bonds: Homolysis and heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Huckel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). D and L; cis-trans nomenclature; CIP Rules: R/ S (for one chiral carbon atoms) and E / Z Nomenclature (for up to two C=C systems).

Unit-IV

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Up to 5 Carbons).Preparation: Catalytic hydrogenation, Wurtz reaction,Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Up to 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeff's rule); cis-alkenes (Partial catalytic hydrogenation) and trans-alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis,

Alkynes: (Up to 5 Carbons) Preparation: Acetylene from $CaC_2$and conversion to higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$,ozonolysis.

Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry, Wiley India, 5thEdn., 2008.
2. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017.
3. ShriverD. E.,Atkins P. W., InorganicChemistry, Oxford University Press,5thEdn..
4. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry - Principles of structure and reactivity,, Pearson Education, 4th Ed. 2002.

5. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
6. BhalArun & BhalB S , Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.
7. Kalsi, P. S. Stereochemistry Conformation and Mechanism; 8thEdn, New Age International, 2015.

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.
2. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.
3. Mallick, Madan and Tuli, S. Chand Selected Topic in Inorganic Chemistry,, 17thEdn. 2010.
4. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications.

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

To determine the strength of sodium carbonate/bicarbonate and oxalic acid solutions by volumetric analysis. To learn the detection of functional groups in organic compounds. Identify different compounds by paper chromatography.

Section A : Inorganic Chemistry

Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMn0_4$.
4. Estimation of Fe(II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$

Section B:Organic Chemistry

1. Detection of extra elements (N, S, Cl) in organic compounds (containing up to two extra elements)
2. Separation of mixtures by Chromatography: Measure the R_1 value in each case (combination of two compounds to be given)

(3) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.

(4) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
3. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

+3 FIRST YEAR SECOND SEMESTER

GE - 2

CHEMICAL ENERGETICS,
EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

Time : **3** Hrs. End Semester Theory : **50** Marks
Credit : **04** Mid Semester Theory : **15** Marks

COURSE OUTCOME

To explain chemical energetics and chemical equilibria and to explain the ionic equilibria, common ion effect and determination pH of different salts. To study the preparation, important reactions of aromatic hydrocarbon, alky/aryl halides, the preparation and important reactions of alcohols, phenols, and ethers.

Section A: Physical Chemistry-I

Unit-I

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics. Limitations of First Law of Thermodynamic.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, Enthalpy of combustion and neutralisation integral and differential enthalpies of solution and dilution. Specific heat, molar capacities, Derivation of C_p -C_v = R Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature - Kirchhoff's equation.

Statement of Third Law of thermodynamics: Calculation of absolute entropies of substances.

Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and $\Delta G°$, Le Chatelier's principle. Relationships between K_p, K_c and K_x for reactions involving ideal gases

Unit- II

Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts - applications of solubility product principle.

Section B: Organic Chemistry-II

Unit- III

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Alkyl benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Up to 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile &isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by-OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Unit- IV

Alcohols, Phenols and Ethers (Up to 5 Carbons)

Alcohols: Preparation: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes and ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMn0_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction,

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): Formaldehyde, acetaldehyde, acetone and benzaldehyde

Preparation: from acid chlorides and from nitriles.

Reactions- Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives, Iodoform test. Aldol Condensation, Cannizzaro's reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co, 47th Edn., 2017.
3. K. L Kapoor, Text Book of Physical Chemistry, Mac Grow Hill, 3rdEdn. 2017.
4. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

5. Arun Bahl & B S Bahl, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.

Reference Books:

1. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications.
2. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

LAB

Credit : **02** **25** Marks

COURSE OUTCOME

Learn to determine the heat capacity of the calorimeter, enthalpy of neutralisation, ionisation etc. Learn to prepare buffer solutions with different pH. Purification by crystallisation and melting point determination of organic compounds.

Section A : Physical Chemistry

Thermochemistry (any three)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of ΔH.

Ionic equilibria

pH measurements

a) Measurement of pH of different solutions like aerated drinks, fruit juices, shampoos and soaps (use dilute solutions of soaps and shampoos to prevent damage to the glass electrode) using pH-meter.

b) Preparation of buffer solutions:
   - Sodium acetate-acetic acid
   - Ammonium chloride-ammonium hydroxide

   Measurement of the pH of buffer solutions and comparison of the values with theoretical values.

Section B : Organic Chemistry

1. Purification of organic compounds by crystallization (from water) and determination of melting. Preparations, recrystallisation, determination of melting point and calculation of quantitative yields of the followings:

   (a) Bromination of Phenol/Aniline

   (b) Benzoylation of amines/phenols

   (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

Reference Books

1. A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009).
3. Khosia, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co., New Delhi (2011).
4. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005).

+3 SECOND YEAR THIRD SEMESTER

GE - 3

GENERIC ELECTIVE PAPER I (THEORY)

ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

SECTION A : INORGANIC CHEMISTRY-1

Time : **3** Hrs. End Semester Theory : **50** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Unit-I

Atomic Structure

Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra.

Quantum mechanics: Time independent Schrodinger equation and meaning of various terms in it. Significance of ψ and ψ^2, Schrodinger equation for hydrogen atom. Radial and angular parts of the hydogenic wave functions (atomic orbitals) and their variations for ls, 2s, 2p, 3s, 3p and 3d orbitals (Only graphical representation). Quantum numbers and their significance, shapes of s, p and d atomic orbitals, nodal planes.

Rules for filling electrons in various orbitals, Electronic configurations of the atoms. Stability of half-filled and completely filled orbitals, concept of exchange energy. Relative energies of atomic orbitals, Anomalous electronic configurations.

Unit-II

Chemical Bonding and Molecular Structure

Ionic Bonding: General characteristics, energy considerations.Lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Lande equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules and its applications.

Covalent bonding: VB Approach: Shapes of some inorganic molecules and ions on the basis of VSEPR and hybridization with suitable examples of linear, trigonal planar, square planar, tetrahedral, trigonal bipyramidal and octahedral arrangements.

Concept of resonance and resonating structures in various inorganic and organic compounds.

MO Approach: Rules for the LCAO method, bonding and antibonding MOs and their characteristics for S-S, S-P and P-P combinations of atomic orbitals, nonbonding combination of orbitals, MO treatment of homonuclear diatomic molecules (N_2, 0_2) and heteronuclear diatomic molecules (CO, NO). Comparison of VB and MO approaches

Section B: Organic Chemistry-1

Unit-III

Fundamentals of Organic Chemistry

Physical Effects, Electronic Displacements: Inductive effect, Electromeric effect, Resonance and hyperconjugation. Cleavage of bonds: Homolysis and heterolysis.

Structure, shape and reactivity of organic molecules: Nucleophiles and electrophiles. Reactive Intermediates: Carbocations, Carbanions and free radicals.

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values. Aromaticity: Huckel's rule.

Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (up to two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). D and L; cis-trans nomenclature; CIP Rules: R/ S (for one chiral carbon atoms) and E / Z Nomenclature (for up to two C=C systems).

Unit-IV

Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Alkanes: (Up to 5 Carbons).Preparation: Catalytic hydrogenation, Wurtz reaction,Kolbe's synthesis, from Grignard reagent. *Reactions:* Free radical Substitution: Halogenation.

Alkenes: (Up to 5 Carbons)Preparation: Elimination reactions: Dehydration of alkenesand dehydrohalogenation of alkyl halides (Saytzeff's rule); cis-alkenes (Partial catalytic hydrogenation) and trans-alkenes (Birch reduction). *Reactions:* cis-addition (alk. $KMnO_4$) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis,

Alkynes: (Up to 5 Carbons)Preparation: Acetylene from $CaC_2$and conversion intohigher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides.

Reactions: formation of metal acetylides, addition of bromine and alkaline $KMnO_4$,ozonolysis.

Recommended Text Books:

1. Lee J. D., Concise Inorganic Chemistry, Wiley India, 5thEdn., 2008.
2. Puri, Sharma, Kalia, Principles of Inorganic Chemistry, Vishal Pub. Co., 33rd ed., 2017.
3. Shriver D. E.,Atkins P. W., InorganicChemistry, Oxford University Press,5thEdn..

4. Huheey J. E., Keiter E. A. and Keiter R. L., Inorganic Chemistry - Principles of structure and reactivity,, Pearson Education, 4th Ed. 2002.

5. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).

6. Bhal Arun & Bhal B S , Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.

7. Kalsi, P. S. Stereochemistry Conformation and Mechanism; 8thEdn, New Age International, 2015.

Reference books

1. Das Asim K., Fundamentals of Inorganic Chemistry, Vol. II, CBS Publications, 2nd Ed. 2010.

2. Pradeep's Inorganic Chemistry, Vol. I & II, Universal Book seller, 14th Ed. 2017.

3. Mallick, Madan and Tuli, S. Chand Selected Topic in Inorganic Chemistry,, 17thEdn. 2010.

4. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications.

LAB

Credit : **02** **25** Marks

Section A : Inorganic Chemistry

Volumetric Analysis

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture.
2. Estimation of oxalic acid by titrating it with $KMnO_4$.
3. Estimation of water of crystallization in Mohr's salt by titrating with $KMnO_4$.
4. Estimation of Fe(II) ions by titrating it with $K_2Cr_2O_7$ using internal indicator.
5. Estimation of Cu(II) ions iodometrically using $Na_2S_2O_3$

Section B:Organic Chemistry

1. Detection of extra elements (N, S, Cl) in organic compounds (containing up to two extra elements)
2. Separation of mixtures by Chromatography: Measure the R_1 value in each case (combination of two compounds to be given)

(3) Identify and separate the components of a given mixture of 2 amino acids (glycine, aspartic acid, glutamic acid, tyrosine or any other amino acid) by paper chromatography.

(4) Identify and separate the sugars present in the given mixture by paper chromatography.

Reference Books:

1. Mendham, J., A. I. Vogel's Quantitative Chemical Analysis 6th Ed., Pearson, 2009.

2. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

3. Ahluwalia, V.K., Dhingra, S. and Gulati A, College Practical Chemistry, University Press (2005)

+3 SECOND YEAR FOURTH SEMESTER

GE - 4

CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL ORGANIC CHEMISTRY

Time : **3** Hrs. End Semester Theory : **50** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Section A: Physical Chemistry-I

Unit-I

Chemical Energetics

Review of thermodynamics and the Laws of Thermodynamics. Limitations of First Law of Thermodynamic.

Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, Enthalpy of combustion and neuterlisation integral and differential enthalpies of solution and dilution. Specific heat, molar capacities, Derivation of C_p -C_v = R Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature - Kirchhoff's equation.

Statement of Third Law of thermodynamics: Calculation of absolute entropies of substances.

Chemical Equilibrium

Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between ΔG and $\Delta G°$, Le Chatelier's principle. Relationships between K_p , K_c and K_x for reactions involving ideal gases

Unit- II

Ionic Equilibria

Strong, moderate and weak electrolytes, degree of ionization, factors affecting degree of ionization, ionization constant and ionic product of water. Ionization of weak acids and bases, pH scale, common ion effect. Salt hydrolysis-calculation of hydrolysis constant, degree of hydrolysis and pH for different salts. Buffer solutions. Solubility and solubility product of sparingly soluble salts - applications of solubility product principle.

Section B: Organic Chemistry-II

Unit- III

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

Aromatic hydrocarbons

Preparation (Benzene): from phenol, by decarboxylation, from acetylene, from benzene sulphonic acid. Reactions: (Case benzene): Electrophilic substitution: nitration, halogenation and sulphonation. Friedel-Craft's reaction (alkylation and acylation) (up to 4 carbons on benzene). Side chain oxidation of alkyl benzenes (up to 4 carbons on benzene).

Alkyl and Aryl Halides

Alkyl Halides (Up to 5 Carbons) Types of Nucleophilic Substitution (SN1, SN2 and SNi) reactions.

Preparation: from alkenes and alcohols. Reactions: hydrolysis, nitrite & nitro formation, nitrile &isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

Aryl Halides Preparation: (Chloro, bromo and iodo-benzene case): from phenol, Sandmeyer Gattermann reactions.

Reactions (Chlorobenzene): Aromatic nucleophilic substitution (replacement by-OH group) and effect of nitro substituent. Benzyne Mechanism: KNH_2/NH_3 (or $NaNH_2/NH_3$).

Unit- IV

Alcohols, Phenols and Ethers (Up to 5 Carbons)

Alcohols: Preparation: Preparation of 1°, 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes and ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk. $KMn0_4$, acidic dichromate, conc. HNO_3). Oppeneauer oxidation Diols: (Up to 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

Phenols: (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction,

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Aldehydes and ketones (aliphatic and aromatic): Formaldehyde, acetaldehyde, acetone and benzaldehyde

Preparation: from acid chlorides and from nitriles.

Reactions- Reaction with HCN, ROH, $NaHSO_3$, NH_2-G derivatives, Iodoform test. Aldol Condensation, Cannizzaro's reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction.

Recommended Text Books:

1. Atkins P. W. & Paula, J. de, Elements of Physical Chemistry, Oxford University Press, 6th Ed., (2006).
2. Principles of Physical Chemistry, Puri, Sharma & Pathania, Vishal Publishing Co, 47th Edn., 2017.
3. K. L Kapoor, Text Book of Physical Chemistry, Mac Grow Hill, 3rdEdn. 2017.
4. Morrison, R. N. & Boyd, R. N., Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
5. Arun Bahl & B S Bahl, Advanced Organic Chemistry, 2nd Edition, S. Chand Publisher, 2012.

Reference Books:

1. Kheterpal S.C., Pradeep's Physical Chemistry, Vol. I & II, Pradeep Publications.
2. Dhawan, S.N., Pradeep's Organic Chemistry, (Vol. I and II), Pradeep Publications

LAB

Credit : **02** **25** Marks

Section A : Physical Chemistry

Thermochemistry (any three)

1. Determination of heat capacity of calorimeter for different volumes.
2. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.
3. Determination of enthalpy of ionization of acetic acid.
4. Determination of integral enthalpy of solution of salts (KNO_3, NH_4Cl).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of AH.

COMPUTER SCIENCE

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 1

PROGRAMMING USING C

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Program Specific Outcomes (PSOs):

1. Ability to apply knowledge of computing, mathematics, and basic sciences that may be relevant and appropriate to the domain.
2. Ability to analyze a problem, identify and define the computing requirements, which may be appropriate to its solution.
3. Ability to design, implement, and evaluate computer-based system, process, component, or program to meet desired needs.
4. Ability to analyze the local and global impact of computing on individuals, organizations, and society.
5. Recognition of the need for and an ability to engage in continuing professional development.
6. Ability to use current techniques, skills, and tools necessary for computing practices.
7. Ability to use and apply current technical concepts and practices in the core development of solutions in the form of Information technology.
8. Aability to identify and analyze user needs and take them into account in the selection, creation, evaluation, and administration of computer-based systems.

OBJECTIVES:

- To learn basics of C programming language.
- To be able to develop logics to create programs / applications in C.

Unit-1

Introduction: Introduction to Programming Language, Introduction to C Programming, Keywords & Identifiers, Constants, Variables, Input and Output Operations, Compilation and pre-processing,

Data types: Different data types, Data types qualifier, modifiers. Memory representation, size and range,

Operators: Operators (Arithmetic, Relational, Logical. Bitwise, Assignment & compound assignment, Increment & Decrement, Conditional), Operator types (unary, binary, ternary). Expressions, Order of expression (Precedence and associativity)

Control structures: Decision Making and Branching (Simple IF Statement, IF...ELSE Statement, Nesting IF... ELSE Statement, ELSE IF Ladder), Selection control structure (Switch Statement).

Unit-2

Loops: The WHILE Statement, The DO...WHILE Statement The FOR Statement, Jumps in Loops,

Array: Concept of Array, Array Declaration, types of array (one and multiple dimension). Character Arrays and Strings, Subscript and pointer representation of array, Array of Pointers, Limitation of array,

Pointers: Concept of Pointer (null pointer, wild pointer, dangling pointer, generic pointer), Pointer Expressions, Accessing the Address of a Variable, Declaring Pointer Variables, Initializations of Pointer Variable, Accessing a Variable through its Pointer, Pointer arithmetic.

Unit-3

Storage class: Types (auto, register, static, extern), scope rules, declaration and definition. **Function:** Function & types (User defined function, library function) Function Definition, Declaration, Function Calls, Header file and library, Function Arguments, string handling function (strlen, strcmp, strcpy, strncpy, strcat, strstr), Function recursion. Functions Returning Pointers, Pointers to Functions, Command line arguments, Application of pointer (dynamic memory allocation).

Unit-4

Structure and Union: Defining, Declaring, Accessing, Initialization Structure, nested structure, self-referential structure, bit-field. Arrays of Structures, Structures and Functions, Unions, difference between structure and union, active data member, structure within union, Self-referential Structure,

File: File Management in C, Defining and Opening a File, File opening modes (read, write, append), Closing a File. File operations, file and stream, Error Handling During I/O Operations, sequential and random access file, low level and high level file.

Text Books:

1. E. Balagurusamy, "Programming in ANSI C", 4/e, (TMH)

Reference Books:

1. B. Kernighan & Dennis Ritchie, 'The C Programming Language", 2/e PHI
2. Paul Deitel, Harvey Deitel, "C: How to Program", 8/e, Prentice Hall.
3. P.C. Sethi, P.K. Behera, "Programming using C", Kalyani Publisher, Ludhiana

PRACTICAL

Credit : **02** **25** Marks

Programming Fundamentals using C Lab

1. Write a Program to find greatest among three numbers.
2. Write a Program to all arithmetic operation using switch case.
3. Write a Program to print the sum and product of digits of an integer.
4. Write a Program to reverse a number.
5. Write a Program to compute the sum of the first n terms of the following series
   S= 1 + 1/2+1/3+1/4+......
6. Write a Program to compute the sum of the first n terms of the following series
   5=1-2+3-4+5 ....

7. Write a function that checks whether a given string is Palindrome or not. Use this function to find whether the string entered by user is Palindrome or not.
8. Write a function to find whether a given no. is prime or not. Use the same to generate the prime numbers less than 100.
9. Write a Program to compute the factors of a given number.
10. Write a program to swap two numbers using macro.
11. Write a Program to print a triangle of stars as follows (take number of lines from user):
12. Write a Program to perform following actions on an array entered by the user:
    a) Print the even-valued elements
    (b) Print the odd-valued elements
    (c) Calculate and print the sum and average of the elements of array
    (d) Print the maximum and minimum element of array
    (e) Remove the duplicates from the array
    (f) Print the array in reverse order

    The program should present a menu to the user and ask for one of the options. The menu should also include options to re-enter array and to quit the program.
13. Write a Program that prints a table indicating the number of occurrences of each alphabet in the text entered as command line arguments.
14. Write a program that swaps two numbers using pointers.
15. Write a program in which a function is passed address of two variables and then alter its contents.
16. Write a program which takes the radius of a circle as input from the user, passes it to another function that computes the area and the circumference of the circle and displays the value of area and circumference from the main( ) function.
17. Write a program to find sum and average of n elements entered by the user. To write this program, allocate memory dynamically using malloc( ) / calloc( ) functions.
18. Write a menu driven program to perform following operations on strings:
    (a) Show address of each character in string
    (b) Concatenate two strings without using strcat function.
    (c) Concatenate two strings using strcat function.
    (d) Compare two strings
    (e) Calculate length of the string (use pointers)
    (f) Convert all lowercase characters to uppercase
    (g) Convert all uppercase characters to lowercase
    (h) Calculate number of vowels
    (i) Reverse the string
19. Given two ordered arrays of integers, write a program to merge the two-arrays to get an ordered array.
20. Write a program to copy the content of one file to other.

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 2

DIGITAL LOGIC OBJECTIVES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

- To understand different methods used for the simplification of Boolean functions and arithmetic.
- To design and implement combinational circuits, synchronous & asynchronous sequential circuits.
- To study in detail about Semiconductor Memory Systems.

Unit-1

Character Codes, Decimal System, Binary System, Decimal to Binary Conversion, Hexadecimal Notation, Boolean Algebra, Basic Logic Functions: Electronic Logic Gates, Synthesis of Logic Functions, Minimization of Logic Expressions, Minimization using Karnaugh Maps, Synthesis with NAND and NOR Gates, Tri-State Buffers

Unit-2

Arithmetic: Addition and Subtraction of Signed Numbers, Addition/ Subtraction Logic Unit, Design of Fast Adders: Carry-Lookahead Addition, Multiplication of Positive Numbers. Signed-Operand Multiplication: Booth Algorithm. Fast Multiplication: Bit-Pair Recodng Multipliers, Carry-Save Addition of Summands, Integer Division, Floating-Point Numbers and Operations: IEEE Standard for Floating-Point Numbers, Arithmetic Operations on Floating-Point Numbers, Guard Bits and Truncation, Implementing Floating-Point Operations.

Unit-3

Flip-Flops, Gated Latches. Master-Slave Flip-Flops, Edge-Triggering, T Flip-Flops, JK Flip-Flops. Registers and Shift Registers, Counters, Decoders, Multiplexers, Programmable Logic Devices (PLDs), Programmable Array Logic (PAL), Complex Programmable Logic Devices (CPLDs), Field-Programmable Gate Array (FPGA). Sequential Circuits, UP/ DOWN Counters, Timing Diagrams, The Finite State Machine Model, Synthesis of Finite State Machines.

Unit-4

Memory System: Semiconductor RAM Memories, Internal Organization of Memory Chips, Static Memories. Asynchronous DRAMS, Synchronous DRAMS, Structure of Large Memories, Memory System Considerations, RAMBUS Memory. Read-Only Memories: ROM, PROM, EPROM, EEPROM, Flash Memory, Speed, Size, and Cost of Memory. Secondary Storage: Magnetic Hard Disks, Optical Disks, Magnetic Tape Systems.

Text Books:

1. Carl Hamacher, Z. Vranesic, S. Zaky: Computer Organization, 5/e (TMH)

Reference Books:

1. M. Morris Mano: Digital Logic and Computer Design, Pearson

PRACTICAL

Credit : **02** **25** Marks

Digital Logic Lab

1. Introduction to Xilinx software (VHDL)

Write the VHDL code for

2. Realizing all logic gates.
3. Combination Circuit.
4. ADDER.
5. SUBTRACTOR.
6. MUX.
7. DE-MUX.
8. Encoder.
9. Decoder.
10. PAL. II.PLA.

Write the VHDL program for the following Sequential Logic Circuits

12. Flip Flops.
13. Shift Registers.
14. Counters.
15. Memory Elements.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 3

PROGRAMMING USING C++

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES

- To know about the Object Oriented Programming concepts.
- To learn basics of C++ programming language. To be able to develop logics to create programs/ applications in C++.

Unit-1

Principles of Object-Oriented Programming: Object-Oriented Programming (OOP) Paradigm, Basic Concepts of OOP, Benefits of OOP. Characteristics of OOPS, Object Oriented Languages, Applications of OOP.

Introduction to C++, Difference between C & C++, Tokens, Data types, Operators, Structure of C++ Program, C++ statements. Expressions and Control Structures. Functions in C++: Argument passing in function, Inline Functions, Default Arguments, Const. Arguments, Friend function.

Unit-2

Classes and Objects: Defining Member Functions. Making an outside Function Inline, Nested Member Functions, Private Member Functions. Arrays within a Class Objects, as Function Arguments, Friend Functions.

Constructors & Destructors: Constructors, Parameterized Constructors, Constructors with Default Arguments, Dynamic Initialization of Objects, Copy Constructor, Dynamic Constructors, Destructors.

Unit-3

Inheritance: Basics of Inheritance, Type of Inheritance, Virtual Base Classes, Abstract Classes, Member Classes, Nesting of Classes. Polymorphism: Pointers, Pointers to Pointers to Derived Classes, Virtual Functions, Pure Virtual Functions, Function Overloading, Operator Overloading.

Unit-4

Managing Console I/O Operations : C++ Streams, C++ Stream Classes, Unformatted I/O Operations, Formatted Console I/O Operations, Managing Output with Manipulators. Files: Classes for File Stream Operations, Opening and Closing a File, Detecting end-of-file. File Modes, File Pointers and their Manipulations, Sequential Input and Output Operations, Updating a File: Random Access, Error Handling during File Operations, Command-line Arguments.

Text Books

1. E. Balgurusawmy, Object Oriented Programming with C++, 4/e (TMH).
2. Paul Deitel, Harvey Deitel, "C++: How to Program", 9/e. Prentice Hall.

Reference Books:

1. Bjarne Stroustroup, Programming - Principles and Practice using C++, 2/e, Addison-Wesley2014
2. Herbtz Schildt, C++: The Complete reference, MGH, 4/ed.
3. P. C. Sethi, P. K. Behera, "Programming in C++"- Kalyani Publisher, Ludhiana

PRACTICAL

Credit : **02** **25** Marks

Programming using C++ **Lab**

1. Write a Program to find greatest among three numbers using nested if.. .else statement.
2. Write a Program to check a number is prime or not.
3. Write a Program to find the GCD and LCM of two numbers.
4. Write a program to print the result for following series: 1! +2! + 3! +............
5. Write a program to print multiplication table from 1 to 10.
6. Write a Program for Swapping of two numbers using pass by value.
7. Write a Program for Swapping of two numbers using pass by address.
8. Write a Program for Swapping of two numbers using pass by reference.

9. Write a Program to find sum of four numbers using default argument passing.
10. Write a Program to find square and cube of a number using inline function.
11. Write a Program to find the factorial of a number.
12. Write a Program to find reverse of a number.
13. Write a program to find sum of four numbers using default argument passing in member function.
14. Write a Program to find area of circle, triangle and rectangle using function overloading.
15. Write a program to distinguish the properties of static and non-static ata members.
16. Write a program to show the method of accessing static private member function.
17. Write a program to show the ways of calling constructors and destructors.
18. Write a program to perform ++ operator overloading using member function.
19. Write a program to perform ++ operator overloading using friend function.
20. Write a program to perform + operator overloading for two complex number addition.
21. Write a program to perform + operator overloading for string concatenation.
22. Write a program to perform single inheritance.
23. Write a program to perform multiple inheritance.
24. Write a program to create an integer array using new operator and find the sum and average of array elements.
25. Write a program to implement virtual destructor.
26. Create the Person class. Create some objects of this class (by taking information from the user). Inherit the class Person to create two classes Teacher and Student class. Maintain the respective information in the classes and create, display and delete objects of these two classes (Use Runtime Polymorphism).
27. Write a program to Copy the contents of one file to other.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 4

DATA STRUCTURE

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES

- To learn how the choice of data structures impacts the performance of programs.
- To study specific data structures such as arrays, linear lists, stacks, queues, hash tables, binary trees, binary search trees, heaps and AVL trees.
- To learn efficient searching and sorting techniques.

Unit-1

Introduction: Basic Terminology. Data structure, Time and space complexity, Review of Array, Structures, Pointers.

Linked Lists: Dynamic memory allocation, representation, Linked list insertion and deletion, Searching, Traversing in a list. Doubly linked list. Sparse matrices.

Unit-2

Stack: Definition, Representation. Stack operations, Applications (Infix-Prefix-Postfix Conversion & Evaluation, Recursion).

Queues: Definition, Representation, Types of queue, Queue operations, Applications.

Unit-3

Trees: Tree Terminologies. General Tree. Binary Tree. Representations, Traversing, BST, Operations on BST, Heap tree, AVL Search Trees, M-way search tree, Applications of all trees.

Unit-4

Sorting: Exchange sorts, Selection Sort, Bubble sort, Insertion Sorts, Merge Sort. Quick Sort, Radix Sort, Heap sort.

Searching: Linear search, Binary search.

Text book

1. Classic Data Structure , D. Samanta , PHI, 2/ed.

REFERENCES

1. Ellis Horowitz, Sartaj Sahni, “Fundamentals of Data Structures”, Galgotia Publications, 2000.
2. Sastry C.V., Nayak R, Ch. Rajaramesh, Data Structure & Algorithms, I. K. International Publishing House Pvt. Ltd, New Delhi.

PRACTICAL

Credit : **02** **25** Marks

Data Structure Lab

Write a C/ C++ Program for the fallowings

1. To insert and delete elements from appropriate position in an array.
2. To search an element and print the total time of occurrence in the array.
3. To delete all occurrence of an element in an array.
4. Array implementation of Stack.
5. Array implementation of Linear Queue.
6. Array implementation of Circular Queue.
7. To implement linear linked list and perform different operation such as node insert and delete, search of an item, reverse the list.
8. To implement circular linked list and perform different operation such as node insert and delete.
9. To implement double linked list and perform different operation such as node insert and delete.

10. Linked list implementation of Stack.
11. Linked list implementation of Queue.
12. Polynomial representation using linked list.
13. To implement a Binary Search Tree.
14. To represent a Sparse Matrix.
15. To perform binary search operation.
16. To perform Bubble sort.
17. To perform Selection sort.
18. To perform Insertion sort.
19. To perform Quick sort.
20. To perform Merge sort.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 5

JAVA PROGRAMMING

Time : **3** Hrs.	End Semester Theory : **60** Marks
Credit : **04**	Mid Semester Theory : **15** Marks

OBJECTIVES

- To learn the fundamentals of Object Oriented Programming in Java environment.
- To learn the use of Java language and the Java Virtual Machine.
- To write simple Java programming applications.

Unit-1

Introduction to Java: Java History, Architecture and Features, Understanding the semantic and syntax differences between C++ and Java, Compiling and Executing a Java Program. Variables, Constants, Keywords (super, this, final, abstract, static, extends, implements, interface) , Data Types, Wrapper class, Operators (Arithmetic, Logical and Bitwise) and Expressions, Comments, Doing Basic Program Output, Decision Making Constructs (conditional statements and loops) and Nesting, Java Methods (Defining, Scope, Passing and Returning Arguments, Type Conversion and Type and Checking, Built-in Java Class Methods). Input through keyboard using Command line Argument, the Scanner class, BufferedReader class.

Unit-2

Object-Oriented Programming Overview: Principles of Object-Oriented Programming, Defining & Using Classes, Class Variables & Methods, Objects, Object reference, Objects as parameters, final classes, Garbage Collection.

Constructor : types of constructor, this keyword, super keyword. Method overloading and Constructor overloading. Aggregation vs Inheritance, Inheritance: extends vs implements, types of Inheritance, Interface, Up-Casting, Down-Casting. Auto-Boxing, Enumerations, Polymorphism, Method Overriding and restrictions. Package: Pre-defined packages and Custom packages.

Unit-3

Arrays: Creating & Using Arrays (ID, 2D, 3D and Jagged Array), Array of Object, Referencing Arrays Dynamically. Strings and I/O: Java Strings: The Java String class, Creating & Using String Objects, Manipulating Strings, String Immutability& Equality, Passing Strings To & From Methods, StringBuffer Classes and StringBuilder Classes. IO package: Understanding StreamsFile class and its methods. Creating, Reading, Writing using classes: Byte and Character streams, File OutputStream, FileInput Stream, File Writer, File Reader print Stream, Print Writer. Compressing and Uncompressing File.

Unit-4

Exception Handling, Threading, Networking and Database Connectivity: Exception types, uncaught exceptions, throw, built-in exceptions. Creating your own exceptions; Multi-threading: The Thread class and Runnable interface, creating single and multiple threads, Thread prioritization, synchronization and communication, suspending/resuming threads. Usingjava.net package. Overview of TCP/IP and Datagram programming. Accessing and manipulating databases using JDBC.

Text Books:

1. E. Balagurusamy, “Programming with Java”, TMH. 4/Ed,

Reference books:

1. Herbert Schildt, “The Complete Reference to Java”. TMH, 10/Ed.

PRACTICAL

Credit : **02** **25** Marks

Java Programming Lab

1. To find the sum of any number of integers entered as command line arguments.
2. To find the factorial of a given number.
3. To convert a decimal to binary number.
4. To check if a number is prime or not. by taking the number as input from the keyboard.
5. To find the sum of any number of integers interactively, i.e.. entering every number from the keyboard, whereas the total number of integers is given as a command line argument
6. Write a program that show working of different functions of String and String Buffer classs like setCharAt( ). setLength( ), append( ). insert( ). concat( )and equals( ).
7. Write a program to create a - “distance” class with methods where distance is computed in terms of feet and inches, how to create objects of a class and to see the use of this pointer
8. Modify the - ‘’distance” class by creating constructor for assigning values (feetandinches) to the distance object. Create another object and assign second object as reference variable to another object reference variable. Further create a third object which is a clone of the first object.
9. Write a program to show that during function overloading, if no matching argument is found, then Java will apply automatic type conversions (from lower to higher data type)

10. Write a program to show the difference between public and private access specifiers. The program should also show that primitive data types are passed by value and objects are passed by reference and to learn use of final keyword.
11. Write a program to show the use of static functions and to pass variable length arguments in a function.
12. Create a multi-file program where in one file a string message is taken as input from the user and the function to display the message on the screen is given in another file (make use of Scanner package in this program).
13. Write a program to create a multilevel package and also creates a reusable class to generate Fibonacci series, where the function to generate Fibonacci series is given in a different file belonging to the same package.
14. Write a program that creates illustrates different levels of protection in classes/ subclasses belonging to same package or different packages
15. Write a program - "DivideByZero" that takes two numbers a and b as input, computes a/b, and invokes Arithmetic Exception to generate a message when the denominator is zero.
16. Write a program to show the use of nested try statements that emphasizes the sequence of checking for catch handler statements.
17. Write a program to create your own exception types to handle situation specific to your application (Hint: Define a subclass of Exception which itself is a subclass of Throwable).
18. Write a program to demonstrate priorities among multiple threads.
19. Write a program to demonstrate different mouse handling events like mouseClicked( ), mouseEntered(), mouseExited(), mousePressed(). mouseReleased() & mouseDragged().
20. Write a program to demonstrate different keyboard handling events.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 6

DATABASE SYSTEMS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES

- To learn the fundamental elements of database system.
- To learn the basic concepts of relational database management systems.
- To learn various SQL commands.

Unit-1

Introduction to Database and Database Users, Database System Concepts and Architecture: data Models, schema, and instances, Conceptual Modeling and Database Design: Entity Relationship (ER) Model: Entity Types, Entity Sets, Attributes, Keys, Relationship Types, Relationship Sets, Roles and Structural Constraints, Weak Entity Types, ER Naming Conventions. Enhanced Entity-Relationship (EER) Model.

Unit-2

Database Design Theory and Normalization: Functional Dependencies, Normal Forms based on Primary Keys, Second and third Normal Forms, Boyce-Codd Normal Form, Multivalued Dependency and Fourth Normal Form, Join Dependencies and Fifth Normal Form.

Unit-3

Relational data Model and SQL: Relational Model Concepts, Basic SQLs, SQL Data Definition and Data types. Constraints in SQL, Retrieval Queries in SQL, INSERT, DELETE, UPDATE Statements in SQL, Relational Algebra and Relational Calculus: Unary Relational Operations: SELECT and PROJECT, Binary Relation: JOIN and DIVISION.

Unit-4

Introduction to Transaction Processing Concepts and Theory: Introduction to Transaction Processing, Transaction and System Concepts, Properties of Transactions, Recoverability, Serializability, Concurrency Control Techniques, Locking techniques for Concurrency Control, Concurrency Control based on Time-Stamp Ordering.

Text Book:

1. Fundamentals of Database Systems, 6th edition, Ramez Elmasri, Shamkant B. Navathe, Pearson Education

Reference Book:

1. An Introduction to Database System, Date C. J. - Pearson Education, New Delhi - 2005

PRACTICAL

Credit : **02** **25** Marks

Database Systems Labs

Create and use the following database schema to answer the given queries.

EMPLOYEE Schema

Field	**Type**	**NULL**	**KEY**	**DEFAULT**
Eno	Char(3)	NO	PRI	NIL
Enatne	Varchar(SO)	NO		NIL
Jobjype	Varchar(SO)	NO		NIL
Manager	Char(3)	YES	FK	NIL
Hire date	Date NO	NIL		
Dno	Integer	YES	FK	NIL
Commission	Decimal(10,2)	YES		NIL
Salary	Decimal(7,2)	NO		NIL

DEPARTMENT Schema

Field	**Type**	**NULL KEY**	**DEFAULT**
Dno	Integer	No PRI	NULL
Dname	Varchar(50)	Yes	NULL
Location	Varchar(SO)	Yes	New Delhi

Query List

1. Query to display Employee Name, Job, Hire Date, Employee Number; for each employee with the Employee Number appearing first.
2. Query to display unique Jobs from the Employee Table.
3. Query to display the Employee Name concatenated by a Job separated by a comma.
4. Query to display all the data from the Employee Table. Separate each Column by a comma and name the said column as THE_OUTPUT.
5. Query to display the Employee Name and Salary of all the employees earning more than $2850.
6. Query to display Employee Name and Department Number for the Employee No= 7900.
7. Query to display Employee Name and Salary for all employees whose salary is not in the range of $1500 and $2850.
8. Query to display Employee Name and Department No. of all the employees in Dept 10 and Dept 30 in the alphabetical order by name.
9. Query to display Name and Hire Date of every Employee who was hired in 1981.
10. Query to display Name and Job of all employees who don’t have a current Manager.
11. Query to display the Name, Salary and Commission for all the employees who earn commission.
12. Sort the data in descending order of Salary and Commission.
13. Query to display Name of all the employees where the third letter of their name is ‘A’.
14. Query to display Name of all employees either have two ‘R’s or have two ‘A’ s in their name and are either in Dept No = 30 or their Mangers Employee No = 7788.
15. Query to display Name, Salary and Commission for all employees whose Commission Amount is 14 greater than their Salary increased by 5%.
16. Query to display the Current Date.
17. Query to display Name, Hire Date and Salary Review Date which is the 1st Monday after six months of employment.
18. Query to display Name and calculate the number of months between today and the date each employee was hired.
19. Query to display the following for each employee <E-Name> earns < Salary> monthly but wants <3*Current Salary>. Label the Column as Dream Salary.
20. Query to display Name with the 1s’ letter capitalized and all other letter lower case and length of their name of all the employees whose name starts with T, ‘A’ and ‘M’.
21. Query to display Name, Hire Date and Day of the week on which the employee started.
22. Query to display Name, Department Name and Department No for all the employees.
23. Query to display Unique Listing of all Jobs that are in Department # 30.
24. Query to display Name, Department Name of all employees who have an ‘A’ in their name.

25. Query to display Name, Job, Department No. and Department Name for all the employees working at the Dallas location.
26. Query to display Name and Employee no. Along with their Manger's Name and the Manager's employee no; along with the Employees Name who do not have a Manager.
27. Query to display Name, Department No. And Salary of any employee whose department No. and salary matches both the department no. And the salary of any employee who earns a commission.
28. Query to display Name and Salaries represented by asterisks, where each asterisk (*) signifies $100.
29. Query to display the Highest, Lowest, Sum and Average Salaries of all the employees.
30. Query to display the number of employees performing the same Job type functions.
31. Query to display the no. of managers without listing their names.
32. Query to display the Department Name, Location Name, No. of Employees and the average salary for all employees in that department.
33. Query to display Name and Hire Date for all employees in the same dept. as Blake.
34. Query to display the Employee No. And Name for all employees who earn more than the average salary.
35. Query to display Employee Number and Name for all employees who work in a department with any employee whose name contains a 'T'.
36. Query to display the names and salaries of all employees who report to King.
37. Query to display the department no, name and job for all employees in the Sales department.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 7

DISCRETE MATHEMATICAL STRUCTURE

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES

- To learn the mathematical foundations for Computer Science.
- Topics covered essential for understanding various courses.

Unit-1

Logics and Proof: Prepositional Logic, Prepositional Equivalences, Predicates and Quantifiers Nested Quantifiers, Rules inference. Mathematical Induction.

Sets and Functions: Sets, Relations, Functions. Closures of Equivalence Relations, Partial ordering well ordering, Lattice, Sum of products and product of sums principle of Inclusions and Exclusions

Unit-2

Combinatory: Permutations, Combinations, Pigeonhole principle

Recurrence Relation : Linear and Non-linear Recurrence Relations, Solving Recurrence Relation using Generating Functions.

Unit-3

Graphs: Introduction to graphs, graphs terminologies, Representation of graphs, Isomorphism, **Connectivity & Paths:** Connectivity, Euler and Hamiltonian Paths, Introduction to tree, tree traversals, spanning tree and tree search: Breadth first search, Depth first search, cut-set, cut-vertex.

Unit-4

Modeling Computation: Finite State Machine, Deterministic Finite Automata (DFA), Non-Deterministic Finite Automata (NFA), Grammars and Language, Application of Pumping Lemma for Regular Language.

Text Books:

1. "Discrete Mathematics and its Applications with Combinatory and Graph Theory" 7th edition by Kenneth H. Rosen.

Reference Books:

1. Elements of Discrete Mathematics by C. L. Liu and D.P. Mohapatra, TMH, 2012
2. J. P Tremblay, R. Manohar, "Discrete Mathematical Structures with Applications to Computer Science", TMH, 1997.
3. A Modern Approach to Discrete Mathematics and Structure by J. K. Mantri & T. K Tripathy ,Laxmi Publication

PRACTICAL

Credit : **02** **25** Marks

Discrete Mathematical Structure Lab

Write the following programs using C/ C++ 1

1. Tower of Hanoi
2. Graph representation using Adjacency List.
3. Graph representation using Adjacency Matrix.
4. String Matching using finite state machine.
5. Detecting whether a number is even or odd using Finite State Machine.
6. To identify keywords such as char, const, continue using Finite State Machine.
7. To find the power set for a given set.
8. To find GCD of two numbers using recursion.
9. To find Binomial coefficients.

10. To find Permutation and Combination result for a given pair of values n and r.
11. To check a number is prime or not.
12. To calculate the Euclidean distance between two points.
13. To find the Roots of polynomials.
14. Find the shortest path pair in a plane.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 8

OPERATING SYSTEM

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES

- To understand Operating system structure and services.
- To understand the concept of a Process, memory, storage and I/O management.

Unit-1

Introduction to Operating System, System Structures: Operating system services, system calls, system programs, Operating system design and implementation, Operating system structure.

Unit-2

Process Management: Process Concept, Operations on processes, Process scheduling and algorithms. Inter-process Communication, Concepts on Thread and Process, Deadlocks: Deadlock detection, deadlock prevention, and deadlock avoidance fundamentals.

Unit-3

Memory Management Strategies: Swapping, Contiguous Memory Allocation, Paging. Segmentation, Virtual Memory Management: Concepts, implementation (Demand Paging), Page Replacement, Thrashing.

Unit-4

Storage Management: File System concept, Access Methods, File System Mounting, File Sharing and File Protection, Implementing File Systems, Kernel I/O Systems.

Text book :

Operating System Concepts, Abraham Silberschatz, Peter B. Galvin, and Greg Gagne, Eighth Edition, Wiley Student Edition 2009.

Reference book:

1. Morden Operating System , Tanenbaum ,Pearson , 4/ed. 2014

2. Richard F Ashley, Linux with Operating System Concepts, Chapman and Hall/CRC Published August 26, 2014

3. Richard Blum. Linux Command Line and Shell Scripting Bible, O' Reilly

PRACTICAL

Credit : **02** **25** Marks

Operating System Lab

1. Write a program (using *fork()* and/or *exec()* commands) where parent and child execute:
   a) same program, same code.
   b) same program, different code.
   c) before terminating, the parent waits for the child to finish its task.
2. Write a program to report behavior of Linux kernel including kernel version, CPU type and model. (CPU information)
3. Write a program to report behavior of Linux kernel including information on configured memory, amount of free and used memory, (memory information)
4. Write a program to print file details including owner access permissions, file access time, where file name is given as argument.
5. Write a program to copy files using system calls.
6. Write a program using C to implement FCFS scheduling algorithm.
7. Write a program using C to implement Round Robin scheduling algorithm.
8. Write a program using C to implement SJF scheduling algorithm.
9. Write a program using C to implement non-preemptive priority based scheduling algorithm.
10. Write a program using C to implement preemptive priority based scheduling algorithm.
11. Write a program using C to implement SRTF scheduling algorithm.
12. Write a program using C to implement first-fit, best-fit and worst-fit allocation strategies.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 9

COMPUTER NETWORKS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES

- To learn how do computers and terminals actually communicate with each other.
- To understand the parts of a communication network and how they work together.

Unit-1

Introduction to Data Communications and Network Models: Protocols and Standards, Layers in OSI Models, Analog and Digital Signals, Transmission Modes, Transmission Impairment, Data Rate Limits, Performance, Digital Transmission, Network Devices & Drivers: Router, Modem, Repeater, Hub, Switch, Bridge (fundamental concepts only).

Unit-2

Signal Conversion: Digital-to-Digital Conversion, Analog-to-Digital Conversion, Digital-to-analog Conversion, Analog-to-analog Conversion.

Transmission Media: Guided Media, Unguided Media, Switching Techniques: Packet Switching, Circuit Switching, Datagram Networks, Virtual-Circuit Networks, and Structure of a Switch.

Unit-3

Error Detection and Correction: Checksum, CRC, Data.Link Control: Framing, Flow and Error Control, Noiseless Channels, Noisy channels, (Stop and Wait ARQ, Sliding Window Protocol , Go Back N, Selective Repeat) HDLC, Point-to-Point Protocol. Access Control: TDM, CSMA/CD, and Channelization (FDMA, TDMA, and CDMA).

Unit-4

Network Layer: Logical Addressing, IPv4 Addresses, IPv6 Addresses, Virtual-Circuit Networks: Frame Relay and ATM, Transport Layer: Process-Process Delivery: UDP, TCP. Application layers: DNS, SMTP, POP, FTP, HTTP, Basics of WiFi (Fundamental concepts only), Network Security: Authentication, Basics of Public Key and Private Key, Digital Signatures and Certificates (Fundamental concepts only).

Text Books:

1. Data Communications and Networking, Fourth Edition by Behrouza A. Forouzan,TMH.

Reference Books:

1. Computer Networks, A. S. Tanenbaum, 4th edition, Pearson Education.

PRACTICAL

Credit : **02** **25** Marks

Computer Networks Lab

Use C/C++/ any Network Simulator

1. Simulate Even Parity generator and checker.
2. Simulate two dimensional Parity generator and checker.
3. Simulate checksum generator and checker.
4. Simulate Hamming code method.
5. Simulate Cyclic Redundancy Check (CRC) error detection algorithm for noisy channel.
6. Simulate and implement stop and wait protocol for noisy channel.
7. Simulate and implement go back n sliding window protocol.
8. Simulate and implement selective repeat sliding window protocol.
9. Simulate and implement distance vector routing algorithm.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 10

COMPUTER GRAPHICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES

- To be able to learn the core concepts of Computer Graphics.
- To be able to create effective programs for solving graphics problems.

Unit-1

Computer Graphics: A Survey of Computer graphics, Overview of Graphics System: Video Display Devices, Raster-Scan Systems, Input Devices, Hard-Copy Devices, Graphics Software.

Unit-2

Graphics Output Primitives: Point and Lines, Algorithms for line, circle & ellipse generation, Filled-Area Primitives. Attributes of Graphics Primitives: Point, line, curve attributes, fill area attributes, Fill methods for areas with irregular boundaries.

Unit-3

Geometric Transformations (both 2-D & 3-D): Basic Geometric Transformations, Transformation Matrix, Types of transformation in 2-D and 3-D Graphics: Scaling, Reflection, shear transformation, rotation, translation. 2-D, 3-D transformation using homogeneous coordinates.

Unit-4

Two Dimensional Viewing: Introduction to viewing and clipping. Viewing transformation in 2-D. Viewing pipeline. Clipping Window, Clipping Algorithms: Point clipping, Line clipping and Polygon clipping.

Text books

1. Mathematical Elements for Computer Graphics, D. F. Rogers & J. A. Adams, MGH, 2/ed.
2. Donald Hearn & M. Pauline Baker, “Computer Graphics with OpenGL”, Pearson Education.

Reference books

1. D. Hearn and M. Baker, “Computer Graphics with Open GL”, Pearson, 2/ed.
2. D. F. Rogers, “Procedural Elements for Computer Graphics”, MGH

PRACTICAL

Credit : **02** **25** Marks

Computer Graphics Lab

Develop the programs using C/C++ or Java

1. Write a program to implement Bresenhanr s line drawing algorithm.
2. Write a program to implement mid-point circle drawing algorithm.

3. Write a program to clip a line using Cohen and Sutherland line clipping algorithm.
4. Write a program to clip a polygon using Sutherland Hodgeman algorithm.
5. Write a program to fill a polygon using Scan line fill algorithm.
6. Write a program to apply various 2D transformations on a 2D object (use homogenous coordinates).
7. Write a program to apply various 3D transformations on a 3D object and then apply parallel and perspective projection on it.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 11

WEB TECHNOLOGIES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES

- To learn the fundamentals of web designing.
- To design and develop standard and interactive web pages.
- To learn some popular web scripting languages.

Unit-1

Web Essentials: Clients, Servers and Communication: The Internet - Basic Internet protocols — The WWW, HTTP request message — response message, web clients web servers - case study. Introduction to HTML: HTML, HTML domains, basic structure of an HTML document - creating an HTML document, mark up tags, heading, paragraphs, line breaks, HTML tags. Elements of HTML, working with text, lists, tables and frames, working with hyperlink, images and multimedia, forms and controls

Unit-2

Introduction to cascading style sheets: Concepts of CSS, creating style sheet, CSS properties, CSS styling (background, text format, controlling fonts), working with the block elements and objects. Working who lists and tables, CSS ID and class. Box model (introduction, border properties, padding properties, margin properties), CSS colour, groping, Dimensions, display, positioning, floating, align, pseudo class, Navigation bar, image sprites.

Unit-3

Java scripts: Client side scripting, what is Java script, simple Java script, variables, functions, conditions, loops and repetitions. Java scripts and objects, Java script own objects, the DOM and web browser environment, forms and validations. DHTML: Combining HTML, CSS, Java scripts, events and buttons, controlling your browser.

Unit-4

PHP: Starting to script on server side, PHP basics, variables, data types, operators, expressions, constants, decisions and loop making decisions. Strings - creating, accessing strings, searching, replacing and formatting strings. Arrays: Creation, accessing array, multidimensional arrays, PHP with Database.

Text Book:

1. Web Technologies - Black Book — Dream Tech Press
2. Matt Doyle, Beginning PHP 5.3 (wrox-Willey publishing)
3. John Duckett, Beginning HTML, XHTML, CSS and Java script.

Reference Book:

1. HTML, XHTML and CSS Bible, 5ed, Willey India-Steven M. Schafer.

PRACTICAL

Credit : **02** **25** Marks

Web Technology Lab

1. Acquaintance with elements, tags and basic structure of HTML files.
2. Practicing basic and advanced text for formatting.
3. Practice use of image, video and sound in HTML documents.
4. Designing of web pages- Document layout, list, tables.
5. Practicing Hyperlink of web pages, working with frames.
6. Working with forms and controls.
7. Acquaintance with creating style sheet, CSS properties and styling.
8. Working with background, text font, list properties.
9. Working with HTML elements box properties in CSS.
10. Develop simple calculator for addition, subtraction, multiplication and division operation using Java script.
11. Create HTML page with Java script which takes integer number as a input and tells whether the number is odd or even.
12. Create HTML page that contains form with fields name, Email, mobile number, gender, favorite colour and button; now write a Java script code to validate each entry. Also write a code to combine and display the information in text box when button is clicked.
13. Write a PHP program to check if number is prime or not.
14. Write a PHP program to print first ten Fibonacci numbers.
15. Create a MySQL data base and connect with PHP.
16. Write PHP script for string and retrieving user information from my SQL table.
    a. Write a HTML page which takes Name, Address, Email and Mobile number from user (register PHP).
    b. Store this data in MySQL data base.
    c. Next page display all user in HTML table using PHP (display .PHP).
17. Using HTML, CSS, Javascript, PHP, MySQL, design a authentication module of a web page.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 12

SOFTWARE ENGINEERING

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES:

- To learn the way of developing software with high quality and the relevant techniques.
- To introduce software engineering principles for industry standard.
- To focus on Project management domain and Software risks management.

Unit-1

Introduction: Evolution of Software to an Engineering Discipline, Software Development Projects, Exploratory Style of Software Development, Emergence of Software Engineering, Changes in Software Development Practices, Computer Systems Engineering. Software Lifecycle Models: Waterfall Model and its Extensions, Rapid Application Development (RAD), Agile Development Models, Spiral Model.

Unit-2

Responsibilities Project Management: Software Project Management Complexities, Responsibilities of a Software Project Manager, Project Planning, Metrics for Project Size Estimation, Project Estimation Techniques, Empirical Estimation Techniques, COCOMO, Halstead's Software Science, Staffing Level Estimation, Scheduling, Organization and Team Structures, Staffing, Risk Management, Software Configuration Management.

Unit-3

Requirement Analysis and Specification: Requirements Gathering and Analysis, Software Requirement Specifications, Formal System Specification Axiomatic Specification, Algebraic Specification, Executable Specification and 4GL.

Software Design: Design Process, Characterize a Good Software Design, Cohesion and Coupling, Layered Arrangements of Modules, Approaches to Software Design (Function Oriented & Object-Oriented).

Unit-4

Coding and Testing: Coding: Code Review, Software Documentation, Testing, Unit Testing, Black Box and White Box Testing, Debugging, Program Analysis Tools, Integration Testing, System Testing. Software Maintenance.

Text Book:

1. Fundamental of Software Engineering, Rajib Mall, Fifth Edition, PHI Publication, India.

Reference Books:

1. Software Engineering—Ian Sommerville, 10/Ed, Pearson.
2. Software Engineering Concepts and Practice — Ugrasen Suman, Cengage Learning India Pvt, Ltd.

3. R. Misra, C. Panigrahi, B. Panda: Principles of Software Engineering & System Design, YesDee Publication

PRACTICAL

Credit : **02** **25** Marks

Software Engineering Lab

S. No. Practical Title

1.
   - Problem Statement,
   - Process Model
2. Requirement Analysis:
   - Creating a Data Flow
   - Data Dictionary, Use Cases
3. Project Management:
   - Computing FP
   - Effort
   - Schedule, Risk Table, Timeline chart
4. Design Engineering:
   - Architectural Design
   - Data Design, Component Level Design
5. Testing:
   - Basis Path Testing

Sample Projects:

1. **Criminal Record Management:** Implement a criminal record management system for jailers, police officers and CBI officers.
2. **Route Information:** Online information about the bus routes and their frequency and fares
3. **Car Pooling:** To maintain a web based intranet application that enables the corporate employees within an organization to avail the facility of carpooling effectively.
4. Patient Appointment and Prescription Management System
5. Organized Retail Shopping Management Software
6. Online Hotel Reservation Service System
7. Examination and Result computation system
8. Automatic Internal Assessment System
9. Parking Allocation System
10. Wholesale Management System

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 13

ARTIFICIAL INTELLIGENCE

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES:

- To learn the basic concepts of AI principles and approaches.
- To develop the basic understanding of the building blocks of AI.

Unit-1

Introduction to Artificial Intelligence, Background and Applications, Turing Test and Rational Agent approaches to AI, Introduction to Intelligent Agents, their structure, behavior and environment.

Unit-2

Problem Solving and Searching Techniques: Problem Characteristics, Production Systems, Control Strategies, Breadth First Search, Depth First Search, Hill climbing and its Variations, Heuristics Search Techniques: Best First Search, A* algorithm, Constraint Satisfaction Problem. Introduction to Game Playing, Min-Max and Alpha-Beta pruning algorithms.

Unit-3

Knowledge Representation : Introduction to First Order Predicate Logic, Resolution Principle, Unification, Semantic Nets, Conceptual Dependencies, Frames, and Scripts, Production Rules, Conceptual Graphs.

Unit-4

Dealing with Uncertainty and Inconsistencies Truth Maintenance System, Default Reasoning, Probabilistic Reasoning, Bayesian Probabilistic Inference, Possible World Representations, Basics of NLP.

Text books

1. Artificial Intelligence a Modern Approach, Stuart Russell and Peter Norvig, Pearson 3/ed.

Reference books

1. Artificial Intelligence, Rich &Knight, TMG , 3 e/d.
2. DAN.W. Patterson, Introduction to A.I and Expert Systems - PHI, 2007
3. W.F. Clocksin and Mellish, Programming in PROLOG, Narosa Publishing House, 3rd edition, 2001

PRACTICAL

Credit : **02** **25** Marks

Artificial Intelligence Lab

Write a Prolog program

1. To find the factorial of a number
2. To remove the nth item from a list.

3. To find the permutation of a set.
4. To implement append for two lists.
5. To implement palindrome.
6. To find the greater of two numbers X and Y.
7. To find the greatest number in the list of numbers.
8. To find the sum of given list of numbers.
9. To find the reverse of a list.
10. To solve 8 queens problem.
11. To solve 8-puzzle problem using best first search
12. To implement DPS.
13. To implement BFS.
14. To implement best first search.
15. To solve traveling salesman problem.

+3 THIRD YEAR SIXTH SEMESTER
Core Paper - 14
ALGORITHM DESIGN TECHNIQUES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES:

- To be able to learn design principles and concepts of algorithms.
- To have a mathematical foundation in analysis of algorithm.

Unit-1

Introduction: Algorithm specification: Pseudo code. Space complexity and time complexity. Analysis and design of Insertion sort algorithm. Divide and Conquer paradigm. Recurrence relations, Solving Recurrences: Substitution methods, Recursion tree method, and Master method.

Unit-2

Searching and Sorting: Analysis of Linear Search, Binary Search, Merge Sort and Quick Sort, Heap Sort. Hashing: Hash functions, Hash table, Collision resolution: Chaining and Open Addressing (Linear probing, Quadratic probing, Double hashing).

Unit-3

Greedy Technique : General Method. Applications : Fractional Knapsack Problem, Job Sequencing with Deadlines, Huffman Codes.

Dynamic Programming: General Method, Applications: Matrix Chain Multiplication, Longest common subsequence.

Unit-4

Graph Algorithms: Representations of Graphs, Breadth-first search. Depth-first search, Topological sort, Minimum Spanning Trees: Prim's and KruskaPs algorithm, Single-source shortest paths: Bellman-Ford algorithm, Dijkstra's algorithm.

Text books

1. Introduction to Algorithms, by Thomas H, Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein, PHI.

Reference books

1. Algorithm Desgin, by Jon Kleinberg, Eva Tardos.

PRACTICAL

Credit : **02** **25** Marks

Algorithm Design Techniques Lab

Using C or C++ implement the following

1. Quick sort.
2. Heap sort.
3. Merge sort.
4. Matrix Multiplication using recursion.
5. Linear Search.
6. Binary Search.
7. Huffman code.
8. Fractional knapsack problem.
9. Matrix chain multiplication.
10. Longest Common Subsequence.
11. Prim's algorithm.
12. Kruskal's algorithm.
13. BFS.
14. DFS.
15. Dijkstra Algorithm.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 1

NUMERICAL TECHNIQUES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES:

- To learn various numerical techniques.
- To be able to implement different numerical techniques using programming language.

Unit-1

Floating point representation and computer arithmetic. Significant digits, Errors: Round-off error, Local truncation error, Global truncation error, Order of a method, Convergence and terminal conditions, Efficient computations.

Unit-2

Bisection method, Secant method, Regula-Falsi method Newton-Raphson method. Newton's method for solving nonlinear systems.

Unit-3

Interpolation: Lagrange's form and Newton's form Finite difference operators, Gregory Newton forward and backward differences Interpolation Piecewise polynomial interpolation: Linear interpolation.

Unit-4

Numerical integration: Trapezoid rule, Simpson's rule (only method), Newton-Cotes formulas, Gaussian quadrature, Ordinary differential equation: Euler's method Modified Euler's methods, Runge-Kutta second methods

1. S.S. Sastry, "Introductory Methods of Numerical Analysis", EEE , 5/ed.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation. New Age International Publisher, 6/e (2012)

Reference books

1. Numerical Analysis: J. K. Mantri & S. Prahan, Laxmi Publication.
2. Introduction to Numerical Analysis, Josef Stoer and Roland Bulirsch. Springer.

PRACTICAL

Credit : **02** **25** Marks

Numerical Techniques Lab

Implement using C/ C++ or MATLAB/ Scilab

1. Find the roots of the equation by bisection method.
2. Find the roots of the equation by secant/Regula-Falsi method.

3. Find the roots of the equation by Newton's method.
4. Find the solution of a system of nonlinear equation using Newton's method.
5. Find the solution of tri-diagonal system using Gauss Thomas method.
6. Find the solution of system of equations using Jacobi/Gauss-Seidel method.
7. Find the cubic spline interpolating function.
8. Evaluate the approximate value of finite integrals using Gaussian/Romberg integration.
9. Solve the boundary value problem using finite difference method.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 2

UNIX SHELL PROGRAMMING

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES:

- To learn the basics of UNIX OS, UNIX commands and File system.
- To familiarize students with the Linux environment.
- To learn fundamentals of shell scripting and shell programming.
- To be able to write simple programs using UNIX.

Unit-1

Introduction: Unix Operating systems. Difference between Unix and other operating systems, Features and Architecture, Installation, Booting and shutdown process, System processes (an overview). External and internal commands. Creation of partitions in OS, Processes and its creation phases - Fork, Exec, wait, exit.

Unit-2

User Management and the File System: Types of Users, Creating users, Granting rights, User management commands, File quota and various file systems available. File System Management and Layout, File permissions, Login process. Managing Disk Quotas, Links (hard links. symbolic links)

Unit-3

Shell introduction and Shell Scripting: Shell and various type of shell, Various editors present in Unix, Different modes of operation in vi editor. Shell script, Writing and executing the shell script. Shell variable (user defined and system variables), System calls, Using system calls, Pipes and Filters.

Unit-4

Unix Control Structures and Utilities: Decision making in Shell Scripts (If else, switch), Loops in shell, Functions, Utility programs (cut, paste, join, tr, uniq utilities), Pattern matching (grep).

Text Books:

1. Sumitabha, Das, Unix Concepts And Applications, Tata McGraw-Hill Education, 2017, 4/Ed.

Reference Books:

1. Nemeth Synder & Hein, Linux Administration Handbook, Pearson Education, 2010, *21* Ed.

PRACTICAL

Credit : **02** **25** Marks

Unix Programming Lab

1. Write a shell script to check if the number entered at the command line is prime or not.
2. Write a shell script to modify "cal" command to display calendars of the specified months.
3. Write a shell script to modify "cal" command to display calendars of the specified range of months.
4. Write a shell script to accept a login name. If not a valid login name display message "Entered login name is invalid".
5. Write a shell script to display date in the mm/dd/yy format.
6. Write a shell script to display on the screen sorted output of "who" command along with the total number of users.
7. Write a shell script to display the multiplication table of any number.
8. Write a shell script to compare two files and if found equal asks the user to delete the duplicate file.
9. Write a shell script to find the sum of digits of a given number.
10. Write a shell script to merge the contents of three files, sort the contents and then display them page by page.
11. Write a shell script to find the LCD (least common divisor) of two numbers.
12. Write a shell script to perform the tasks of basic calculator.
13. Write a shell script to find the power of a given number.
14. Write a shell script to find the greatest number among the three numbers.
15. Write a shell script to find the factorial of a given number.
16. Write a shell script to check whether the number is Armstrong or not.

+3 THIRD YEAR SIXTH SEMESTER

DSE - 3

DATA SCIENCE

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES:

- To learn emerging issues related to various fields of data science.
- To understand the underlying principles of data science, exploring data analysis.
- To learn the basics of R Programming.

Unit-1

Data Scientist's Tool Box: Turning data into actionable knowledge, introduction to the tools that will be used in building data analysis software: version control, markdown, git, GitHub, R, and R Studio.

Unit-2

R Programming Basics: Overview of R, R data types and objects, reading and writing data, Control structures, functions, scoping rules, dates and times, Loop functions, debugging tools, Simulation, code profiling.

Unit-3

Getting and Cleaning Data: Obtaining data from the web, from APIs, from databases and from colleagues in various formats, basics of data cleaning and making data "tidy".

Unit-4

Exploratory Data Analysis: Essential exploratory techniques for summarizing data, applied before formal modeling commences, eliminating or sharpening potential hypotheses about the world that can be addressed by the data, common multivariate statistical techniques used to visualize high-dimensional data.

Text Books

1. Rachel Schutt, Cathy O'Neil, "Doing Data Science: Straight Talk from the Frontiline" by Schroff/ O'Reilly, 2013.

Reference Books

1. Foster Provost, Tom Fawcett, "Data Science for Business" What You Need to Know About Data Mining and Data-Analytic Thinking by O'Reilly, 2013.
2. John W. Foreman, "Data Smart: Using data Science to Transform Information into Insight" by John Wiley & Sons, 2013.
3. Eric Seigel, "Predictive Analytics: The Power to Predict who Will Click, Buy, Lie, or Die", 1st Edition, by Wiley, 2013.

PRACTICAL

Credit : **02** **25** Marks

Elementary Data Science Lab

1. Write a program that prints "Hello World" to the screen.
2. Write a program that asks the user for a number n and prints the sum of the numbers 1 to n
3. Write a program that prints a multiplication table for numbers up to 12.
4. Write a function that returns the largest element in a list.
5. Write a function that computes the running total of a list.
6. Write a function that tests whether a string is a palindrome.
7. Implement linear search.
8. Implement binary search.
9. Implement matrices addition, subtraction and Multiplication
10. Fifteen students were enrolled in a course. There ages were:

    20 20 20 20 20 21 21 21 22 22 22 22 23 23 23

    i. Find the median age of all students under 22 years,
    ii. Find the median age of all students.
    iii. Find the mean age of all students.
    iv. Find the modal age for all students.
    v. Two more students enter the class. The age of both students is 23. What is now mean, mode and median?

+3 THIRD YEAR SIXTH SEMESTER

DSE - 4

PROJECT WORK/ DISSERTATION OR DATA MINING

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

OBJECTIVES:

- To introduce the basic concepts of data warehousing, data mining, Issues, and Implication.
- To learn the core topics like Association rules, Classification & Prediction and Clustering techniques.
- To make a study on the Applications and Trends in Data Mining.

Unit-1

Data Warehouse Fundamentals: Introduction to Data Warehouse, OLTP Systems, OLAP, Differences between OLTP and OLAP, Characteristics of Data Warehouse, Functionality of Data Warehouse, Advantages and Applications of Data Warehouse, Advantages, Applications, Top-Down and Bottom-Up Development Methodology, Tools for Data warehouse development, Data Warehouse Types, Data cubes

Unit-2

Introduction to Data Mining: Data mining, Functionalities, Data Preprocessing: Preprocessing the Data, Data cleaning. Data Integration and Transformation, Data reduction, Discretization and Concept hierarchies.

Unit-3

Mining Association Rules: Basics Concepts - Single Dimensional Boolean Association Rules from Transaction Databases, Multilevel Association Rules from transaction databases, Multi dimension Association Rules from Relational Database and Data Warehouses. Apriori Algorithm.

Unit-4

Classification and Prediction: Introduction, Issues, Decision Tree Induction, NaYve Bayesian Classification, Classification based on Concepts from Association Rule Mining, Classifier Accuracy.

Text Books:

1. J. Han and M. Kamber, Data Mining Concepts and Techniques, Elsevier, 2011

Reference Books:

1. K.P. Soman ,Shyam Diwakar, V.Ajay ,2006, Insight into Data Mining Theory and Practice, Prentice Hall of India Pvt. Ltd - New Delhi.
2. Data Mining Techniques, Arun K. Pujari, Universities Press, 2006
3. Modern Approaches of Data Mining: Theory & Practice, M. Panda, S. Dehuri, M. R. Patra, Narosa Publishing House. 2018.

PRACTICAL

Credit : **02** **25** Marks

Data Mining Lab

Using Scilab/ MATLAB/ C/ Python/ R

1. Build a Data Warehouse and perform it's operations.
2. Perform data preprocessing tasks and Demonstrate performing association rule mining on data sets.
3. Demonstrate performing classification on data sets.
4. Demonstrate performing clustering on data sets.
5. Demonstrate performing Regression on data sets.
6. Credit Risk Assessment. Sample Programs using German Credit Data.
7. Sample Programs using Hospital Management System.

MATHEMATICS

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 1
CALCULUS

Time: **3** Hrs. End Semester Theory: **60** Marks

Credit: **04** Mid Semester Theory: **15** Marks

Course Objective:

The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of mathematical nature as well as practical problems. More precisely, main target of this course is to explore the different tools for higher order derivatives, to plot various curves and to solve the problems associated with differentiation and integration of vector functions

Course Outcome:

After completing the course, students are expected to be able to use Leibnitz's rule to evaluate derivatives of higher order, able to study the geometry of various types of functions, evaluate the area, volume using the techniques of integrations, able to identify the difference between scalar and vector, acquired knowledge on some the basic properties of vector functions.

$\int \sin^n x \, dx,$ **Unit-I:**

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems the type $e^{ax+b} \sin x$, $e^{ax+b} \cos x$, $(ax + b)^n \sin x$, $(ax + b)^n \cos x$, concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L' Hospital's rule, Application in business, economics and life sciences.

Unit-II:

Riemann integration as a limit of sum, integration by parts, Reduction formulae, derivations and illustrations of reduction formulae of the type $\int \cos^n x \, dx$, $\int \tan^n x \, dx$, $\int \sec^n x \, dx$, $\int (\log x)^n x \, dx$, $\int \sin^n x \cos^n x \, dx$, definite integral, integration by substitutions.

Unit-III:

Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution, techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics.

Unit-IV:

Triple product, introduction to vector functions, operations with vector-valued functions, limits and continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

LIST OF PRACTICALS

(Using any software/ MATLAB to be performed on a Computer.)

1. Plotting the graphs of the functions e^{ax+b}, log(ax+b), 1/ax+b , sin(ax+b), cos(ax+b) and |ax+b| to illustrate the effect of a and b on the graph.
2. Plotting the graphs of the polynomial of degree 4 and 5.
3. Sketching parametric curves (E.g. Trochoid, cycloid, hypocycloid).
4. Obtaining surface of revolution of curves.
5. Tracing of conics in Cartesian coordinates /polar coordinates.
6. Sketching ellipsoid, hyperboloid of one and two sheets (using Cartesian co-ordinates).

BOOKS RECOMMENDED:

1. H. Anton, I. Bivens and S. Davis, Calculus, 10thEd.,John Wiley and Sons (Asia)P. Ltd., Singapore, 2002. Ch 5 (5.2, 5.3, 5.5), Ch 10 (10.1, 10.4-10.6), Ch 11 (11.4), Ch 12 (12.1, 12.2).
2. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014. Ch 4 (4.7), Ch 5, Ch 10, Ch 13, Ch 15 (15.1-15.6), Ch 17.
3. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014. Ch 2, Ch 4.

BOOKS FOR REFERNCE:

1. James Stewart, Single Variable Calculus, Early Transcendentals, Cengage Learning, 2016.
2. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi,2005.

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 2

DISCRETE MATHEMATICS

Time: **3** Hrs. — End Semester Theory: **60** Marks
Credit: **04** — Mid Semester Theory: **15** Marks

Course Objective:

This is a preliminary course for the basic courses in mathematics and all its applications. The objective is to acquaint students with basic counting principles, set theory and logic, matrix theory and graph theory.

Course Outcome:

The acquired knowledge will help students in simple mathematical modeling. They can study advance courses in mathematical modeling, computer science, statistics, physics, chemistry etc.

Unit-I:

Sets, relations, Equivalence relations, partial ordering, well ordering, axiom of choice, Zorn's lemma, Functions, cardinals and ordinals, countable and uncountable sets, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments, Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, modular arithmetic, Chinese remainder theorem, Fermat's little theorem.

Unit-II:

Principles of Mathematical Induction, pigeonhole principle, principle of inclusion and exclusion Fundamental Theorem of Arithmetic, permutation combination circular permutations binomial and multinomial theorem, Recurrence relations, generating functions, generating function from recurrence relations.

Unit-III:

Matrices, algebra of matrices, determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems, Eigen values, Eigen vectors of a matrix.

Unit-IV:

Graph terminology, types of graphs, sub-graphs, isomorphic graphs, Adjacency and incidence matrices, Paths, Cycles and connectivity, Eulerian and Hamiltonian paths, Planar graphs.

BOOKS RECOMMENDED:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.
2. Kenneth Rosen Discrete mathematics and its applications Mc Graw Hill Education 7th edition. Ch 1 (1.1, 1.2, 1.7, 1.8), Ch 2 (2.1 – 2.3, 2.5), Ch 3 (3.4, 3.5, 3.7), Ch 4 (4.1 – 4.4), Ch 5 (5.1 – 5.3), Ch 6 (6.1 – 6.5), Ch 8 (8.2 – 8.5, 8.7), Ch 9 (9.5, 9.6).
3. V Krishna Murthy, V. P. Mainra, J. L. Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd. Ch 5 (Excluding proofs of theorem), Ch 6 (6.2, 6.4 – 6.8)

BOOKS FOR REFERENCE:

1. J. L. Mott, A. Kendel and T.P. Baker: Discrete mathematics for Computer Scientists and Mathematicians, Prentice Hall of India Pvt Ltd, 2008.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 3
REAL ANALYSIS

Time: **3** Hrs. End Semester Theory: **60** Marks
Credit: **04** Mid Semester Theory : **15** Marks

Course Objective:

The objective of the course is to have the knowledge on basic properties of the field of real numbers, studying Bolzano-Weierstrass Theorem , sequences and convergence of sequences, series of real numbers and its convergence etc. This is one of the core courses essential to start doing mathematics.

Course Outcome:

On successful completion of this course, students will be able to handle fundamental properties of the real numbers that lead to the formal development of real analysis and understand limits and their use in sequences, series, differentiation and integration. Students will appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

UNIT-I

Review of Algebraic and Order Properties of R, ε-neighborhood of a point in R, Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R. Intervals, Interior point, Open Sets, Closed sets, Limit points of a set, Illustrations of Bolzano-Weierstrass theorem for sets, closure, interior and boundary of a set.

UNIT-II

Sequences and Subsequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences. Divergence Criteria, Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion. Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

UNIT-III

Limits of functions (epsilon-delta approach), sequential criterion for limits, divergence criteria. Limit theorems, one sided limits, Infinite limits and limits at infinity, Continuous functions, sequential criterion for continuity & discontinuity. Algebra of continuous functions, Continuous functions on an interval, Boundedness Theorem, Maximum Minimum Theorem, Bolzano's Intermediate value theorem, location of roots theorem, preservation of intervals theorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem, Monotone and Inverse Functions.

UNIT-IV

Differentiability of a function at a point & in an interval, Caratheodory's theorem, chain Rule, algebra of differentiable functions, Mean value theorem, interior extremum theorem. Rolle's theorem, intermediate value property of derivatives, Darboux's theorem. Applications of mean value theorem to inequalities.

BOOKS RECOMMENDED:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002. Ch 6 (6.1.5 - 6.1.7), Ch 9 (9.2.6, 9.2.7).
2. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co. Ch 2 (2.1 – 2.4, 2.6), Ch 4 (4.1 – 4.7, 4.10 – 4.13), Ch 5 (5.1 – 5.5), Ch 6 (6.1 – 6.7, 6.9), Ch 7 (7.1 – 7.4 (Excluding Cauchy MVT)).

BOOKS FOR REFERENCE:

1. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
2. A.Kumar, S. Kumaresan, A basic course in Real Analysis, CRC Press, 2014.
3. Brian S. Thomson, Andrew. M. Bruckner, and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall,2001.
4. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis, Jones & Bartlett, Second Edition, 2010.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 4

DIFFERENTIAL EQUATIONS

Time :**3** Hrs. End Semester Theory :**60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Course Objective:

Differential Equations introduced by Leibnitz in 1676 models almost all Physical, Biological, Chemical systems in nature. The objective of this course is to familiarize the students with various methods of solving differential equations and to have a qualitative applications through models. The students have to solve problems to understand the methods.

Course Outcome:

A student completing the course is able to solve differential equationsand is able to model problems in nature using Ordinary Differential Equations. This is also prerequisite for studying the course in Partial Differential Equations and models dealing with Partial Differential Equations.

UNIT-I

Differential equations and mathematical models, General, Particular, explicit, implicit and singular solutions of a differential equation. Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equations and Bernoulli's equation, special integrating factors and transformations.

UNIT-II

Introduction to compartmental models, Exponential decay radioactivity (case study of detecting art forgeries), lake pollution model (with case study of Lake Burley Griffin), drug assimilation into the blood (case study of dull, dizzy and dead), exponential growth of population, Density dependent growth, Limited growth with harvesting.

UNIT-III

General solution of homogeneous equation of second order, principle of superposition, Wronskian, its properties and applications, method of undetermined coefficients, Method of variation of parameters, Linear homogeneous and non-homogeneous equations of higher order with constant coefficients, Euler's equation.

UNIT-IV

Equilibrium points, Interpretation of the phase plane, predatory-pray model and its analysis, epidemic model of influenza and its analysis, battle model and its analysis.

Practical / Lab work to be performed on a computer:

Modeling of the following problems using Matlab / Mathematica / Maple etc.

1. Plotting of second & third order solution family of differential equations.
2. Growth & Decay model (exponential case only).
3. (a) Lake pollution model (with constant/seasonal flow and pollution concentration)/
   (b) Case of single cold pill and a course of cold pills.
   (c) Limited growth of population (with and without harvesting).

4. (a) Predatory- prey model (basic volterra model, with density dependence, effect of DDT, two prey one predator).
   (b) Epidemic model of influenza (basic epidemic model, contagious for life, disease with carriers).
   (c) Battle model (basic battle model, jungle warfare, long range weapons).
5. Plotting of recursive sequences.

BOOKS RECOMMENDED:

1. J. Sinha Roy and S Padhy: A course of Ordinary and Partial differential equation Kalyani Publishers, New Delhi. Ch 1, Ch 2 (2.1 – 2.7), Ch 4 (4.1 – 4.6)
2. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab, 2ndEd., Taylor and Francis group, London and New York,2009. Ch 1 (1.1), Ch 2 (2.1 – 2.3, 2.5 – 2.8, 2.11), Ch 3 (3.1-3.3), Ch 5 (5.1, 5.2, 5.7), Ch 6 (6.1 – 6.4).

BOOKS FOR REFERENCE:

1. Simmons G F, Differential equation, Tata Mc Graw Hill, 1991.
2. Martin Braun, Differential Equations and their Applications, Springer International, Student Ed.
3. S. L. Ross, Differential Equations, 3rd Edition, John Wiley and Sons, India.
4. C.Y. Lin, Theory and Examples of Ordinary Differential Equations, World Scientific, 2011.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 5

THEORY OF REAL FUNCTIONS

Time :**3** Hrs. End Semester Theory :**60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Course Objective:

The objective of the course is to have knowledge on limit theorems on functions, limits of functions, continuity of functions and its properties, uniform continuity, differentiability of functions, algebra of functions and Taylor's theorem and, its applications. The student how to deal with real functions and understands uniform continuity, mean value theorems.

Course Outcome:

On the completion of the course, students will have working knowledge on the concepts and theorems of the elementary calculus of functions of one real variable. They will work out problems involving derivatives of function and their applications. They can use derivatives to analyze and sketch the graph of a function of one variable, can also obtain absolute value and relative extrema of functions. This knowledge is basic and students can take all other analysis courses after learning this course.

UNIT-I

L' Hospital's Rules, other Intermediate forms, Cauchy's mean value theorem, Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions, Relative extreme, Taylor's series and Maclaurin's series, expansions of exponential and trigonometric functions.

UNIT-II

Riemann integration; inequalities of upper and lower sums; Riemann conditions of integrability. Riemann sum and definition of Riemann integral through Riemann sums; equivalence of two definitions; Riemann integrability of monotone and continuous functions; Properties of the Riemann integral; definition and integrability of piecewise continuous and monotone functions. Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.

UNIT-III

Improper integrals: Convergence of Beta and Gamma functions. Pointwise and uniform convergence of sequence of functions, uniform convergence, Theorems on continuity, derivability and integrability of the limit function of a sequence of functions.

UNIT-IV

Series of functions; Theorems on the continuity and derivability of the sum function of a series of functions; Cauchy criterion for uniform convergence and Weierstrass M-Test Limit superior and Limit inferior, Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and integration of power series; Abel's Theorem; Weierstrass Approximation Theorem.

BOOKS RECOMMENDED:

1. R.G. Bartle & D. R. Sherbert, Introduction to Real Analysis, John Wiley &Sons. Ch 6 (6.4.1 – 6.4.6)
2. G. Das and S. Pattanayak, Fundamentals of mathematics analysis, TMH Publishing Co. Ch 4 (4.8, 4.14), Ch 7 (7.4, 7.5), Ch 8 (8.1 – 8.6), Ch 9 (9.1 – 9.8)
3. S. C. Mallik and S. Arora, Mathematical analysis, New Age International Ltd., New Delhi.

BOOK FOR REFERENCES:

1. A. Kumar, S. Kumaresan, A basic course in Real Analysis, CRC Press, 2014
2. K. A. Ross, Elementary analysis: the theory of calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004A.Mattuck, Introduction toAnalysis, Prentice Hall.
3. Charles G. Denlinger, Elements of real analysis, Jones and Bartlett (Student Edition), 2011

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 6
GROUP THEORY-I

Time :**3** Hrs. End Semester Theory :**60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Course Objective:

Group theory is one of the building blocks of modern algebra. Objective of this course is to introduce students to basic concepts of group theory and examples of groups and their properties. This course will lead to future basic courses in advanced mathematics, such as Group theory-II and ring theory.

Course Outcome:

A student learning this course gets idea on concept and examples of groups and their properties. He understands cyclic groups, permutation groups, normal subgroups and related results. After this course he can opt for courses in ring theory, field theory, commutative algebras, linear classical groups etc. and can be apply this knowledge to problems in physics, computer science, economics and engineering.

UNIT-I

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups, Subgroups and examples of subgroups, centralizer, normalizer, center of a group,

UNIT-II

Product of two subgroups, Properties of cyclic groups, classification of subgroups of cyclic groups, Cycle notation for permutations, properties of permutations, even and odd permutations, alternating group,

UNIT-III

Properties of cosets, Lagrange's theorem and consequences including Fermat's Little theorem, external direct product of a finite number of groups, normal subgroups, factor groups.

UNIT-IV

Cauchy's theorem for finite abelian groups, group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of isomorphisms, first, second and third isomorphism theorems.

BOOKS RECOMMENDED:

1. Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi. Ch 1 (p31 – p40), Ch 2 (p42 – p59), Ch 3 (p60 – p74), Ch 4 (p75 – p90), Ch 5 (p93 – p105, p112 – p115 except problem 59), Ch 6 (p120 – p126, p132 – p136), Ch 7 (p138 – p144, p150 – p152), Ch 8 (p156, p157), Ch 9 (p174 – p180, 182), Ch 10 (194 - 201).
2. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

BOOK FOR REFERENCES:

1. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
2. Joseph 1. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
3. I. N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 7
PARTIAL DIFFERENTIAL EQUATIONS AND SYSTEM OF ODEs

Time :**3** Hrs. End Semester Theory :**60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Course Objective:

The objective of this course is to understand basic methods for solving Partial Differential Equations of first order and second order. In the process, students will be exposed to Charpit's Method, Jacobi Method and solve wave equation, heat equation, Laplace Equation etc. They will also learn classification of Partial Differential Equations and system of ordinary differential equations.

Course Outcome:

After completing this course, a student will be able to take more courses on wave equation, heat equation, diffusion equation, gas dynamics, non-linear evolution equations etc. All these courses are important in engineering and industrial applications for solving boundary value problem.

UNIT-I

Partial Differential Equations - Basic concepts and Definitions, Mathematical Problems. First-Order Equations: Classification, Construction and Geometrical Interpretation. Method of Characteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms of First-order Linear Equations. Method of Separation of Variables for solving first order partial differential equations.

UNIT-II

Derivation of Heat equation, Wave equation and Laplace equation. Classification of second order linear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equations to canonical forms.

UNIT-III

The Cauchy problem, Cauchy problem of an infinite string. Initial Boundary Value Problems, Semi-Infinite String with a fixed end, Semi-Infinite String with a Free end. Equations with non-homogeneous boundary conditions, Non- Homogeneous Wave Equation. Method of separation of variables, Solving the Vibrating String Problem, Solving the Heat Conduction problem

UNIT-IV

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions, The method of successive approximations.

LIST OF PRACTICALS (USING ANY SOFTWARE)

(i) Solution of Cauchy problem for first order PDE.

(ii) Finding the characteristics for the first order PDE.

(iii) Plot the integral surfaces of a given first order PDE with initial data.

(iv) Solution of the wave equation $\frac{\partial^2 u}{\partial t^2} - C\frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions :

(a) $u(x,0) = \phi(x)$, $u_t(x,0) = \psi(x)$, $x \in R$, $t > 0$

(b) $u(x,0) = \phi(x)$, $u_t(x,0) = \psi(x)$, $u(0, t) = 0$, $x \in (0, \infty)$, $t > 0$.

(c) $u(x,0) = \phi(x)$, $u_t(x,0) = \psi(x)$, $u_x(0, t) = 0$, $x \in (0, \infty)$, $t > 0$.

(d) $u(x,0) = \phi(x)$, $u_t(x,0) = \psi(x)$, $u(0, t) = 0 = u(l, t)$, $x \in (0, l)$, $t > 0$.

(v) Solution of the diffusion equation $\frac{\partial u}{\partial t} - K\frac{\partial^2 u}{\partial x^2} = 0$ for the following associated conditions

(a) $u(x, 0) = \phi(x)$, $u_t(0, t) = a$, $u(l, t) - b$, $x \in (0, l)$, $t > 0$

(b) $u(x, 0) = \phi(x)$, $x \in R$, $t \in (0, T)$

(c) $u(x, 0) = \phi(x)$, $u(0, t) = a$, $x \in (0, \infty)$, $t \geq 0$.

BOOKS RECOMMENDED :

1. Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Birkhauser, Indian reprint, 2014. Ch 1 (1.2, 1.3), Ch 2 (2.1 – 2.7), Ch 3 (3.1 - 3.6), Ch 4 (4.1 – 4.3), Ch 5 (5.1, 5.4, 5.5), Ch 7 (7.1 – 7.6).

2. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India. Ch 7 (7.1 – 7.4), Ch 8 (8.3).

BOOK FOR REFERENCES :

1. J Sinha Roy and S Padhy: A course of Ordinary and Partial differential equation Kalyani Publishers,New Delhi,

2. Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed., Elsevier Academic Press, 2004.

3. Robert C. Mc Owen: Partial Differential Equations, Pearson Education Inc.

4. T Amarnath: An Elementary Course in Partial Differential Equations, Narosa Publications.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 8

NUMERICAL METGHODS AND SCIENTIFIC COMPUTING

Time :**3** Hrs. End Semester Theory :**60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Use of Scientific Calculator is allowed.

Course Objective:

Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of systems of linear equations and differential equations, interpolation, differentiation, evaluating integration.

Course Outcome:

Students can handle physical problems to find an approximate solution. After getting trained a student can opt for advance courses in numerical analysis in higher mathematics. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.

UNIT-I

Rate of convergence, Algorithms, Errors: Relative, Absolute, Round off, Truncation. Approximations in Scientific computing, Error propagation and amplification, conditioning, stability and accuracy, computer arithmetic mathematical software and libraries, visualisation,

Numerical solution of non-linear equations: Bisection method, Regula- Falsi method, Secant method, Newton- Raphson method, Fixed-point Iteration method.

UNIT-II

Rate of convergence of the above methods. System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis. Computing eigen-values and eigenvectors

UNIT-III

Polynomial interpolation: Existence uniqueness of interpolating polynomials. Lagrange and Newtons divided difference interpolation, Error in interpolation, Central difference & averaging operators, Gauss-forward and backward difference interpolation. Hermite and Spline interpolation, piecewise polynomial interpolation.

UNIT-IV

Numerical Integration: Some simple quadrature rules, Newton-Cotes rules, Trapezoidal rule, Simpsons rule, Simpsons 3/8th rule, Numerical differentiation and integration, Chebyshev differentiation and FFT, Richard-son extrapolation.

PRACTICAL/LAB WORK TO BE PERFORMED ON A COMPUTER:

Use of computer aided software (CAS), for example Matlab / Mathematica / Maple / Maxima etc., for developing the following Numerical programs:

(i) Calculate the sum 1/1 + 1/2 + 1/3 + 1/4 + --------- + 1/N.

(ii) To find the absolute value of an integer.

(iii) Enter- 100 integers into an array and sort them in an ascending' order.

(iv) Any two of the following

- (a) Bisection Method
- (b) Newton Raphson Method
- (c) Secant Method
- (d) Regular Falsi Method

(v) Gauss-Jacobi Method

(vi) SOR Method or Gauss-Siedel Method

(vii) Lagrange Interpolation or Newton Interpolation

(viii) Simpson's rule.

Note: For any of the CAS Matlab / Mathematica / Maple / Maxima etc., Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expression, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

BOOKS RECOMMENDED:

1. M. K. Jain, S. R. K. Iyengar and R. K. Jain, Numerical Methods for Scientific and Engineering Computation, New age International Publisher, India. Ch 1, Ch 2 (2.1 – 2.3, 2.5 except Muller and Chebyshev method, 2.6 (upto p59)), Ch 3 (3.1, 3.2 (upto p120), 3.4 (except SOR method), 3.5), Ch 4 (Upto 4.4 excluding Stirling & Bessel interpolation, 4.5, 4.6 (upto p259)), Ch 5 (5.1, 5.2 (upto p331), 5.4, 5.6, 5.7, 5.9)
2. Michael Heath: Scientific Computing : An introductory Survey.

BOOK FOR REFERENCES:

1. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2. Kendall E. Atkinson: An Introduction to Numerical Analysis
3. C. F. Gerald and P. O. Wheatley, App.ied Numerical Analysis, Pearson Education, India, 7th Edition, 2008
4. S. D. Conte & S. de Boor: Elementary Numerical Analysis: An Algorithmic Approach.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 9

TOPOLOGY OF METRIC SPACES

Time :**3** Hrs. End Semester Theory : **60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Course Objective:

This is an introductory course in topology of metric spaces. The objective of this course is to impart knowledge on open sets, closed sets, continuous functions, connectedness and compactness in metric spaces.

Course Outcome:

On successful completion of the course students will learn to work with abstract topological spaces. This is a foundation course for all analysis courses in future.

UNIT-I

Metric spaces, sequences in metric spaces, Cauchy sequences, complete metric spaces, open and closed balls, neighborhood, open set, interior of a set, limit point of a set, closed set, diameter of a set, Cantor's theorem.

UNIT-II

Subspaces, Countability Axioms and Separability, Baire’s Category theorem.

UNIT-III

Continuity: Continuous mappings, Extension theorems, Real and Complex valued Continuous functions, Uniform continuity, Homeomorphism, Equivalent metrics and isometry, uniform convergence of sequences of functions.

UNIT-IV

Contraction mappings and applications, connectedness, Local connectedness, Bounded sets and compactness, other characterization of compactness, continuous functions on compact spaces,

BOOKS RECOMMENDED:

1. Satish Shirali & Harikishan L. Vasudeva, Metric Spaces, Springer Verlag London (2006) (First Indian Reprint 2009). Ch 1 (1.2 – 1.5), Ch 2, Ch 3, Ch 4 (4.1, 4.2), Ch 5 (5.1 – 5.3).

BOOK FOR REFERENCES:

1. S. Kumaresan, Topology of Metric Spaces, Narosa Publishing House, Second Edition 2011.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 10
RING THEORY

Time :**3** Hrs. End Semester Theory : **60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Course Objective:

This is a second course in modern algebra which deals with ring theory. Somebasics of ring theory like rings, subrings, ideals, ring homomorphisms and their properties and. This course is an integral part of any course on Modern algebra the ohers being Group theory and Field Theory.

Course Outcome:

After completing this course, this will help students to continue more courses in advanced Ring theory modules, Galois groups.

UNIT-I

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring, Ideals, ideal generated by a subset of a ring, factor rings, operations on ideals.

UNIT-II

Prime and maximal ideals. Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients.

UNIT-III

Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, Unique factorization in Z[x].

UNIT-IV

Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

BOOKS RECOMMENDED:

1. Joseph A. Gallian, Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi. Ch 12, Ch 13, Ch 14, Ch 15, Ch 16, Ch 17, Ch 18.
2. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.

BOOK FOR REFERENCES:

1. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
2. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
3. I. N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 11
MULTIVARIATE CALCULUS

Time :**3** Hrs. End Semester Theory : **60** Marks

Credit :**04** Mid Semester Theory : **15** Marks

Course Objective:

The objective of this course to introduce functions of several variable to a student after he has taken a course in one variable calculus. The course will introduce partial derivatives and several of its consequences and will introduce double and triple integrals along with line integrals which are fundamental to all streams where calculus can be used.

Course Outcome:

After reading this course a student will be able to calculate partial derivatives, directional derivatives, extreme values and can calculate double, triple and line integrals. He will have idea of basic vector calculus including green's theorem, divergence theorem and stoke's theorem. He can take courses in calculus on manifolds, Differential geometry and can help in numerical computations involving several variables.

UNIT-I

Functions of several variables, limit and continuity of functions of two variables. Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.

UNIT-II

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems. Definition of vector field, divergence and curl, Double integration over rectangular region, double integration over nonrectangular region. Double integrals in polar co-ordinates,

UNIT-III

Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates. Change of variables in double integrals and triple integrals.

UNIT-IV

Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path. Green's theorem, surface integrals, integrals over parametrically defined surfaces. Stokes' theorem, The Divergence theorem.

BOOKS RECOMMENDED:

1. M. J, Strauss, G. L. Bradley and K. J. Smith, Calculus (3rd Edition), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007. Ch 11, Ch 12, Ch 13.
2. S.C. Mallik and S. Arora : Mathematical Analysis, New Age International Publications

BOOK FOR REFERENCES:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer(SIE). Indian reprint, 2005.

3. James Stewart, Multivariable Calculus, Concepts and Contexts,2nd Ed., Brooks/Cole, Thomson Learning, USA, 2001.

4. S Ghorpade, B V Limaye, Multivariable calculus, Springer international edition

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 12
LINEAR ALGEBRA

Time :**3** Hrs. End Semester Theory : **60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Course Objective:

Linear algebra is a basic course in almost all branches of science. A full course in undergraduate program will help students in finding real life applications later.. The objective of this course is to introduce a student the basics of linear algebra and some of its application

Course Outcome:

The student will use this knowledge wherever he/She goes after undergraduate program. It has applications in computer science, finance mathematics, industrial mathematics, bio mathematics and what not.

UNIT-I

Vector spaces, subspaces, examples, algebra of subs paces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces. Linear transformations, null space, range, rank and nullity of a linear transformation.

UNIT-II

Matrix representation of a linear transformation, Algebra of linear transformations, Isomorphisms, Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix, Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis, annihilators, Basics of Fields.

UNIT-III

Eigenspaces of a linear operator, diagonalizability. Invariant subspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator, Inner product spaces and norms, Gram-Schmidt orthogonalization process,

UNIT-IV

Orthogonal complements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation, minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

BOOKS RECOMMENDED:

1. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra (4th Edition), Pearson, 2018. Ch 1 (1.1 – 1.6), Ch 2 (2.1 – 2.6), Ch 5 (5.1, 5.2, 5.4).

BOOKS FOR REFERENCE:

1. Rao A.R. and Bhim Sankaram, Linear Algebra Hindustan Publishing house.
2. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 13
COMPLEX ANALYSIS

Time :**3** Hrs. End Semester Theory : **60** Marks
Credit :**04** Mid Semester Theory : **15** Marks

Course Objectives:

The objective of the course is aimed to provide an introduction to the theories for functions of a complex variable. The concepts of analyticity and complex integration are presented. The Cauchy's theorem and its applications, the calculus of residues and its applications are discussed in detail.

Course Outcome:

Students will be able to handle certain integrals not evaluated earlier and will know a technique for counting the zeros of polynomials. This course is prerequisite to many other advance analysis courses.

UNIT-I

Complex Numbers and Complex plane: Basic properties, convergence, Sets in the Complex plane, Functions on the Complex plane: Continuous functions, holomorphic functions, power series, Integration along curves.

UNIT-II

Cauchy's Theorem and Its Applications: Goursat's theorem, Local existence of primitives and Cauchy's theorem in a disc, evaluation of some integrals, Cauchy's integral formulas.

UNIT-III

Morera's theorem, Sequences of holomorphic functions, Holomorphic functions defined in terms of integrals, Schwarz reflection principle, Zeros and poles.

UNIT-IV

Meromorphic Functions and the Logarithm: The residue formula, Examples, Singularities and meromorphic functions, the argument principle and applications, the complex logarithm.

BOOKS RECOMMENDED:

1. Elias M. Stein & Rami Shakarchi, Complex Analysis, Princeton University press, Princeton and Oxford, 2003. Ch 1, Ch 2, Ch 3, Ch 4, Ch 5 (5.1 – 5.4).

BOOKS FOR REFERENCE:

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications (Eighth Edition), McGraw - Hill International Edition, 2009.

2. G. F. Simmons, Introduction to Topology and Modern Analysis, Mcgraw-Hill, Edition 2004.

3. Joseph Bak and Donald 1. Newman, Complex analysis (2ndEdition), Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., New York, 1997.

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 14
GROUP-THEORY-II

Time :**3** Hrs. End Semester Theory : **60** Marks
Credit :**06** Mid Semester Theory : **15** Marks

Course Objective:

The objective of this course is to be exposed to more advanced results in group theory after completing a basic course. The course introduces results on automorphism, commutator subgroup, group action Sylow theorems etc.

Course Outcome:

The knowledge of automorphism helps to study more on field theory. Students learn on direct products, group actions, class equations and their applications with proof of all results. This course helps to opt for more advanced courses in algebra and linear classical groups.

UNIT-I

Automorphism, inner automorphism, automorphism groups, automorphism groups of finite and infinite cyclic groups, applications of factor groups to automorphism groups. characteristic subgroups.

UNIT-II

Commutator subgroup and its properties, Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

UNIT-III

Group actions, stabilizers and kernels, permutation representation associated with a given group action, Application of group actions: Generalized Cayley's theorem, Index theorem.

UNIT-IV

Groups acting on themselves by conjugation, class equation and consequences, conjugacy in Sn, p - groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of A_n for n ≥ 5, non-simplicity tests.

BOOKS RECOMMENDED:

1. John B. Fraleigh, A First Course in Abstract Algebra, Narosa Publishing House, New Delhi. Ch 3 (Sec-15 (p150, 151), Sec - 16).

2. Joseph A. Gallian Contemporary Abstract Algebra (4th Edition), Narosa Publishing House, New Delhi. Ch 6 (p128 – p132), Ch 8 (p156 – p162), Ch 9 (p180 – p187), Ch 11, Ch 24 (p387 – p395), Ch 25, Ch 29 (p478, p479) .

BOOK FOR REFERENCES:

1. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
2. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
3. J.R. Durbin, Modern Algebra, John Wiley & Sons, New York Inc., 2000.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 1
LINEAR PROGRAMMING

Time :**3** Hrs. End Semester Theory : **80** Marks
Credit :**06** Mid Semester Theory : **20** Marks

Course Objective :

The objective of this course is to familiarize industrial problems to students with various methods of solving Linear Programming Problems, Transportation Problems, Assignment Problems and their applications. Also, students will know the application oflinear Programming method in Game Theory.

Course Outcome :

More knowledge on this topic in higher studies will help students to deal industrial models. This is also prerequisite for studying advanced courses in Nonlinear Programming Problems, Inventory Control Problem and Queuing Theory etc.

UNIT-I

Introduction to linear Programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

UNIT-II

Duality, formulation of the dual problem, primal-dual relationships, Fundamental Theorem of Duality, economic interpretation of the dual.

UNIT-III

Transportation problem and its mathematical formulation, northwest-corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem. Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

UNIT-IV

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

BOOKS RECOMMENDED:

1. Kanti Swarup, Operations Research, Sultan Chand & Sons, New Delhi. Books. Ch 4 (4.1 – 4.4), Ch 5 (5.1 – 5.4, 5.5, 5.8), Ch 10 (10.1 – 10.3, 10.5, 10.9), Ch 11 (11.1 – 11.3), Ch 17 (17.1 – 17.5, 17.9).

BOOKS FOR REFERENCE:

1. S. Hillier and G.J. Lieberman, Introduction to Operations Research- Concepts and Cases (9th Edition), Tata McGraw Hill, 2010.
2. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows (2nd edition), John Wiley and Sons, India, 2004.
3. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
4. Hamdy A. Taha, Operations Research: An Introduction (10th edition), Pearson, 2017.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 2
PROBABILITY AND STATISTICS

Time : **3** Hrs. End Semester Theory : **80** Marks
Credit :**06** Mid Semester Theory : **20** Marks

Course Objective :

The objective of the course is to expertise the student to the extensive role of statistics in everyday life and computation, which has made this course a core course in allbranches of mathematical and engineering sciences.

Course Outcome :

The students shall learn probability and statistics for various random variables, multivariate distributions, correlations and relations. He shall learn law of large numbers and shall be able to do basic numerical calculations.

UNIT-I

Probability: Introduction, Sample spaces, Events, probability of events, rules of probability, conditional probability, independent events, Bayes's theorem, Probability distributions and probability densities: random variables, probability distributions, continuous random variables, probability density functions, Multivariate distributions, joint distribution function, joint probability density function, marginal distributions, conditional distributions, conditional density, The theory in practice, data analysis, frequency distribution, class limits, class frequencies, class boundary, class interval, class mark, skewed data, multimodality, graphical representation of the data, measures of location and variability. Population, sample, parameters

UNIT-II

Mathematical Expectation: Introduction, expected value of random variable, moments, Chebyshev's theorem, moment generating functions, product moments, moments of linear combinations of random variables, conditional expectations, the theory in practice, measures of location, dispersion

UNIT-III

Special probability distributions: Discrete Uniform distribution, binomial distribution, Negative binomial, geometric, hypergeometric, poisson, multinomial distribution, multinomial. Special probability densities; Uniform distribution, gamma, exponential, gamma, chi-square, beta distribution, normal, normal approximation to binomial, bivariate normal, Functions of random variables, distribution function technique, transformation technique-one variable, several variables, moment generating function technique.

UNIT-IV

Sampling distributions: population distribution, random sample, sampling distribution of mean, Central Limit theorem, Sampling distribution of the mean: finite populations, chi-square, t, F distributions, regression and correlation: Bivariate regression, regression equation, Linear regression, method of least squares.

BOOKS RECOMMENDED:

1. Irwin Miller and Marylees Miller, John E. Freund's Mathematical Statistics with Applications (8thEdition), Pearson, Asia, 2014. Ch 1 (1 – 8), Ch 3 (1 – 8), Ch 4, Ch 5 (1 – 9), Ch 6 (1 – 7), Ch 7 (1 – 5), Ch 8 (1 – 7), Ch 14 (1 – 3).

BOOK FOR REFERENCES:

I. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson Education, Asia, 2007.

2. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, (3rd Edition), Tata McGraw- Hill, Reprint 2007.

3. Sheldon Ross, Introduction to Probability Models (9th Edition), Academic Press, Indian Reprint, 2007.

+3 THIRD YEAR SIXTH SEMESTER

DSE - 3
DIFFERENTIAL GEOMETRY

Time :**3** Hrs. End Semester Theory :**80** Marks
Credit :**06** Mid Semester Theory : **20** Marks

Course Objective:

After learning methods on curve tracing and Analytic Geometry, the objective of this course is to teach Differential geometry of curves and surfaces which trains a student using tools in calculus to derive intrinsic properties of plain curves and space curves.

Course Outcome:

After completing this course a student will learn on serret-Frenet formulae, relation between tangent, normal and binormals, first and second fundamental forms and ideas on various curvatures. He has scope to take more advanced courses in surface theory and geometry.

UNIT-I

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae. Osculating circles, Osculating circles and spheres. Existence of space curves.

UNIT-II

Evolutes and involutes of curves. Theory of Surfaces: Parametric curves on surfaces, surfaces of revolution, helicoids, Direction coefficients. First and second Fundamental forms.

UNIT-III

Principal and Gaussian curvatures. Lines of curvature, Euler's theorem. Rodrigue's formula, Conjugate and Asymptotic lines. Developables : Developable associated with space curves and curves on surfaces, Minimal surfaces.

UNIT-IV

Geodesics: Canonical geodesic equations. Nature of geodesics on a surface of revolution. Clairaut's theorem. Normal property of geodesics. Torsion of a geodesic. Geodesic curvature. Gauss-Bonnet theorem. Surfaces of constant curvature.

BOOKS RECOMMENDED:

1. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012. Ch 1, Ch 2 (1 – 18), Ch 3 (1 – 7).

BOOK FOR REFERENCES:

1. A. Pressley, Elementary Differential Geometry, Springer Internationl Edition, 2014.
2. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.
3. C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.
4. D.J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.

+3 THIRD YEAR SIXTY SEMESTER

DSE - 4 (Optional/ Project)
NUMBER THEORY

Time :**3** Hrs. End Semester Theory :**80** Marks
Credit :**06** Mid Semester Theory : **20** Marks

Course Objective:

The main objective of this course is to build up the basic theory of the integers, prime numbers and their primitive roots, the theory of congruence, quadratic reciprocity lawand number theoretic functions, Fermat's last theorem, to acquire knowledge in cryptography specially in RSA encryption and decryption.

Course Outcome:

Upon successful completion of this course students will able to know the basic definitions and theorems in number theory, to identify order of an integer, primitive roots, Euler's criterion, the Legendre symbol, Jacobi symbol and their properties, to understand modular arithmetic number-theoretic functions and apply them to cryptography.

UNIT- I

Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture, linear congruences, complete set of residues, Chinese remainder theorem, Fermat's little theorem, Wilson's theorem.

UNIT-II

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product, the Mobius inversion formula, the greatest integer function, Euler's phi-function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

UNIT-III

Order of an integer modulo n, primitive roots for primes, composite numbers having primitive roots, Euler's criterion, the Legendre symbol, Jacobi symbol and their properties, quadratic reciprocity, quadratic congruences with composite moduli.

UNIT-IV

Affine ciphers, Hill ciphers, p vg h v g gv public key cryptography, RSA encryption and decryption, the equation $x^2 + y^2 = z^2$, Fermat's Last Theorem.

BOOKS RECOMMENDED:

1. David M.Burton, Elementary Number Theory (6thEdition), Tata McGraw-Hill Edition, Indian reprint, 2007. Ch 2 (2.5), Ch 3 (3.1 – 3.3), Ch 4 (4.1 – 4.4), Ch 5 (5.1 – 5.4), Ch 6 (6.1 – 6.3), Ch 7 (7.1 – 7.4), Ch 8 (8.1 – 8.3), Ch 9 (9.1, 9.3), Ch 10 (10.1), Ch 12 (12.1, 12.2).

BOOK FOR REFERENCES:

1. Thomas Koshy, Elementary Number Theory with Applications (2nd Edition), Academic Press, 2007.
2. Neville Robinns, Beginning Number Theory (2ndEdition), Narosa Publishing House Pvt. Limited, Delhi,2007.

OR

Discipline Specific Elective Paper-IV

PROJECT

Guidelines for +3 (CBCS) Under Graduate(B.A./B.Sc.) Mathematics (Honours) Project

1. Any student registering for doing project is required to inform the HOD, Mathematics the name of his/her project supervisor(s) at the time of pre-registration.
2. By the last date of add and drop, the student must submit the “Project Registration Form’’, appended as Annexure-I to this document, to the HOD, Mathematics. This form requires a project title, the signature of the student, signature(s) of the supervisor(s) and the signature of the HOD, Mathematics of the college/university.
3. The project supervisor(s) should normally be a faculty member(s) of the Department of Mathematics and the topic of the project should be relevant to Mathematical Sciences. If a student desires to have a Project Supervisor from another department of the institute, the prior approval for the same should be sought from the HOD, Mathematics.
4. A student may have at the most two Project Supervisors. If a student desires to have two supervisors, at least one of these should be from the Department of Mathematics.
5. The student(s) will be required to submit one progress report and a final report of the Project to the HOD, Mathematics. The progress report is to be submitted in the sixth week of the semester in which the project is undertaken. The hard copy and an electronic version of the final report of the project should be submitted two weeks before the end semester examination of the sixth semester. In addition the student will be required to make an oral presentation in front of a committee (Under Graduate (B.A./ B.Sc.) Mathematics (Honours) Project committee of the college in which supervisor is one of the members) constituted for this purpose by the Department of Mathematics of the college.

6. The student is expected to devote about 100 hours. The project will be evaluated by a committee of faculty members at the end of the sixth semester. The committee will be constituted by the Under Graduate (B.A./B.Sc.) Mathematics (Honours) Project committee of the college keeping in mind the areas of project they will cover.
7. In each semester the grade of a student will be awarded by the committee in consultation with his/her project supervisor(s). The project is evaluated on the basis of the following components: First Progress Reports: 20%; second/Final Report: 30%; Presentation: 30%; Viva: 20%.
8. Project progress reports should normally be no longer than 250 words and final report should not be longer than 40 A4 size pages in double spacing. Each final project report need to contain the following: (i) Abstract (ii) Table of contents (iii) Review of literature (iv) Main text(v) List of references. It may be desirable to arrange the main text as an introduction, the main body and conclusions.

GUIDELINES FOR STRUCTURING CONTENTS

Sequence of Contents:

The following sequence for the thesis organization should be followed:

(i)	Preliminaries	Title Page
		Certificate
		Abstract/Synopsis
		Acknowledgement and/ or Dedication
		Table of Contents
		List of Figures, Tables, Illustrations,
		Symbols, etc (wherever applicable)
(ii)	Text of Thesis	Introduction
		The body of the thesis, summary and conclusions
(iii)	Reference Material	List of References, Bibliography
(iv)	Appendices	

NOTE:

1. Synopsis/Abstract should be self-complete and contain no citations for which the thesis has to be referred.
2. The Text of the Thesis

(a) Introduction:

Introduction may be the first chapter or its first major division. In either case, it should contain a brief statement of the problem investigated. It should outline the scope, aim, general character of the research and the reasons for the student's interest in the problem.

(b) The body of Thesis

This is the substance of the dissertation inclusive of all divisions, subdivisions, tables, figures, etc.

(c) Summary and conclusions

If required, these are given as the last major division (chapter) of the text. A further and final subdivision titled “Scope for Further Work” may follow.

(d) Reference material

The list of references should appear as a consolidated list with references listed either alphabetically or sequentially as they appear in the text of the thesis.

For referencing an article in a scientific journal the suggested format should contain the following information: authors, title, name of journal, volume number, page numbers and year. For referencing an article published in a book, the suggested format should contain, authors, the title of the book, editors, publisher, year, page number of the article in the book being referred to. For referencing a thesis the suggested format should contain, author, the title of thesis, where thesis was submitted or awarded, year.

ANNEXURE - I

Department of Mathematics
Project Registration Form

Name of the college/university: Name of the student:

Roll No. :

e-mail :

Name of the supervisor(s):

Department(s):

e-mail(s):

Title of the Project:

Signature of the Student:

Signature of supervisor(s): (i)

(ii)

Signature of HOD, Mathematics:

+3 FIRST YEAR FIRST SEMESTER

GE - 1
CALCULUS AND DIFFERENTIAL EQUATIONS

Time :**3** Hrs. End Semester Theory :**80** Marks
Credit :**06** Mid Semester Theory : **20** Marks

Course Objective:

Calculus invented by Newton and Leibnitz is powerful analytical tool to solve mathematical problems which arise in all branches of science and engineering. The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of a mathematical nature as well as practical problems using calculus and differential equation. The aim should be to expose the students to basic ideas quickly without much theoretical emphasis with importance on applications.

Excepted Outcome:

After completing the course, students are expected to be able to apply knowledge of calculus and differential equations in the areas of their own interest.

UNIT-I

Curvature, Asymptotes, Tracing of Curves (Catenary, Cycloid, Folium of Descartes), Rectification, Quadrature, Elementary ideas about Sphere, Cones, Cylinders and Conicoids.

UNIT-II

Review of limits, continuity and differentiability of functions of one variable and their properties, Rolle's theorem, Mean value theorems, Taylor's theorem with Lagrange's theorem and Cauchy's form of remainder, Taylor's series, Maclaurin's series of sinx , cosx , e^x , log (1 + x), $(1 + x)^m$, L' Hospital's Rule, other Intermediate forms.

UNIT-III

Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurin's theorem for functions of two variables(statements &applications), Maxima and Minima of functions of two and three variables, Implicit functions, Lagrange's multipliers (Formulae & its applications).

UNIT-IV

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear). Equations of order one but higher degree. Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters.

BOOKS RECOMMENDED:

1. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014. Ch 3, Ch 4, Ch 6, Ch 8, Ch 10, Ch 14 (14.1 – 14.6), Ch 17 (excluding polar curves).
2. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014.

3. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications. Ch 5 (excluding proofs of theorems), Ch 6 (excluding proofs of theorems), Ch 7 (7.2 only), Ch 15 (excluding proofs of theorems).
4. J. Sinharoy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers. Ch 2 (2.1 – 2.7), Ch 3, Ch 4 (4.1 – 4.4)

BOOK FOR REFERENCES:

1. H. Anton, I. Bivens and S. Davis, Calculus, 10th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
2. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
4. B. P.Acharya and D. C.Sahu : Analytical Geometry of Quadratic Surfaces, Kalyani Publishers.

+3 FIRST YEAR SECOND SEMESTER

GE - 2
ALGEBRA

Time : **3** Hrs.	End Semester Theory : **80** Marks
Credit : **06**	Mid Semester Theory : **20** Marks

Course Objective:

This is a preliminary course for the basic courses in mathematics like, abstractalgebra and linear algebra. The objective is to acquaint students with the properties of natural numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. The basics of linear algebra i.e. vector spaces, matrices are introduced here.

Course Outcome:

The acquired knowledge will help students to study further courses in mathematics like, group theory, ring theory and field theory and linear algebra. It has applications not only in higher mathematics but also in other science subjects like computer science, statistics, physics, chemistry etc.

UNIT-I

Sets, relations, Equivalence relations, partial ordering, well ordering, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments.

UNIT-II

Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

UNIT-III

Matrices, algebra of matrices, determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems,.

UNIT-IV

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples, Introduction to linear transformations, matrix representation of a linear transformation, Eigen values, Eigen vectors of a matrix.

BOOKS RECOMMENDED:

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005. Ch 0, Ch 1, Ch 2, Ch 3, Ch 4, Ch 5 (5.1).
2. V Krishna Murthy, V P Mainra, J L Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd. Ch 3 (3.1, 3.2, 3.3, 3.5, 3.6), Ch 5 (5.1, 5.4 - 5.9), Ch 6 (6.1, 6.2, 6.4 – 6.8).

BOOKS FOR REFERENCE:

1. David C. Lay, Linear Algebra and its Applications,3rd Ed., Pearson Education Asia, Indian Reprint,2007.
2. B S Vatsa and Suchi Vatsa Theory of Matrices New age International third edition 2010.
3. Ward Cheney, David kincaid. Linear algebra theory and applications, Jones and Bartlett , 2010.

OR

GENERIC ELECTIVES (FOUR PAPERS CHOICE)

Generic Elective Paper I

CALCULUS AND DIFFERENTIAL EQUATIONS

Time :**3** Hrs. End Semester Theory :**80** Marks

Credit :**06** Mid Semester Theory : **20** Marks

Course Objective:

Calculus invented by Newton and Leibnitz is powerful analytical tool to solve mathematical problems which arise in all branches of science and engineering. The main emphasis of this course is to equip the student with necessary analytic and technical skills to handle problems of a mathematical nature as well as practical problems using calculus and differential equation. The aim should be to expose the students to basic ideas quickly without much theoretical emphasis with importance on applications.

Excepted Outcome:

After completing the course, students are expected to be able to apply knowledge of calculus and differential equations in the areas of their own interest.

UNIT-I

Curvature, Asymptotes, Tracing of Curves (Catenary, Cycloid, Folium of Descartes), Rectification, Quadrature, Elementary ideas about Sphere, Cones, Cylinders and Conicoids.

UNIT-II

Review of limits,continuity and differentiability of functions of one variable and their properties, Rolle’s theorem, Mean value theorems, Taylor’s theorem with Lagrange’s theorem and Cauchy’s form of remainder, Taylor’s series, Maclaurin’s series of sinx , cosx , e^x , log (1 + x), $(1 + x)^m$, L’ Hospital’s Rule, other Intermediate forms.

UNIT-III

Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurin’s theorem for functions of two variables(statements &applications), Maxima and Minima of functions of two and three variables, Implicit functions, Lagranges multipliers (Formulae & its applications), Concepts of Multiple integrals & its applications.

UNIT-IV

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear). Equations of order one but higher degree.Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters.

BOOKS RECOMMENDED:

1. Shanti Narayan, P. K. Mittal, Differential Calculus, S. Chand, 2014.
2. Shanti Narayan, P. K. Mittal, Integral Calculus, S. Chand, 2014.
3. S.C. Mallik and S. Arora-Mathematical Analysis, New Age International Publications.
4. J. Sinharoy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers.

BOOKS FOR REFERENCE:

1. H. Anton, I. Bivens and S.Davis, Calculus, 10th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
2. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
4. B. P.Acharya and D. C. Sahu: Analytical Geometry of Quadratic Surfaces, Kalyani Publishers.

Generic Elective Paper II

ALGEBRA

Time :**3** Hrs. End Semester Theory :**80** Marks
Credit :**06** Mid Semester Theory : **20** Marks

Course Objective:

This is a preliminary course for the basic courses in mathematics like, abstract algebra and linear algebra. The objective is to acquaint students with the properties of natural numbers i.e. Euclidean algorithm, congruence relation, fundamental theorem of arithmetic, etc. The basics of linear algebra i.e. vector spaces, matrices are introduced here.

Course Outcome:

The acquired knowledge will help students to study further courses in mathematics like, group theory, ring theory and field theory and linear algebra. It has applications not only in higher mathematics but also in other science subjects like computer science, statistics, physics, chemistry etc.

UNIT-I

Sets, relations, Equivalence relations, partial ordering, well ordering, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, statements, compound statements, proofs in Mathematics, Truth tables, Algebra of propositions, logical arguments

UNIT-II

Well-ordering property of positive integers, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

UNIT-III

Matrices, algebra of matrices , determinants, fundamental properties, minors and cofactors, product of determinant, adjoint and inverse of a matrix, Rank and nullity of a matrix, Systems of linear equations, row reduction and echelon forms, solution sets of linear systems, applications of linear systems.

UNIT-IV

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension, examples, Introduction to linear transformations, ,matrix representation of a linear transformation, Eigen values, Eigen vectors of a matrix.

BOOKS RECOMMENDED:

1 Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005.

2 V Krishna Murthy, V P Mainra, J L Arora, An Introduction to Linear Algebra , Affiliated East-West Press Pvt. Ltd

BOOKS FOR REFERENCE:

1. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Pearson Education Asia, Indian Reprint,2007.

2. B S Vatsa and Suchi Vatsa Theory of Matrices New age International third edition 2010.

3. Ward Cheney, David Kincaid. Linear algebra theory and applications, Jones and Bartlett ,2010

Generic Elective Paper III

REAL ANALYSIS

Time :**3** Hrs. End Semester Theory :**80** Marks
Credit :**06** Mid Semester Theory : **20** Marks

Course Objective:

The objective of the course is to have the knowledge on basic properties of the field of real numbers, studying Bolzano-Weiersstrass Theorem , sequences and convergence of sequences, series of real numbers and its convergence etc. This is one of the core courses essential to start doing mathematics.

Course Outcome:

On successful completion of this course, students will be able to handle fundamental properties of the real numbers that lead to the formal development of real analysis and understand limits and their use in sequences, series, differentiation and integration. Students will appreciate how abstract ideas and rigorous methods in mathematical analysis can be applied to important practical problems.

UNIT-I

Review of Algebraic and Order Properties of R, ε-neighborhood of a point in R, Idea of countable sets, uncountable sets and uncountability of R, Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of R, The Archimedean Property, Density of Rational (and Irrational) numbers in R.

UNIT-II

Intervals, Interior point, Open Sets, Closed sets, Limit points of a set , Illustrations of Bolzano-Weierstrass theorem for sets, closure, interior and boundary of a set. Sequences, Bounded sequence, Convergent sequence, Limit of a sequence. Limit Theorems, Monotone Sequences, Monotone Convergence Theorem. Subsequences, Divergence Criteria, Monotone Subsequence Theorem (statement only). Bolzano Weierstrass Theorem for Sequences, Cauchy sequence, Cauchy's Convergence Criterion.

UNIT-III

Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests for convergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integral test, Alternating series, Leibniz test, Absolute and Conditional convergence.

UNIT-IV

Sequence and Series of functions, pointwise and uniform convergences, M_n-test, weierstrass M -test, statement of results about uniform convergence, differentiability and integrability of function, power series and radius of convergence.

BOOKS RECOMMENDED:

1. S.C. Mallik and S. Arora- Mathematical Analysis, New Age International Publications.
2. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co.

BOOKS FOR REFERENCE:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis (3rd Edition), John Wiley and Sons (Asia) Pvt. Ltd., Singapore,2002.
2. A. Kumar, S. Kumaresan, A basic course in Real Analysis, CRC Press, 2014.

3. Brian S. Thomson, Andrew. M. Bruckner, and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall,2001.

4. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis, Jones & Bartlett, Second Edition, 2010.

Generic Elective Paper IV

NUMERICAL METHODS

Time :**3** Hrs. End Semester Theory :**80** Marks
Credit :**06** Mid Semester Theory : **20** Marks

Course Objective:

Calculation of error and approximation is a necessity in all real life, industrial and scientific computing. The objective of this course is to acquaint students with various numerical methods of finding solution of different type of problems, which arises in different branches of science such as locating roots of equations, finding solution of nonlinear equations, systems of linear equations, differential equations, Interpolation, differentiation, evaluating integration.

Course Outcome:

Students can handle physical problems to find an approximated solution. After getting trained a student can opt for advance courses in Numerical analysis in higher mathematics. Use of good mathematical software will help in getting the accuracy one need from the computer and can assess the reliability of the numerical results, and determine the effect of round off error or loss of significance.

UNIT-I

Algorithms, Convergence, Bisection method, False position method, Fixed point iteration method, Newton's method, Secant method. Gauss Elimination and Gauss Jordan methods, LU decomposition, Gauss-Jacobi, Gauss- Siedel.

UNIT-II

Lagrange and Newton interpolation: linear and higher order, finite difference operators.

UNIT-III

Numerical differentiation: forward difference, backward difference and central Difference.

UNIT-IV

Integration: trapezoidal rule, Simpson's rule, Euler's method, Runge-Kutta methods of orders two and four.

BOOKS RECOMMENDED:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and Engineering Computation, 5th Ed., New age International Publisher, India, 2007.

BOOKS FOR REFERENCE:

1. S. S. Sastry, Introductory method for Numerical Analysis, PHI New Delhi,2012.

2. S. D. Conte and Carl De Boor, Elementary Numerical Analysis, Mc Graw Hill, 1980.

PHYSICS

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 1

MATHEMATICAL PHYSICS - I

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objectives:

To provide students the ability to hone the mathematical skills necessary to approach problems in advanced physics courses. Student should be able to understand basic theory of Vector algebra, curvilinear coordinate system, series functions, and calculus.

UNIT - I :

Calculus - I : Plotting of functions, Intuitive ideas of continuous, differentiable functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order Differential Equations and Integrating Factor. Second Order Differential equations: Homogeneous Equations with constant coefficients, Wronskian and general solution, Statement of existence and Uniqueness Theorem for Initial Value Problems, Particular Integral.

UNIT-II

Calculus - II : Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration, Constrained Maximization using Lagrange Multipliers.

Vector algebra : Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations, Vector product, Scalar triple product and their interpretation in terms of area and volume respectively, Scalar and Vector fields.

UNIT-III

Orthogonal Curvilinear Coordinates : Orthogonal Curvilinear Coordinates, Derivation of Gradient, Divergence, Curl, and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems, Comparison of velocity and acceleration in cylindrical and spherical coordinate system

Dirac Delta function and its properties : Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular Function, Properties of Dirac delta function.

UNIT-IV

Vector Differentiation : Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation, Divergence and curl of a vector field, Del, and Laplacian operators, Vector identities

Vector Integration : Ordinary Integrals of Vectors, Multiple integrals. Jacobian, Notion of infinitesimal line, surface and volume elements, Line, surface, and volume integrals of Vector fields, Flux of a vector field, Gauss' divergence theorem, Green's, and Stokes Theorems and their applications (no rigorous proofs)

Textbooks:

1. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber. F. E. Harris (2013, 7th Edn.,Elsevier)

2. Advanced Engineering Mathematics, Erwin Kreyszig (Wiley India) Reference books:
1. Mathematical Physics C. Harper (Prentice Hall India)
2. Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition, Mc-Graw Hill Education)
3. Complex variables and applications, J. W. Brown, and R.V.Churchill Mathematical Physics, SatyaPrakash (Sultan Chand)
4. Mathematical Physics, B. D. Gupta (4th edition, Vikas Publication) Mathematical Physics andSpecial Relativity, M. Das, P.K. Jena, and B.K. .Dash (Srikrishna Prakashan).
5. Mathematical Physics-H.K. Dass, Dr. Rama Verma (S. Chand Publishing). Course Outcomes: After successfully completing the course, student will be able to have a good grasp of the calculus. Students will understand the applications of vector space, vector algebra and series functions and curvilinear coordinates.

CORE - 1 - LAB

Credit : **02** **25** Marks

Course Objective:

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems.
- The course will consist of lectures (both theory and practical) in the Lab.
- Evaluation done not on the programming but on the basis of formulating the problem.
- Aim at teaching students to construct the computational problem to be solved.
- Students can use any one operating system Linux or Microsoft Windows.

Introduction and Overview:

Computer architecture and organization, memory, and Input output devices.

Basics of scientific computing:

Binary and decimal arithmetic, Floating point numbers, algorithms. Sequence. Selection and Repetition, single and double precision arithmetic, underflow, and overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods Algorithm.

Errors and error Analysis:

Truncation and round off errors, Absolute and relative errors. Floating point computations. Systematic and Random Errors, Propagation of Errors, Normal Law of Errors. Standard and Probable Error.

Review of C and C++ Programming :

Introduction to Programming, constants, variables and Fundamentals data types, operators and Expressions. I/O statements, scanf and printf, c in and c out. Manipulators for data formatting,Control statements (decision making and looping statements) (If Statement. If else Statement, Nested-If structure, Else-If Statement. Ternary-if operator. Go to Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop.

Break and Continue Statements. Nested Loops, Arrays (1D and 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.

Programs:

Sum and average of list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search

Random number generation:

Area of circle, area of square, volume of sphere, value of II

Reference Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Schaum's outline of Programming with C++ J. Hubbard, 2000, McGraw-Hill Pub.
3. Numerical Recipesin C: The Art of Scientific Computing. W.H. Pressetal, 3rd Edn. 2007, Cambridge University Press.
4. A first course in Numerical Methods, U.M. Ascher and C. Greif. 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
6. Numerical Methods for Scientists and Engineers, R.W. Hamming. 1973, Courier Dover Pub.
7. An Introduction to computational Physics, T. Pang, 2nd Edn. 2006.Cambridge Univ. Press.

Course Outcomes:

After completion of practical, the students will be able grasp the knowledge of computer language and will be able to solve mathematical problems using computer language which can be applied in day to day life.

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 2

MECHANICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

To make students learn about various fields of mechanics in depth in order to prepare them for advanced methods for solving numerical and conceptual problems associated with mechanics.

UNIT - I

Rotational Dynamics: Centre of Mass, Motion of COM, Centre of Mass and Laboratory frames, Angular momentum of a particle and system of particles, Principle of conservation of angular momentum, Rotation about a fixed axis, Moment of Inertia, Perpendicular and Parallel Axis Theorems, Routh Rule, calculation of moment of inertia for cylindrical and spherical bodies. Kinetic energy of rotation, Eulers Equations of Rigid Body motion, Motion involving both translation and rotation. Moment of Inertia of a Flywheel.

Non-Inertial Systems : Non-inertial frames and fictitious forces, Uniformly rotating frame, Laws of physics in rotating coordinate systems, Centrifugal force, Coriolis force and its applications.

UNIT - II

Elasticity : Relation between Elastic constants, Twisting torque on a Cylinder or Wire, Bending of beams, External bending moment, Flexural rigidity, Single and double cantilever

Fluid Motion: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube. Surface tension, Gravity waves and ripple.

Viscosity: Poiseuille's Equation for Flow of a Liquid with corrections.

UNIT-III

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy, Inertial and gravitational mass, Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution, Differential Equation of motion with central force and its solution. The first Integrals (two), Concept of power Law Potentials, Kepler's Laws of Planetary motion, Satellites:Geosynchronous orbits. Weightlessness, Basic idea of global positioning system (GPS),Physiological effects on astronauts.

UNIT-IV

Oscillations: Simple Harmonic Oscillations. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Equation of motion and solution(cases of oscillatory, critically damped, and overdamped) Forced oscillations: Transient and steady states;Resonance sharpness of resonance; power dissipation and Quality Factor, Bar Pendulurn, Kater's Pendulum.

Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity, Lorentz Transformations. Simultaneity and order of events, Lorentz contraction, Time dilation, Relativistic transformation of velocity, Frequency and wave number, Relativistic addition of velocities. Variation of mass with velocity, Massless Particles, Mass-energy Equivalence, Relativistic Doppler effect Relativistic Kinematics, Transformation of Energy and Momentum.

Text Books:

1. Mechanics, D.S.Mathur(S. Chand Publishing)
2. Introduction to Special Relativity, R. Resnick (John Wiley)

Reference Books:

1. Introduction to Mechanics Daniel Klapnner and Robert Kolenkow. McGrawHill.
2. Mechanics by K.R Simon
3. Mechanics. Berkeley Physics, vol. 1, C.Kittel, W. Knight, etal (Tata McGraw- Hill) 204 Syllabus-Science
4. Physics. Resnick. Halliday and Walker (8/e.2008,Wiley) Theoretical Mechanics-M.R. Spiegel(Tata McGrawHill).
6. Feynman Lectures. Vol. I. R.P.Feynman, R.B. Leighton, M. Sands (Pearson)
7. Mechanics-M. Das. P. K. Jena and R.N. Mishra (SrikrishnaPublications)

Course Outcomes:

After completion of course students will have understanding of various fields of mechanics in depth. The students will be ready to dive into advanced methods for solving numerical and conceptual problems associated with mechanics.

CORE - 2 - LAB

Credit : **02** **25** Marks

Course Objective:

To make students apply the knowledge of mechanics in order to verify theoretical outcomes practically through use of different pre known methods.

Experiments:

1. To study surface tension by capillary rise method.
2. To determine the height of a building using a Sextant.
3. To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c) Modulus of rigidity.
4. To determine the Moment of Inertia of a Flywheel.
5. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuilles method).
6. To determine the Modulus of Rigidity of a Wire by Maxwell'sneedle.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, AsiaPublishingHouse.
2. Advanced level Physics Practicals, Michael Nelson, and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers.
3. A Text Book of Practical Physics, I. Prakash, and Ramakrishna. 11thEdn, 2011, Kitab Mahal.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 3

ELECTRICITY AND MAGNETISM

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

To make students understand electrostatics and magneto statics in depth and explore the branch of electromagnetic with Maxwell's equations. The course also emphasise on concepts of electrical circuits and network theorems for student's understanding.

UNIT-I

Electric Field and Electric Potential:

Electric field: Electric field lines, Electric flux, Gauss Law with applications to charge distributions with cylindrical and planar symmetry, Conservative nature of Electrostatic Field. Electrostatic Potential, Potential and Electric Field of a dipole, Force and Torque on a dipole, Potential calculation in different simple cases, Laplace's, and Poisson equations. The Uniqueness Theorem, Method of Images, and its application to (1) Plane Infinite Sheet and (2) Sphere.Electrostatic energy of system of charges, Electrostatic energy of a charged sphere, Conductors in an electrostatic Field, Surface charge and force on a conductor.

UNIT-II

Magnetic Field: Magnetic Force, Lorentz Force, Biot-Savarts Law, Current in a Loop as a Magnetic Dipole and its Dipole Moment (analogy with Electric Dipole). Amperes Circuital Law and its application to (1) Solenoid (2) Toroid (3) Helmholtz coil, Properties of B:curl and divergence. Vector Potential, Ballistic Galvanometer: Torque on a current Loop, Current and Charge Sensitivity, Electromagnetic damping, Logarithmic decrement, CDR.

UNIT-III

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges, Electrical Susceptibility and Dielectric Constant, Capacitor (parallel plate, spherical, cylindrical)filled with dielectric, Displacement vector $\vec{D}$, Relations between , and , Gauss Law in dielectrics. Magnetic Properties of Matter: Magnetization vector (**M**), Magnetic Intensity (**H**), Magnetic Susceptibility and permeability, Relation between **B**, **H**. **M**, Ferromagnetism, **B-H** curve,and hysteresis.

Electromagnetic Induction: Faraday's Law, Lenz's Law. Self-Inductance and Mutual Inductance,Reciprocity Theorem, Energy stored in a Magnetic Field, Introduction to Maxwell's Equations

UNIT-IV

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance, Series LCR Circuit: (1) Resonance (2) Power Dissipation (3) Quality Factor. (4) Band Width, Parallel LCR Circuit.

Network theorems: Ideal Constant-voltage and Constant-current Sources, Network Theorems:Thevenin theorem. Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to DC circuits. Transient Currents Growth and decay of current in RC and LR circuits.

Text Books:

1. Introduction to Electrodynamics - D. J. Griffiths (Pearson, 4th edition. 2015)
2. Foundations of Electromagnetic Theory-Ritz and Milford (Pearson)

Reference Books:

1. Classical Electrodynamics, J. D. Jackson (Wiley).
2. Electricity and Magnetism D. C. Tayal (Himalaya Publishing house)
3. Electricity, Magnetism and Electromagnetic Theory- S. Mahajan and Choudhury (Tata McGrawHill)
4. Feynman Lectures Vol.2, R. P. Feynman, R. B. Leighton. M. Sands (Pearson)
5. Electricity and Magnetism, J. H. Fewkes and J. Yarwood. Vol. I (Oxford Univ. Press)

Course Outcomes:

After completion of course, students would have understanding of electrostatics and magneto statics and Maxwell's equations in depth, along with electrical circuits and network theorems.

CORE - 3 - LAB

Credit : **02** **25** Marks

Credit : **02** **25 Marks**

Course objectives:

To make students learn use of multimeter, potentiometer, and many other passive and active elements of circuit for practical knowledge of phenomena occurring in electrical circuits. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Fosters Bridge. To compare capacitances using De-Sauty's bridge.
4. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
5. To verify the Thevenin and Norton theorems.
6. To determine self-inductance of a coil by Anderson's bridge.
7. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b)Impedance at resonance, (c) Quality factor Q, and (d) Band width.
8. To study the response curve of a parallel LCR circuit and determine its (a) Anty resonance frequency and (b) Quality factor Q.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse.
2. A Text book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed., 2011, Kitab Mahal.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers.
4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Course Outcomes:

After performing the practical, students will be able to devise electrical circuits and solve problems associated with it in their day to day life.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 4

WAVES AND OPTICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

To make student create a picture of phenomena in optics with deeper understanding of reasons behind them, for preparing young minds before exploring advanced topics.

UNIT-I

Geometrical optics: Fermat's principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics, Cardinal points and Cardinal planes of an optical system. Idea of dispersion, Application to thick Lens and thin Lens, Ramsden, and Huygens eyepiece.

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front, Huygen's Principle. Temporal and Spatial Coherence.

UNIT - II

Wave Motion : Plane and Spherical Waves, Longitudinal and Transverse Waves, Plane Progressive (Traveling) Waves. Wave Equation, Particle and Wave Velocities, Differential Equation, Pressure of a Longitudinal Wave, Energy Transport, Intensity of Wave. Superposition of two perpendicular Harmonic Oscillations : Graphical and Analytical Methods, Lissajous Figures(1:1 and 1:2) and their uses, Superposition of N harmonic waves.

UNIT- III

Interference : Division of amplitude and wave front, Young's double slit experiment, Lloyds Mirror and Fresnel's Bi-prism. Phase change on reflection: Stoke's treatment. Interference in

Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes). Fringes of equal thickness (Fizeau Fringes), Newtons Rings: Measurement of wavelength and refractive index. Interferometer: Michelson's Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index,and (5) Visibility of Fringes,Fabry-Perot interferometer.

UNIT - IV

Fraunhofer diffraction: Single slit, Circular aperture, Resolving Power of a telescope, Double slit, N multiple slits. Diffraction grating, Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions, Fresnel's Half-Period Zones for Plane Wave, Explanation of Rectilinear Propagation of Light, Theory of a Zone Plate: Multiple Foci of a Zone Plate, Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.

Text Books:

1. A text book of Optics N. Subrahmanyam and Brij Lal (S.Chand Publishing)
2. Optics - Ajoy Ghatak (McGraw Hill)

Reference Books:

1. Optics-E.Hecht(Pearson)
2. Fundamentals of Optics - F.A.JenkinsandH.E.White(McGraw-Hill)
3. Geometrical and Physical Optics R.S. Longhurst (Orient Blackswan)
4. The Physics of Vibrations and Waves-HJ.Pain (John Wiley)
5. Optics P.K.Chakrabarty.
6. Principles of Optics-MaxBom and EmilWolf (Pergamon Press)
7. The Physics of Waves and Oscillations - N.K.Bajaj (McGraw Hill)

Course Outcomes:

After completion of course students will be have a picture of phenomena in optics with deeper understanding of reasons behind them, before exploring advanced topics.

CORE - 4 - LAB

Credit : **02** **25** Marks

Course Objectives:

To make students apply the knowledge of optics in order to verify theoretical outcomes practically through use of different pre known methods.

1. To determine frequency of an electric tuning fork by "Meldls" experiment and verify λ^2 -T law.
2. To plot the I-D curve and to determine the refractive index of a prism.
3. To determine refractive index of the Material of a prism using sodium source.
4. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
5. To determine wavelength of sodium light using Newtons Rings.
6. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.

7. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Book of Practical Physics, I. Prakash and Ramakrishna, 11th Ed.,2011, KitabMahal.
3. Advanced level Physics Practicals, Michael Nelson, and Jon M. Ogborn, 4th Edition, reprinted1985, Heinemann Educational Publishers
4. A Laboratory Manual of Physics for undergraduate classes. D. P. Khandelwal, 1985, Vani.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 5

MATHEMATICAL PHYSICS-II

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objectives:

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Fourier Series-I: Periodic functions, Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only), Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series, Expansion of functions with arbitrary period, Expansion of non-periodic functions over an interval,Even and odd functions and their Fourier expansions and Application, Summing of Infinite Series, Term-by-Term differentiation and integration of Fourier Series, Parseval Identity.

UNIT-II

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance, Singularities of Bessel's and Laguerre Equations, Frobenius method and its applications to differential equations: Legendre and Hermite Differential Equations, Legendre, and Hermite Polynomials: Rodrigues Formula, Generating Function, Orthogonality.

UNIT-III

Polynomials: Simple recurrence relations of Legendre and Hermite Polynomials, Expansion of function in a series of Legendre Polynomials, Associated Legendre Differential Equation, Associated Legendre polynomials, Spherical Harmonics.

Some Special Integrals: Beta and Gamma Functions and relation between them, Expression of Integrals in terms of Gamma Functions, Error Function (Probability Integral).

UNIT-IV

Partial Differential Equations: Solutions to partial differential equations using separation of variables: Laplace's Equation in problems of rectangular, cylindrical, and spherical symmetry. Conducting and dielectric sphere in an external uniform electric field. Wave equation and its solution for vibrational modes of a stretched string.

Text Books:

1. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris (2013, 7th Edn., Elsevier)
2. Advanced Engineering Mathematics, Envin Kreyszig (Wiley India)

Reference Books:

1. Mathematical Physics and Special Relativity, M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan).
2. Mathematical Physics-H. K. Dass, Dr. Rama Verma (S. Chand Publishing).
3. Mathematical Physics C. Harper (Prentice Hall India) (Complex Variable)
4. Schaum's Outlines Series M. Spiegel (2nd Edition, McGraw Hill Education)
5. Complex variables and applications J.W.Brown and R.V.Churchill
6. Mathematical Physics, Satya Prakash (Sultan Chand)
7. Mathematical Physics B.D.Gupta (4th edition, Vikas Publication)

Course Outcomes:

The emphasis of the course is on applications in solving problems of interest to physicists. Students will be prepared for solving problems, seen and unseen.

CORE - 5 - LAB

Credit : **02** **25** Marks

Course Objective:

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on theprogramming but on the basis of formulating the problem.

Topics Introduction to Numerical Computation Software Scilab:

Introduction to Scilab, Advantages, disadvantages, Scilab computation software, Scilab environment Command window, Edit window, Figure window, Variables and arrays, Initialising variables in Scilab. Multi dimensional arrays, Sub array, Special. Values Displaying output data, data file, Scalar and array operations. Hierarchy of operations, Built in Scilab . Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational and logical perators, the while loop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorization(2) User defined functions, Introduction to Scilab functions, Variables Passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character string function,Multi dimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program(2).

Curve fitting, Least square fit Goodness of fit. standard constant Deviation: Ohms law to calculate, R. Hookes law to calculate spring constant.

Solution of Linear system of equations by Gauss elimination Solution method and Gauss Seidal method. Diagonalization matrices, Inverse of a matrix, Eigenvectors, problems:

Solutions of meshi equations of electric circuits (3 meshes), Solution of coupled spring mass systems (3 masses)

Solution of ODE First order Differential equadon Euler, modifted Euler Runge-Kutta second methods Second order differential equation. Fixed difference method:

First order Differential Equation

- Radioactive decay
- Current in RC, LC circuits with DC source
- Newtons law of cooling
- Classical equations of motion

Second order Differential Equation

- Harmonic oscillator (no friction)
- Damped Harmonic oscillator
- Over damped
- Critical damped
- Oscillatory
- Forced Harmonic oscillator
- Transient and Steady state solution
- Apply above to LCR circuits also

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.FRiley. M.P.Hobson and S. J.20 Bence, 3rd ed., 2006, Cambridge University Press.
2. Complex Variables, A.S. Fokas and M.J. Ablowitz, 8th Ed., 2011. Cambridge Univ. Press.
3. First course in complex analysis with applications. D.GZill and P.D.Shana - han, 1940, Jones and Bartlett.
4. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V.Wouwer, P. Saucez, C.V. Fernandez. 2014 Springer
5. Scilab by example: M.Affouf 2012, ISBN: 978-1479203444
6. Scilab (A free software to Matlab) : H.Ramchandran, A.S.Nair.2011 S.Chand and Company

   Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing.

Course Outcomes:

After completion of practical, the students will be able grasp the knowledge of computer language and will be able to solve mathematical problems using computer language which can be applied in day to day life.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 6
THERMAL PHYSICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The aim is to make students learn about branch of thermodynamics, phenomena associated with and laws governing thermodynamically systems, and its stability.

UNIT-I

Introduction to Thermodynamics : Recapitulation of Zeroth and First law of thermodynamics,

Second Law of Thermodynamics: Reversible and Irreversible process with examples, Kelvin and Clausius Statements and their Equivalence, Carnot's Theorem, Applications of Second Law of Thermodynamics. Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy, Entropy of a perfect gas, Principle of increase of Entropy, Entropy Changes in Reversible and Irreversible processes with examples, Entropy of the Principle of Increase of Entropy, Temperature Entropy Diagram for Carnot's Cycle, Third Law of Thermodynamics, Unattainability of Absolute Zero.

UNIT-II

Thermodynamic Potentials: Extensive and Intensive Thermodynamic Variables,

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibbs Free Energy, their definitions, Properties and Applications, Surface Films and Variation of Surface Tension with Temperature, Magnetic Work, Cooling due to adiabatic demagnetization.

Phase Transitions: First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

Maxwells Thermodynamic Relations: Derivations and applications of Maxwells Relations, Maxwells Relations: (1) Clausius Clapeyron equation (2) Relation between C_p and C_v (3)TdS Equations,(4)Joule-Kelvin coefficient for Ideal and Vander Waal Gases (5) Energy equations (6) Change of Temperature during Adiabatic Process.

UNIT-III

Kinetic Theory of Gases

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification, Sterns Experiment, Mean. RMS and Most Probable Speeds,Degrees of Freedom, Law of Equipartition of Energy (No proof required). Specific heats of Gases.

Molecular Collisions: Mean Free Path, Collision Probability, Estimates of Mean Free Path.

Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

UNIT-IV

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation, The Virial Equation, Andrews Experiments on CO_2 Gas. Critical Constants, Continuity of Liquid and Gaseous State. Vapour and Gas, Boyle Temperature, Vander Waals Equation of State for Real Gases, Values of Critical Constants, Law of Corresponding States, Comparison with Experimental Curves, P-V Diagrams, Joules Experiment, Free Adiabatic Expansion of a Perfect Gas, Joule-Thomson Porous Plug Experiment, Joule- Thomson Effect for Real and Vander Waal Gases,Temperature of Inversion, Joule-Thomson Cooling.

Text Books:

1. Thermal Physics, A. B. Gupta (Books and allied Ltd)
2. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman (McGraw- Hill)

Reference Books:

1. Theory and experiments on thermal Physics, P.K.Chakrabarty (New central book agency limited)
2. Thermodynamics,Kinetic Theory and Statistical Thermodynamics-Searsand Salinger(Narosa)
3. A Treatise on Heat- Meghnad Saha and B.N.Srivastava (The Indian Press) Heat,Thermodynamics and Statistical Physics, N. Subrahmanyam and Brij Lal (S.Chand Publishing)
4. Thermal and Statistical Physics M.Das, P.K. Jena, S. Mishra, R.N.Mishra (Shri Krishna Publication)

Course Outcomes:

The students will have understanding of branch of thermodynamics, phenomena associated with and laws governing thermodynamically systems, and its stability.

CORE PAPER - 6 - LAB

(Minimum 5 experiments to be done)

Credit : **02** **25** Marks

Course Objective:

To make students apply the knowledge of thermodynamics in order to verify theoretical outcomes practically through use of different pre known methods.

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barnes constant flow method.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer(PRT).
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. To determine J by Calorimeter.

6. To determine the specific heat of liquid by the method of cooling.
7. To determine the specific heat of solid by applying radiation of correction.

Reference Books:

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia PublishingHouse.
2. A Text Book of Practical Physics, I.Prakash and Ramakrishna. 11 th Ed., 2011, Kitab Mahal.
3. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogbora, 4th Edition, reprinted1985, Heinemann Educational Publishers.
4. A Laboratory Manual of Physics for undergraduate classes,D.PKhandelwal,1985, Vani Pub.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 7

ANALOG SYSTEMS AND APPLICATIONS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

To emphasise on students to gain knowledge of analog and digital systems, circuit analysis, algebra associated with it to make them able utilize in better way for the development and application purposes.

UNIT-I

Semiconductor Diodes: P and N type semiconductors, energy level diagram, conductivity and mobility, Concept of Drift velocity, PN junction fabrication (simple idea), Barrier formation in PN Junction diode. Static and Dynamic Resistance, Current flow mechanism in Forward and Reverse Biased Diode, Drift velocity derivation for Barrier Potential, Barrier Width, and current Step Junction.

Two terminal device and their applications: (1) Rectifier Diode: Half- wave Rectifiers Centertapped and bridge type Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, L and C Filters (1) Zener Diode and Voltage Regulation, Principle and structure of LEDS, (2) Photo diode(3) Solar Cell.

UNIT - II

Bipolar Junction Transistors: n-p-n and p-n-p transistors. Characteristics of CB,CE and CC Configurations, Current gains α and β, Relation between α and β. Load line analysis of Transistors, DC Load and Q-point, Physical mechanism of current flow, Active, Cut-off and Saturation Regions.

Transistors Biasing: Transistor Biasing and Stabilization circuits, Fixed Bias, and Voltage Divider Bias.

Amplifiers: Transistors as 2-port network h-parameter Equivalent Circuit, Analysis of a single stage CE amplifier using Hybrid Model, Input and Output impedance. Current, Voltage and Power Gains, Classification of class A, B and C amplifiers, Push-pull amplifier (class B).

UNIT - III

Coupled Amplifier: RC-coupled amplifier and its frequency response.

Feedback in Amplifiers: Effect of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain Stability, Distortion and Noise. Sinusoidal Oscillations, Barkhausen's Criterion for self-sustained oscillator. RC Phase shift oscillator, determination of Frequency, Hartley and Colpitts oscillators.

UNIT-IV

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical OPAMP(IC741). Open-loop and Closed loop Gain. Frequency Response. CMRR, Slew Rate and concept of virtual ground.

Application of Op-Amps: (1) Inverting and non-inverting amplifiers (2) Adder (3) Subtractor, (4) Differentiator, (5) Integrator (6) Log amplifier, (7) Zero crossing detector (8) Wein-Bridgoscillator.

Text Books:

1. Foundations of Electronics-Raskhit and Chattopadhyay (New age International Publication)
2. Concept of Electronics- D.C.Tayal (HimalayPublication)

Reference Books:

1. Electronic devices and circuits R.L. Boylstad (Pearson India)
2. Electronic Principles-A.P. Malvino (Tata McGraw Hill)
3. Principles of Electronics- V. K. Mehta and Rohit Mehta (S. Chand Publication)
4. OP-Amps and Linear Integrated Circuit-R. A. Gayakwad (Prentice Hall)
5. Physics of Semiconductor devices, Donald A Neamen (Prentice Hall)

Course Objective:

After completion of course, students would have knowledge of analog and digital systems, circuit analysis, algebra associated with it to make them able to understand computer organization and utilization in better way for the development and problem solving.

CORE - PAPER - 7 - LAB

(Minimum 5 experiments to be done)

Credit : **02** **25** Marks

Course Objective:

To make student use the theories of analog and digital circuits, in order to get hold of circuits and obtain desirable result for better understanding.

1. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
2. Study of V-I and power curves of solar cells, and find maximum power point and efficieny.
3. To study the characterstics of a Bipolar Junction Transistor in CE configuration and draw load line.

4. To study the various biasing configurations of BJT for normal class A operation.
5. To study the frequency response of voltage gain of a RC - coupled transistor amplifier.
6. To design and study OP Amp-IC (741/351) as inverting and non inverting amplifier.
7. To design and study OP AMP-IC (741/351) as integrator and differentiation and study frequencyresponse.
8. To design and study OP AMP - IC (741/351) as adder and subtractor.
9. To design a wien bridge oscillator for given frequency using a OP-amp.
10. To design a phase shift oscillator of given specifications using BJT.

Reference Books:

1. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
2. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
3. Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
4. Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

Course Objective:

Students will be able to devise and use digital circuits in their daily life for different application purposes.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 8

MATHEMATICAL PHYSICS - III

Time : **3** Hrs.	End Semester Theory : **60** Marks
Credit : **04**	Mid Semester Theory : **15** Marks

Course Objective:

The emphasis of the course is on applications in solving problems of interest to physicists. Students are examined on the basis of problems, seen and unseen.

Unit - I

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation Eulers De Moivre's theorem, Roots of complex Numbers, Functions of Complex Variables, Analyticity and Cauchy-Riemann Conditions, Examples of analytic functions, Singular functions:poles and branch points, order of singularity, branch cuts, Integration of a function of a complex variable, Cauchy's Inequality, Cauchy'sIntegral formula, Simply and multiply connected region,Laurent and Taylors expansion, Residues and Residue Theorem, Application in solving Definite Integrals.

Unit - II

Integral Transforms-I: Fourier Transforms: Fourier Integral theorem, Fourier Transform, Examples, Fourier Transform of trigonometric Gaussian finite-wave train and other functions, Representation of Dirac delta function as Fourier Integral, Fourier transform of derivatives, Inverse Fourier Transform.

Unit - III

Integral Transforms-II: Convolution theorem, Properties of Fourier Transforms (translation, charge conjugation), Three dimensional Fourier transforms with examples, Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat flow Equations.

UNIT-IV

Laplace Transforms: Laplace Transforms (LT) of Elementary functions.

Properties of Laplace Transforms: Change of Scale Theorem, Shifting Theorem, LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function. Periodic Functions, Inverse LT,Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

Text Books:

1. Mathematical Methods for Physicists,GB.Arfkcn H. J. Weber, F. E.Harris (2013,7th Edn.,Elsevier)
2. Advanced Engineering Mathematics, ErwinKreyszig(Wiley India)

Reference Books:

1. Mathematical Physics and Special Relativity- M. Das, P. K. Jena and B. K. Dash (Srikrishna Prakashan)
2. Mathematical Physics- H. K. Dass, Dr. Rama Verma (S. Chand Publishing) Mathematical PhysicsC. Harper (Prentice Hall India)
3. Complex Variable: Schaum's Outlines Series M. Spiegel (2nd Edition , Me- Graw Hill Education)
4. Complex variables and applications J.W.Brown and R.V.Churchill
5. Mathematical Physics, Satya Prakash (Sultan Chand)
6. Mathematical Physics B.D.Gupta (4thedition,Vikas Publication)

Course Outcomes:

Students will be able to apply mathematical laws in solving problems of interest to physicists. Students can be examined on the basis of problems, seen and unseen.

CORE - 8 - LAB

Credit : **02** **25** Marks

Course Objective:

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Scilab based simulations (XCos) experiments based on Mathematical Physics problems like.

* **Solve simple differential equations like:**

with y(x=0)=0

$$\frac{d^2y}{dx^2} + 2\frac{dy}{dx} = -y \ with \ y(x=0) = 0, y'(x=0) = 1$$

$$\frac{d^2y}{dx^2} + e^{-x}\frac{dy}{dx} = \text{-y with } y(x=0) = 0, y'(x=0) = 1$$

* **Direct Delta Function**

Evaluate $\int_{-3}^{3} dx \frac{x+3}{\sqrt{2\pi\sigma^2}} e^{\frac{(x-2)^2}{2\sigma^2}}$, for σ = 0.1, 0.01, 0.001 and show that it tends to 5.

* **Fourier Series:**

Program to sum Evaluate the Fourier coefficients of a given periodic function (square wave)

$$\int_{-1}^{1} d\mu \, p_n(\mu) p_m(\mu) = \frac{2}{2n+1} \delta_{m,n}$$

* **Frobenius method and Special functions:**

$$\frac{dy}{dx} + e^{-x} = x^2$$

Plot $P_n(x)$, Legendre polynomial of degree n, and $J_n(x)$, Based function of first kind. Show recursion relation

* Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
* Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.
* Evaluation of trigonometric functions e.g., sin è , Given Bessel's function at N points find its valueat an intermediate point.

  Complex analysis: Calculate $\int \frac{dx}{x^2+2}$ and check it with computer integration.
* Integral transform: FFT of e^{-x^2}

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F. Riley, M.P.Hobson and S. J. Bence, 3rdcd., 2006, Cambridge University Press.
2. Mathematics for Physicists, P.Dennery and A.Krzywicki,1967,DovcrPub-lications
3. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineenng Applications: A. VandeWouwer, P. Saucez, C. V. Fenandez. 2014 Springer ISBN: 978-3319067896
4. Scilab by example: M.Affouf, 2012. ISBN: 978-1479203444.

5. Scilab(A free software to Matlab): H. Ramchandran, A.S.Nair.2011S.Chand and Company.
6. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing.

Course Outcomes:

After completion of practical, the students will be able grasp the knowledge of computer language and will be able to solve mathematical problems using computer language which can be applied in day to day life.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 9

ELEMENTS OF MODERN PHYSICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of concepts and developments of modern physics fields.

UNIT- I

Atomic Spectra and Models: Inadequacy of classical physics, Brief Review of Black body Radiation, Photoelectric effect. Compton Effect, dual nature of radiation wave nature of particles, Atomic spectra, Line spectra of hydrogen atom, Ritz Rydberg combination principle, Alpha Particle Scattering, Ruther- ford Scattering Formula, Rutherford Model of atom and its limitations.

UNIT- II

Atomic Model: Bohrs Model of Hydrogen atom, explanation of atomic spectra, correction for finite mass of the nucleus, Bohr correspondence principle, limitations of Bohr model, discrete energy exchange by atom, Frank Hertz Experiment, Sommer feld's modification of Bohr's Theory. Zeeman Effect, Theory of Normal and Anomalous Zeeman Effect, Paschen Bach Effect, Stark Effect.

UNIT- III

Wave Packet: superposition of two waves, phase velocity and group velocity, wave packets, Gaussian Wave Packet, spatial distribution of wave packet, Localization of wave packet in time, Time development of a wave packet, Wave Particle Duality Complementarity.

Wave Particle Duality: de Broglie hypothesis, Experimental confirmation of matter wave, Davisson-Germer Experiment, velocity of de-Broglie wave, wave particle duality, Complementarity

Uncertainty Principle: Heisenberg Uncertainty Principle, Illustration of the Principle through Experiments of Gamma ray microscope and electron diffraction through a slit, Estimation of ground state energy of harmonic oscillator and hydrogen atom, non-existence of electron in the nucleus, Uncertainty, and complementarities

UNIT-IV

Nuclear Physics-: Radioactivity, stability of the nucleus, Law of radio-active decay, Mean and Half-life, Alphadecay, Beta decay-energy released, spectrum and Pauli's prediction of neutrino, Gamma ray emission energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus, Fission and fusion , Fission and fusion nature of fragments, mass deficit and emission of neutrons. Nuclear reactor: slow neutron interacting with Uranium 235, Fusion and thermo nuclear reactions driving stellar energy (brief qualitative discussion).

Text Books:

1. Concepts of Modem Physics Arthur Beiser (McGraw Hill)
2. Modern Physics Murugeshan and Sivaprasad(S. Chand)

Reference Books:

1. Quantum Mechanics:Theory and Applications, A.K.Ghatak and S.Lokanathan, (Macniillan)
2. Introduction to Quantum Theory, David Park (Dover Publications)
3. Theory and Problems of Modern Physics, Schaum' soutline, R. Gautreau and W. Savin-(Tata McGraw-Hill)
4. Modern Physics-Serway (CENGAGEL earnings)
5. Physics of Atoms and Molecules Bransden and Joachim (Pearson Lndia)
6. Atomic and Nuclear Physics-A.B.Gupta (New Central)
7. Theoretical Nuclear Physics, J.M.Blatt and V.F. Weisskopf (Springer)

Course Outcomes:

The students will have idea about the field of modern physics and record of the developmental works which shall be needful in higher classes.

CORE - 9 - LAB

Credit : **02** **25** Marks

Course Objectives:

To make students apply the knowledge of modern physics in order to verify theoretical outcomes practically through use of different pre known methods.

1. To show the tunnelling effect in tunnel diode using I-Vcharacteristics.
2. To determine the wavelength of laser source using diffraction of single slit.
3. To determine the wavelength of laser source using diffraction of double slits.
4. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.
5. To determine the Planck's constant using LEDs of at least 4 different colours.
6. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
7. To setup the Millikan oil drop apparatus and determine the charge of an electron.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practical, Michael Nelson, and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.

3. A Text Books Book of Practical Physics, LPrakash and Ramakrishna, 11thEdn, 201 I, Kitab Mahal.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 10

DIGITAL SYSTEMS AND APPLICATIONS

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of concepts of digital system, elements, applications and developments.

UNIT - I

Integrated Circuits (Qualitative treatment only): Active and Passive Components, Discrete components, Wafer Chip, Advantages and Drawbacks of ICs, Scale of Integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs, Examples of Linear and Digital ICs.

Digital Circuits: Difference between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversation, BCD, Octal and Hexadecimal numbers, AND, OR and NOT. Gates (realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates and application as Parity Checkers.

UNIT-II

Boolean algebra: De Morgans Theorems: Boolean Laws, Simplification of Logic Circuit using Boolean Algebra, Fundamental Products, Idea of Minterms and Maxterms, Conversion of a Truth table in to Equivalent Logic Circuitby (1) Sum of Products Method and (2) Karnaugh Map.

Introduction to CRO: Block Diagram of CRO, Electron Gun, Deflection system and Time Base, Deflection Sensitivity.

Applications of CRO: (I) Study of Wave Form, (2) Measurement of Voltage, Current, Frequency and Phase Difference.

UNIT-III

Data Processing Circuits: Basic Idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2s complement. Half and Full Adders. Half and Full Subtracters, 4 bits binary Adder/Subtractor.

Timers: 1C 555: block diagram and application as astable multivibrator and Monostable multivibrator.

UNIT-IV

Introduction to Computer Organization: Input/output Devices, Data storage (idea of RAM and ROM), Computer memory. Memory organization and addressing, Memory Interfacing, Memory Map.

Shift registers: Serial-in-serial-out, Serial-in-Parallel-out, Parallel-in-Serial- out and Parallel in-Parallel-out. Shift Registers (only up to 4 bits)

Counters (4 bits): Ring Counter, Asynchronous counters. Decade Counter. Synchronous Counter.

Text Books:

1. Digital Circuits and Logic design: Samuel C, Lee (Printice Hall)
2. Digital Principles and Applications - A.P. Malvino, D.P. Leach and Saha (Tata McGraw) Syllabus-Science 221

Reference Books :

1. The Art of Electronics by Paul Horowitz and Wilfield Hill Cambridge University
2. Electronics by Allan R. Hambley, Prentice Hall 3. Principles of Electronics V.K. Mehta and Rohit Mehta (S.Chand Publishing)
3. Digital Logic and Computer design M. Morris Mano (Pearson)
4. Concepts of Electronics D.C.Tayal (Himalaya Publishing house)

Course Outcomes:

After completion of course, students will be equipped with concepts of digital system, elements, applications and developments.

CORE - 10 - LAB

Credit : **02** **25** Marks

Course Objectives:

To make students apply the theoretical knowledge on digital systems in order to verify theoretical outcomes practically through use of different pre known methods.

1. To measure (a) Voltage, and (b) Time period of a periodic wave form using CRO and to test aDiode and Transistor using a Millimetres.
2. To design a switch (NOT gate) using a transistor.
3. To verity- and design AND, OR, NOT and XOR gates using NAND gates.
4. Half Adder, Full Adder, and 4-bit binaryAdder.
5. Half Subtractor, Full Subtracter, Adder-Subtracter using Full Adder I.C.
6. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
7. To design an astable multivibrator of given specifications using 555 Timer.
8. To design a monostable multivibrator of given specifications using 555 Timer.

Reference Books:

1. Basic Electronics: A Text Books lab manual, RB. Zbar, A.R Malvino,

2. M.A. Miller, 1994, Mc-GrawHill.
3. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
4. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill. Electronic Devices and circuit Theory,R.L. Boylestad and L.D. Nashelsky, 2009, Pearson

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 11

INTRODUCTORY PSYCHOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of concepts of quantum mechanics, mathematics, applications and developments.

UNIT-1

Schrodinger equation : Time dependent Schrodinger equation, Properties of Wave Function, Interpretation of wave function, Probability, and probability current densities in three dimensions, Conditions for Physical Acceptability of Wave Function, Normalization, Linearity and Super position Principles. Wave function of a free particle, Wave Packet, Fourier Transform and momentum space Wave function, Spread of j Gaussian Wave packet, Evolution with time, Position and Momentum Uncertainty.

UNIT-II

Operators: Operators, Commutator Algebra, Position, Momentum, Angular Momentum and Energy operators, Hermitian Operators, Expectation valuesof position and momentum, EhrenfestTheorem, Eigenvalues and Eigenfunctions of Hermitian Operator, Energy Eigen Spectrum, Degeneracy, Orthonormality of Eigen functions, Linear Dependence, Orthogonalisation.

UNIT-III

Time Independent Schrodinger equation in 1 d, 2d and 3d, Hamiltonian,stationary states and energy eigen values, expansion of an arbitrary wave function as a linear combination of energy eigen functions, General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states. General Discussion of Bound states in an arbitrary potential: Continuity of wave function, Boundary condition and emergence of discrete energy levels, Application to one dimensional problem-Square well potential, Quantum mechanics of simple Harmonic Oscillator-Energy Levels and energy eigen functions, groundstate, zero point energy and uncertainty principle, One dimensional infinitely rigid boxenergyeigen values and eigen functions, normalization, quantum dot as example, Quantum mechanical scattering and tunnelling in one dimension across a step potential and rectangular potential barrier.

UNIT-IV

Atoms in Electric and Magnetic Fields: Electron angular momentum. Space quantization, Electron Spinand Spin Angular Momentum, Larmor'sTheorem, Spin Magnetic Moment, Stern-Gerlach Experiment, Vector Atom Model, L-S and J-J coupling, Zeeman Effect, Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. Atomsin

External Magnetic Fields:-Normal and Anomalous Zeeman Effect, Paschen back and Stark Effect (qualitative Discussion only)

Text Books:

1. Introduction to Quantum Theory David Park (Dover Publications)
2. Introduction to Quantum Theory, D. J. Griffiths(Pearson)

Reference Books :

1. Quantum Mechanics, Theory and applications A. Ghatak and S. Lokanathan (Me Millan India)
2. Quantum Mechanics- G Aruldhas (Printice Hallof India)
3. Quantum Physics- S. Gasiorowicz (Wiley)
4. Quantum Mechanics- G.R.Chatwal and S.K.Anand
5. Quantum Mechanics - J.L. Powell and B. Craseman of Narosa)
6. Introduction to Quantum Mechanics M.Das and P.K. Jena (Shri Krishna Publication)

Course Objective:

Students will have a hold of concepts of quantum mechanics, mathematics, applications and developments which will serve as homework while exploring advanced topics in quantum mechanics.

CORE - 11 - LAB

Credit : **02** **25** Marks

Course Objective:

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like (Use finite difference method, matrixmethod, ODE Solver method in all cases)

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E], V(r) = \frac{e^2}{r}$$

where m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wave functions. Remember that the ground state energy of the hydrogen atom is

~ -13.6eV. Take e = 3.795 $\sqrt{(\text{eVÅ})}$, 'c = 1973(eVÅ) and m = 0.511 × 106 e V/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{h^2}[V(r) - E],$$

where m is the reduced mass of the system (which canbe chosen to be the mass of an electron), for the screened coulomb potential: V(r) = $-\frac{e^2}{r}e^{-\frac{r}{a}}$.

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take e = 3.795 $\sqrt{(\text{eVÅ})}$,'c = 1973 (eV) and m= 0.511 × 106 eV/c2, and a = 3Å, 5Å, 7Å. The ground state energy is expected to be above -12 eVin all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m: for the anharmonic oscillator potential: V(r) = .

Find the ground state energy (in MeV) of the particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k =100 MeV/ fm^2,b = 0, 10, 30 MeV/fm^3. In these Units, c = 197.3 MeV fm. [The ground state energy is expected to lie between 90 and 110 M eV for all three cases.]

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

where m is the reduced mass of thetwo-atom systemfor the Morse potential

V(r) = D(e^{-2ar} -e^{-ar}), where r = r - r_0 Find the lowest vibrational energy (inMeV) of the molecule to an accuracy of three significant digits. Also plot the correspondingwave functions for the choices given below:

(a) m = 940 x 10^6 eV/c^2, D = 0.755501eV, a = 1.44, r_0 = 0.131349Å

(b) m = 940 x 10^6 eV/c^2, D = 0.755501 eV, a = 1.44, r_0 = 0.131349Å

Laboratory based experiments:

1. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.
2. Study of Zeeman effect with external magnetic field; Hyper fine splitting
3. To show the tunnelling effect in tunnel diode using I-Vcharacteristics.
4. Quantum efficiency of CCDs

Reference Books:

1. Schaum's outline of Programming with C++. J. Hubbard,2000,McGraw— Hill Publication
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cam- bridge Univ. Press
4. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Femndez.2014 Springer.

5. Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011S. Chand and Co.
6. Scilab Image Processing L.M. Surhone.2010 Betascript Publishing ISBN:9786133459274.

Course Outcomes:

After completion of practical, the students will be able grasp the knowledge of computer language and will be able to solve mathematical problems using computer language which can be applied in day to day life.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 12

SOLID STATE PHYSICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of concepts of solid state physics, chacteristics of solid materials, applications and developments.

UNIT-I

Crystal Structure: Solids, Amorphous and Crystalline Materials, Lattice translation Vectors, Lattice with a Basis. Central and Non-Central Elements. Unit Cell, Miller Indices, Types of Lattices, Reciprocal Lattice, Brillouin zones, Diffraction of X-rays bycrystals, Bragg Law, Atomicand Geometrical Factor

UNIT-II

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear, Mono-atomic and Diatomic Chains, Acoustical and Optical Phonons, Qualitative Description of the phonon spectrum insolids, Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids, T^3Law

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials, ClassicalLangevin's theory of dia- and Paramagnetic Domains, Curies law, Weiss Theory of Ferromagnetism and Ferromagnetic Domains, Discussion of B-H Curve, Hysteresis and Energy Loss.

UNIT-III

Dielectric Properties of Materials: Polarization Local Electrical Field at an Atom, Depolarization Field, Electric Susceptibility, Polarizability, Clausius-Moscotti Equation, Classical theory of Electronic Polarizability.

Lasers: Einstein's A and B co-efficient, Metastable States, Spontaneous and Stimulated emissions, Optical Pumping, and population Inversion, Three Level and Four Level Lasers, Ruby Laser and He-Ne Laser.

UNIT-IV

Elementary band theory: Kronig-Penny model of band Gap, Conductor, Semiconductor (PandN-type) and insulator, Conductivity of Semiconductor, mobility, Hall Effect, Measurement of conductivity (04-probe method) and Hall Co-efficient.

Superconductivity: Experimental Results, Critical Temperature, Critical magnetic field, Meissner effect, Type I and type II Super conductors, London's Equation and Penetration Depth, Isotope effect, Idea of BCS theory (No derivation).

Text Books:

1. Introduction to Solid State Physics- Charles Kittel (Wiley India)
2. LASERS: Fundamentals and Applications- Thyagarajan and Ghatak (Me Millan India)

Reference Books:

1. Solid State Physics- N. W. Ashcroft and N.D.Mermin (Cengage)
2. Solid State Physics-R.K.Puri and V.K. Babbar (S.Chand Publication)
3. Solid State Physics S. O. Pillai (New Age Publication)
4. Lasers and Nonlinear Optics B.B.Laud (Wiley Eastern)
5. Elements of Solid State Physics-J.P. Srivastava (Prentice Hall of India)
6. Elementary Solid State Physics-Ali Omar (Addison Wiley)
7. To study variation of magnetic field along the axis of circular coil.
8. To determine H using deflection Magnetometer.

Course Outcomes:

Students would have grasp of concepts of solid state physics, chacteristics of solid materials, applications and developments which will be helpful while exploring phenomena associated with solid state materials.

CORE - 12 - LAB

(Minimum four experiments to be done)

Credit : **02** **25** Marks

Course Objectives:

To make students apply the knowledge of Solid state physics in order to verify theoretical outcomes practically through use of different pre known methods.

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube- Method)
2. To measure the Magnetic susceptibility of Solids.
3. To measure the Dielectric Constant of a dielectric Materials with frequency
4. To determine the Hall coefficient of a semiconductor sample.
5. To draw the BH curve of Fe using solenoid and to determine the energy loss from Hysteresis 226 Syllabus-Science
6. To measure the band gap of a given semiconductor by four-probemethod.
7. To study variation of magnetic field along the axis of a circular coil carrying current.
8. To determine 'H' using deflection Magnetometer.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
3. A Text Books of Practical Physics, I.Prakash and Ramakrishna, 11 Ed., 2011, Kitab Mahal
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice- Hall of India.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 13

ELECTROMAGNETIC THEORY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of concepts of digital system, elements, applications and developments.

UNIT-I

Maxwell Equations : Maxwells equations, Displacement Current, Vector and Scalar Potentials, Gauge Transformations: Lorentz and Coulomb Gauge, Boundary Conditions at Interface between Different Media, Wave Equations, Plane Waves in Dielectric Media, Poynting Theorem and Poynting Vector, Electro- magnetic (EM) Energy Density, Physical Concept of Electromagnetic Field Energy Density.

UNIT-II

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant,wave impedance, Propagation through conducting media, relaxation time, skindepth, Electricalconductivity of ionized gases, plasma frequency, refractive index, skin depth application topropagation through ionosphere.

UNIT-III

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media, Reflection and Refraction of plane waves at plane interface between two dielectric media, Laws of Reflection and Refraction, Fresnel's Formula for perpendicular and parallel polarization cases, Brewster's law, Reflection and Transmission co-efficient, Total internal reflection,evanescent waves, Metallic reflection (normal incidence)

UNIT IV

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization, Uniaxial and Biaxial Crystals, Light Propagation in Uniaxial Crystal, Double Refraction, Polarization by Double Refraction, Nicol Prism, Ordinary and extra ordinary refractiveindices, Production, and detection of Plane, Circularly and Elliptically Polarized Light,

Phase Retardation Plates: Quarter-Wave and Half- Wave Plates. Babinet's Compensator and its Uses, Analysis of Polarized Light.

Rotatory Polarization: Optical Rotation, Biot's Laws for Rotatory Polarization, Fresnel's Theory of optical rotation, Calculation of angle of rotation, Experimental verification of Fresnel's theory,Specific rotation, Laurents half- shade polarimeter.

Text Books:

1. Introduction to Electrodynamics, D.J. Griffiths (Pearson)
2. Principles of Optics- Max Born and E.Wolf

Reference Books :

1. Classical Electrodynamics by J.D.Jackson.
2. Foundation of electromagnetic theory: Ritz and Milford (Pearson)
3. Electricity and Magnetism : D C Tayal (Himalaya Publication)
4. Optics: A.K.Ghatak
5. Electricity and Magnetism: Chattopadhyaya, Rakhit (NewCentral)

CORE - 13 - LAB

(Minimum four experiments to be done)

Credit : **02** **25** Marks

Course Objectives:

To make students apply the knowledge of Electro-magnetic theory in order to verify theoretical outcomes practically through use of different pre known methods.

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyse elliptically polarized Light by using a Babinet's compensator.
4. To determine the refractive index of liquid by total internal reflection using Wollastonsair-film.
5. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using aGaussian eye piece.
6. To study the polarization of light by reflection and determine the polarizing angle for air-glassinterface.
7. To verify the Stefan's law of radiation and to determine Stefan's constant.
8. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books:

1. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.

2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

3. A Text Books Book of Practical Physics, I.Prakashand Ramakrishna, 11 Ed., 2011, Kitab MahalElectromagnetic Field Theory for Engineers and Physicists, G Lehner, 2010,Springer

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 THIRD YEAR SIXTH SEMESTER
Core Paper - 14
STATISTICAL MECHANICS

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of concepts of statistical mechanics, classical and quantum approaches, and radiations.

UNIT-1

Classical Statistics-I: Microstate and Microstate, Elementary Concept of Ensemble, Micro-canonical, Canonical and Grand Canonical ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function.

UNIT-II

Classical Statistics-II: Thermodynamic Functions of an Ideal Gas, classical Entropy Expression,Gibbs Paradox, Sackur Tetrode equation, Law of equipartition of Energy (with proof)-Applications to Specific Heat and its Limitations, Thermodynamic Functions of a two energy levels system,NegativeTemperature.

UNIT-III

Quantum Statistics: Identical particles, microstates and microstates, Fermions and Bosons, Bose Einstein distribution function and Fermi- Dirac distribution function. Bose- Einstein Condensation, Bose deviation from Planck's law, Effect of temperature on Fermi-Dirac distribution function, degenerate Fermi gas, Density of States Fermi energy.

UNIT-IV

Radiation: Properties of Thermal Radiation, Blackbody Radiation, Pure Temperature dependence, Kirchhoff's law, Stefan Boltzmann law: Thermodynamic proof, Radiation Pressure,Weins Displacement law, Wiens distribution Law, Saha's ionization Formula, Rayleigh Jeans Law, Ultra Violet catastrophe.

Planck's Law of Black body Radiation: Experimental verification, Deduction of (1) Wiens Distribution Law, (2) Rayleigh Jeans Law, (3) Stefan Boltzmann Law, (4) Weins Displacement Law from Planck's Law.

Text Books:

1. Introduction to Statistical Physics by Kerson Huang (Wiley).
2. Statistical Physics, Berkeley Physics Course, F. Re if (Tata Me Graw-Hill)

ReferenceBooks:

1. Statistical Mechanics, B .K.Agarwal and Melvin Eisner (New Age International)
2. Thermodynamics, Kinetic Theory and Statistical Thermodynamics: Francis W.Sears and Gerhard, L. Salinger (Narosa)
3. Statistical Mechanics: R.K.Pathria and Paul D. Beale (Academic Press)

Course Outcomes:

Students will develop a good understanding of statistical mechanics, classical and quantum approaches, and radiations.

CORE - 14 - LAB

(Minimum four experiments to be done)

Credit : **02** **25** Marks

Course Objective:

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Use C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Weins Law and Raleigh-JeansLaw at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function,(c) Debyedistribution function for high temperature (room temperature) and low temperatureand compare them for the twocases.
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

Reference Books:

1. Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, Wiley India Edition
2. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford UniversityPress.
3. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W.Sears and GerhardL.Salinger, 1986, Narosa.
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009,Springer
5. Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scientific and EngineeringApplications: A. Vande Wouwer, P. Saucez, C. V. Fernndez. 2014 Springer ISBN: 978-3319067896

6. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444.
7. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-6133459274.

Course Outcomes:

After completion of practical, the students will be able grasp the knowledge of computer language and will be able to solve mathematical problems using computer language which can be applied in day to day life.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 1

CLASSICALDYNAMICS

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The emphasis of the course is on applications in solving problems associated with dynamics of system using advanced methods in classical mechanics. Students are to be examined on the basis of problems, seen and unseen.

UNIT-I

Generalised co-ordinates and Velocities, Generalised Force, Principle of virtual work Derivationof Lagranges equation of motion from D'Alembert's Principles, Lagrangian and its Application to Simple, Compound and Double Pendulums, Single Particle in Space, Atwood's Machine, Dumbbell,Linear harmonic oscillator.

UNIT-II

Hamilton's Principle, Calculus of Variation, and derivation of Euler-Lagranges equation, Lagrange's Equations derived from Hamilton's Principles, Hamiltonian, and its applications to Shortest Distance between two points in a plane, Geodesic Problem, minimum surface of revolution, Brachistochrone problem, The Equations of motion and first integrals, The equivalentone-dimensional problem and classification of orbits, canonical momenta, Hamilton's equations of motion, Motion of charged particles in external electric and magnetic fields, Applications to central force motion and coupled oscillators.

UNIT- III

Special theory of Relativity (Postulates of special theory of relativity),Lorentz transformations, Minkowski space, The invariant interval, light cone and world lines, space time diagrams, Times-dilation, length contraction and Twin paradox, Variation of mass with velocity, mass energy relation.

UNIT- IV

Four Vectors: Space Like, Time-like and light-like. Four velocity and acceleration, Four momentum and energy-momentum relation. Doppler effects from a four vector perspective, Concept of four-force, Conservation of four momentum, Application to two body decay of an unstable particle.

Text Books:

1 Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko (Pearson)
2. Classical Mechanics N C Rana and P S Joag.

Reference Books :

1. Mechanics-D.S.Mathur (Sultan Chand)
2. Solved problems in Classical Mechanics, O.L. Delange and J.Pierrus (Ox-ford Press) (2010)
3. Classical Mechanics-M. Das, P.K.Jena, M. Bhuyan, R.N.Mishra (Srikrishna Prakashan)
4. Mathematical Physics with Classical Mechanics-Satya Prakash (Sultan Chand and Sons)
5. Introduction to classical dynamics R.K.Takwale and S .Puranik (Tata McGraw Hill)
6. Classical Mechanics J.C.Upadhyay (Himalayan Publisher)
7. Classical Dynamics of particles and systems - S.T.Thorton and Marion (Cengage Publication)

Course Outcomes:

Students will become familiar with problems with dynamics of a system using advanced concepts of classical mechanics with greater ease.

DSE - 1 - LAB

Credit : **02** **25** Marks

Course Objectives:

To make students apply the knowledge of classical dynamics in order to verify theoretical outcomes practically through use of different pre known methods.

1. Fourier Analysis of periodic wave forms.
2. Verification of Kepler's Third Law of Planatory Motion.
3. Study of power Source.
4. To determine Thermal Conductivity of copper.
5. To determine electrical conductivity of coper and determine Lorentz number.
6. To determine thermal conductivity of a poor conductor.
7. Passive Filters.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 2

NUCLEAR AND PARTICLE PHYSICS

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of nuclear and particle physics, applications and developments.

UNIT-I

General properties of Nuclei: Constituents of nucleus and their intrinsic properties, Quantitative facts about mass, radius, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment electric moments, nuclear excite states.

Radioactivity decays: (a) Alpha decay: basics of alpha-decay processes, theory of alpha emission, Gamow factor, Geiger Nuttall law (b) beta-decay: energy kinematics for beta-decay, positron emission, electron capture, neutrino hypothesis (c) Elementary idea of Gamma decay.

UNIT-II

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, conditions of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic number, basic assumption of shell models.

UNIT-III

Detector for nuclear radiations: Detector for nuclear radiations: Gas detectors: estimation of Electric field, mobility of particle, For ionization chamber and GM Counter. Basic Principle of Scintillation Detectors and Construction of photo-multiplier tube (PMT). Semiconductor Detectors(Si and Ge) for charge Particle and photon detection (Concept of charge carrier and mobility),neutron detector.

Particle Accelerators: Van-de Graff generator (Tandem Accelerator), Linear accelerator, Cyclotron, Synchrotrons.

UNIT-IV

Particle Physics: Particle interactions, basic features, types of particles and its families.

Symmetries and conservation laws: Energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, strangeness and charm, Elementary ideas of quarks and gluons.

Text Books:

1. Introduction to Nuclear Physics By Roy and Nigam
2. Atomic and Nuclear Physics-N.Subramanyam, Brij Lal and Jivan Seshan (S. Chand Publishing)

Reference Books:

1. Introduction to Modern Physics-H.S.Mani and G.K.Mehta (Affiliated east and west)
2. Introductory nuclear Physics-Kenneth S. Krane (Wiley India Pvt. Ltd)

3. Introduction to Elementary Particles-D. Griffith (John Wiley andSons)
4. Concepts of Nuclear Physics - Bernard L. Cohen. (Tata Mcgraw Hill).
5. Concepts of Modern Physics-Arthur Beiser (McGraw Hill)

Course Outcomes:

Students will develop an understanding about nucleus, nuclear forces, decay, reaction mechanism associated with nucleus and particles.

DSE - 2 - LAB

Credit : **02** **25** Marks

Course Objectives:

To make students apply the theoretical knowledge in order to verify theoretical outcomes practically through use of different pre known methods.

1. Stefan's Law of Radiation.
2. Thermal Diffusivity of brass.
3. Measurement of self-inductance of a coil.
4. Measurement of Capacitance.
5. Study of Maxwell's Bridge.
6. Study of Max-Well-Wein Bridge.
7. Thermal Relaxation Time of a Serial light bulb.
8. Determination of K/e using a transistor.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 THIRD YEAR SIXTH SEMESTER

DSE - 3

NANO MATERIALS AND APPLICATIONS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of concepts of nanomaterial system, effect of size on materials, phenomena occurring at nanoscale and how it is different from bulk scale applications and developments.

UNIT-I

Nanoscale Systems: Length scales in physics, Nanostructures: 1D, 2Dand 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, size effects in nano systems, Quantum confinement, Applications of Schrodinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in3D, 2D, ID nano structure and its consequences.

UNIT-II

Synthesis of Nanostructure Materials: Top-down and bottom-up approach, Photolithography Ballmilling. Gas phase condensation, Vacuum deposition, Physical vapour deposition (PVT):Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical vapour deposition(CVD), Sol-Gel Electrodeposition, Spray pyrolysis, Hydro thermalsynthesis, Preparation throughcolloidal methods, MBE growth of quantum dots.

UNIT-III

Characterization: X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunnelling Microscopy

UNIT-IV

Applications: Applications of nanoparticles, quantum dots, nanowires, and thin films for photonicdevices (LED, solar cells). Single electron devices (no derivation). CNT based transistors.Nonmaterial Devices: Quantum dots heterostructure lasers, optical switching, and optical datastorage. Magnetic quantum well; magnetic dots-magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems(NEMS).

Text Books:

1. S.K. Kulkarni, Nanotechnology: Principles and Practices (Capital Publishing Company)
2. Nano science and nano technology, K.K. Choudhury(Narosa)

Reference Books:

1. Nano Science and nanotechnology, Sundar Singh (Pragati Prakashan)
2. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
3. RichardBooker, Earl Boysen, Nanotechnology (John Wiley and Sons).
4. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier,2007).
5. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning . Private Limited).

Course Outcomes:

Students will have a better understanding of nanomaterial system, effect of size on materials, phenomena occurring at nanoscale and how it is different from bulk scale applications and developments.

DSE - 3 - LAB

Credit : **02** **25** Marks

Course Objectives:

To make students apply the theoretical knowledge in order to verify theoretical outcomes practically through use of different pre known methods.

1. Dielectric constant of a non-polar liquid

2. Dipole moment of an organic molecule acetone
3. Energy band gap of silicon.
4. Study of low pass Filter.
5. Study of high pass Filter.
6. Study of baud pass Filter.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 THIRD YEAR SIXTH SEMESTER

DSE - 4

PROJECT OR BASIC INSTRUMENTATION

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of basics of material characterization.

UNIT-I

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errorsin measurements and loading effects.

Multimeter: Principles of measurement of dc voltage and dc current, ac volt- age, ac current and resistance. Specifications of a multimeter and their significance.

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement withrespect to input impedance and sensitivity. Principles of voltage, measurement (block Diagramonly). Specifications of an electronic Voltmeter/ Multimeter and their significance.

AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Blockdiagram ac millivoltmeter, specifications and their significance.

UNIT-II

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only no mathematical treatment), brief discussion on screen phosphor, visual persistence, and chemical composition. Time base operation, synchronization, Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period). Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle ofworking.

UNIT-III

Signal Generators and Analysis Instruments: Block diagram, explanation, and specifications of low frequency signal generators, pulse generator, and function generator, Brief idea for testing, specifications, Distortion factor meter, wave analysis.

UNIT-V

Digital Instruments: Principle and working of digital meters, Comparison of analog and digitalinstruments, Characteristics of a digital meter, Working principles of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter, Working principle of time interval, frequency and period measurement using universal counter/frequency counter, time-base stability, accuracy, and resolution.

Course Outcomes:

Students will be able to design new material systems and study their characteristics and manipulate the properties to make them potential for applications in day to day life.

DSE - 4 - LAB

Credit : **02** **25** Marks

Course Objectives:

To make students apply the theoretical knowledge in order to verify theoretical outcomes practically through use of different pre known methods.

The test of lab skills will be of the following test items:

1. Use of anoscilloscope.
2. CRO as a versatile measuringdevice.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuringvoltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil /transformer.
7. Study the layout of receivercircuit.
8. Trouble shooting circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage acrossa low resistanceand high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q-meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/universalbridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting therange of a given measuring instrument (voltmeter,ammeter) More emphasis should be given on hands-on experiments.

Text Books:

1. A Text Books book of electrical technology-B.L.Theraja(S.Chand Publishing)
2. Digital circuits and systems Venugopal (Tata McGraw Hill)

Reference Books :

1. Digital Electrordcs-Subrata Ghoshal (Cengage Leaming)
2. Electronic Devices and circuits - S. SalivahananandN. S.Kumar (TataMc-GrawHill)
3. Electronic Devices-Thomas L. Floyd (Pearson)

Additional Reference Books for Practical papers :

1. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop (Asia Publishing House)
2. Practical Physics-B .B. Swain (KitabMahal)
3. Practical Physics-B.Ghosh (Vol. I and II)
4. ALaboratory Manual of Physicsfor Undergraduate Classes, D.P.Khandelwal (Vani Publication)
5. B.Sc. Practical Physics- C.L.Arora (S.Chand Publishing)
6. B.Sc. Practical Physics H. Singh andP.S.Hemne (S. Chand Publishing)

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 FIRST YEAR FIRST SEMESTER

GE - 1

(MECHANICS AND PROPERTIES OF MATTER, OSCILLATION AND WAVES, THERMAL PHYSICS, ELECTRICITY AND MAGNETISM AND ELECTRONICS)

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have a grasp of concepts mechanics, properties of matter, electro-magnetic characteristics and numerical problems associated to them.

UNIT-I

Mechanics and Properties of Matter

Moment of Inertia, Parallel axis and perpendicular axis theorem, M.I. of a Solid sphere and Solid cylinder, Gravitational potential, and field due to a thin spherical shell and a solid sphere atexternal points and internal points, Relation among elastic constants, depression at free end of a light cantilever, Surface tension, pressure difference across a curved membrane,viscous flow, Poiseuille's formula.

UNIT-II

Oscillation and Waves

Simple harmonic motion, damped harmonic motion, under damped, over damped and critically damped motion, Forced vibration, Resonance, Wave equation in a medium, Velocity of Longitudinal waves in an elastic medium and velocity of transverse wave in a stretched string, Composition of SHM, Lissajous figures for superposition of two orthogonal simple harmonic vibrations (a) with same frequency, (b) frequency with 2:1.

UNIT-III

Thermal Physics

Entropy, change in entropy in reversible and irreversible process, Carnot engine and its efficiency. Carnot Theorem, Second law of thermodynamics, Kelvin-Planck, Clausius formula. Thermal conductivity, differential equation for heat flow in one dimension, Maxwell thermodynamic relation (statement only), Clausius Clapeyron equation, Black body radiation, Planck radiation formula (No derivation).

UNIT-IV

Electricity and Magnetism

Gauss law of electro statics, use of Gauss law to compute electrostatic field due to a linear charge distribution, Magnetic induction B, Lorentz force law, Biot Savarts law, Magnetic inductiondue to long straight current carrying conductor, and in the axis of a current carrying circular coil, Amperes Circuital law, its differential form, The law of electromagnetic equations, its differential and integral form, Maxwells electro-magnetic equations and their physical significance, Growth and decay of currents in LR and RC circuits, time constant, alternating currents in RC, RL and LCR circuits, impedance, power factor, resonance.

P-type and N-type semiconductors, PN-Junction as rectifier, Half wave and Full wave rectifiers(Bridge type), efficiency, ripple factor, use of RC, LC, and filters, working of PNP and NPN transistors, transistor configurations in CE and CB circuits and relation between á and JFET, its operation and characteristics of V-I curve.

Text Books:

1. Properties of Matter D.S. Mathur (S. Chand Publication).
2. Heat and Thermodynamics A.B. Gupta and H.B. Ray (New Central BookAgency).
3. A Text book of oscillations, waves and acoustics (5th ed.) M. Ghosh and D. Bhattacharya (S.Chand Publication).
4. Electricity and magnetism- R. Murugeshan (S.ChandPublishing)
5. Fundamentals of Electronics-Raskhit and Chattopadhyay (New age International Publication)

Reference Books:

1. Physics of Degree students Vol.1 M. Das, P.K. Jena etal (Sri krishna Prakashan).
2. Physics of Degree students Vol.11 M. Das, P.K. Jena etal (Sri krishna Prakashan).

3. Waves and Oscillations (2^{nd} ed) N. Subramaniyam and Brij Lai (Vikas Publications)
4. A Text Books book of Sound (2^{nd} ed) – N. Subramaniyam and Brij Lai (S. Chand Publications)

Course Outcomes:

Students will have conceptual clarification in basics mechanics, properties of matter, electro-magnetic characteristics and become able to solve numerical problems associated to them.

GE - 1 - LAB

Minimum Six experiments to be done

Credit : **02** **25** Marks

Course Objectives:

To make students apply the theoretical knowledge in order to verify theoretical outcomes practically through use of different pre known methods.

1. To determine the moment of inertia of a flywheel.
2. To determine the Youngs modulus Y of a wire by Searls method.
3. To determine the modulus of rigidity of a wire by Maxwells needle/Torsion Pendulum (Dynamic method).
4. To determine g by bar pendulum.
5. To determine the value of Y of a rubber by using travelling microscope.
6. To determine the Rigidity of modulus by static method.
7. To determine the frequency of a tuning Fork by using Sonometer.
8. Verification of Laws of Vibration of a string by using Sonometer.
9. To compare capacitances using DeSautybridge.
10. To determine the Law of resistance by using Carrey Foster bridge.
11. Compare the specific heat of two liquids by method of Cooling.

Reference Books:

1. Advanced Practical Physics for students, B.L.FlintandH.T. Worsnop, 1971, Asia Publishing House
2. A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal (1985), Vani Publication
3. A Text book of Practical Physics, Indu Prakash And Ramakrishna, 11th Edition (2011), Kitab Mahal, New Delhi.

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

+3 FIRST YEAR SECOND SEMESTER

GE - 2

(OPTICS, SPECIAL THEORY OF RELATIVITY, ATOMIC PHYSICS, QUANTUM MECHANICS AND NUCLEAR PHYSICS)

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Objective:

The course emphasize on making students to have conceptual clarification in basics of modern physics, optics and quantum mechanics and be able to solve numerical problems associated to them.

UNIT-I

Optics-I: Elementary ideas of monochromatic aberrations and their minimization, chromatic aberration, achromatic combination, Theory of formation of primary and secondary rainbow, condition of interference, coherent sources, Young's double slit experiment, biprism and measurement of wave length of light by it, colour of thin films and Newtons rings, Fresnel and Fraunhoffer diffraction, diffraction by single slit plane transmission grating.

Optics-II: Electromagnetic nature of light, polarized and unpolarized light, polarization by reflection and refraction, Brewsters Law, Malus Law, Double refraction, Ordinary and extraordinaryrays.

UNIT-II

Atomic Physics: Inadequacy of classical physics, brief outline of Rayleigh Jeans theory and Planck's quantum theory of radiation, particle nature of electromagnetic radiation photo electriceffect, Compton effect, dual nature of radiation, wave nature of particles, de-Broglie hypothesis,matter wave, wave-particle duality, Davisson-Germer experiment. Bohr's theory of Hydrogen atom, explanation of Hydrogen Spectra, correction for finite mass ofthe nucleus, Bohr's correspondence principle, limitations of Bohr's theory, Discrete energy, exchange by atom, Frank Hertz experiment.

UNIT-III

Quantum Mechanics: Heisenberg's Uncertainty relation, Time dependent Schrodinger's waveequation in one dimension and three dimensions. The physical interpretation of the wave function, Probability density and probability current density, Equation of continuity, Normalization of theWave function, Expectation value of an observable, Ehrenfest's theorem. Time independent Schrodinger's wave equation in one dimension particle in a box, energy eigen values andeigenfunctions.

UNIT-IV

Nuclear Physics : Properties of the nucleus Charge, Size, Spin, Magnetic Moment, Mass, Mass defect, Binding energy, Packing fraction, Nuclear force, and its characteristics features, Radioactive decay laws, average life, half-life, nuclear fission, nuclear fusion, Linear accelerators,and cyclotron.

Relativity: Galilean transformation, Newtonian relativity and its limitation, Michelson Morley experiment and its consequence, postulates of specialtheory of relativity. Lorentz transformation,length contraction, time dilation, relativistic mass and momentum, mass energyrelation.

Text Books:

1. University Physics, H. D. Young, R. A. Freedman(Person)
2. Fundamentals of Physics, Resnick, Halliday, Walker(Wiley)

Reference Books :

1. A Text Books book of Optics N.Subrahmanyam and Brij Lai (S.Chand Publishing) *
2. Introduction to Special Relativity-R. Resnick (JohnWiley)
3. Concepts of Modern Physics Arthur Beiser(McGrawHill)
4. Modern Physics H.S. Mani and GK.Mehta

Course Outcomes:

Students will have conceptual clarification in basics of modern physics, optics and quantum mechanics and become able to solve numerical problems associated to them.

GE - 2 - LAB

Minimum Six experiments to be done

Credit : **02** **25** Marks

Course Objectives:

To make students apply the theoretical knowledge in order to verify theoretical outcomes practically through use of different pre known methods.

1. Determination of E.C.E. of Copper.
2. Determination of Refractiveindex of the material of a prism using Sodium light.
3. To determine the wave length of light using plane diffraction grating.
4. To determinethewavelengthoflightusingNewtons' ring.
5. Determination of refractive index of (a) glass and (b) liquid by using travelling microscope.
6. To plot the I-D curve and to determine the refractive index of a prism
7. Determination of radius of curvature of a convex/concave mirror using Kohlrauschs method.
8. To determine the magnifying power of a given telescope.
9. To Obtain the static characteristics of a P-N-P/N-P-N transistor.
10. To determine the reduction factor of a tangent Galvanometer.
11. To study the Variation of magnetic field along the axis of a circular coil carryingcurrent.

Reference Books:

1. Advanced Practical Physics for students, B .L.FlintandH.T.Worsnop, 1971, Asia Publishing House
2. A Laboratory Manual of Physics for Undergraduate Classes,D.P.Khandelwal (1985), Vani Publication
3. A Text book of Practical Physics Indu Prakash And Ramakrishna, 11 th Edition (2011), KitabMahal, NewDelhi

Course Outcomes:

After completion of practical, students will be able to verify theoretical outcomes practically through use of different pre known methods.

STATISTICS

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 1

DESCRIPTIVE STATISTICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Define and compute the various measures of central tendency, dispersion, skewness, and kurtosis.
- Define and compute raw and central moments.
- Understand the use of moments in studying various characteristics of a distribution.
- Know various scales of measurement.
- Compute and interpret Karl Pearsons correlation coefficient.
- Understand the meaning and the significance of probable error of r
- Understand the concepts and meaning of regression coefficients and their relationships with correlation coefficient.
- Appreciate the use of regression analysis for estimation and prediction purposes.
- Know how to fit polynomials and curves.
- Compute indexes to measure price changes and quantity changes over time.
- Construction of index numbers.
- Computation of consumer price index.

UNIT-I

Statistical Methods: Definition and scope of Statistics, concepts of statistical population and sample. Data: quantitative and qualitative, attributes, variables, scales of measurement : nominal, ordinal, interval and ratio, Presentation: tabular and graphical, including histogram and Ogives, Consistency and independence of data with special reference to attributes.

UNIT-II

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: Range, Quartile Deviation, Mean Deviation, Standard Deviation, Coefficient of Variation, Moments, Absolute Moments, Factorial Moments, Skewness And Kurtosis, Sheppard's Corrections.

UNIT-III

Bivariate data: Definition, Scatter Diagram, Simple, Partial And Multiple Correlation (3 variables only), Rank Correlation. Simple linear regression, Principle of least squares and fitting of polynomials and exponential curves.

UNIT-IV

Index Numbers: Definition, construction of index numbers and problems there of for weighted and unweighted index numbers including Laspeyre's, Paasche's, Edgeworth- Marshall and Fisher's Ideal Index numbers. Errors in Index numbers. Chain index numbers, conversion of fixed based to chain based index numbers and vice-versa. Consumer price index numbers. Uses and limitations of index numbers.

TEXT BOOKS:

1. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals Of Mathematical Statistics, 4th Edition (Reprint), Sultan Chand &Sons

SUGGESTED READINGS:

1. Miller, Irwin and Miller, Marylees(2006): John E.Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education, Asia.
2. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Page Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co.Ltd.
3. Mukhopadhyay, P. (1999): Applied Statistics, New Central Book Agency,

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS:

1. Graphical representation of data.
2. Problems based on Measures of Central Tendency.
3. Problems based on Measures of Dispersion.
4. Problems based on Moments, Skewness And Kurtosis.
5. Karl Pearson and rank correlation coefficient.
6. Lines of regression, angle between lines and estimated values of variables.
7. Calculate price and quantity index numbers using simple and weighted average of price relatives.

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 2

ALGEBRA

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes :-

- Understand the relation between roots and coefficients of any polynomial equations.
- Know about linear dependence and independence of vectors.
- Discuss various types of matrices and their properties.
- Use of determinants in solution to the system of linear equations.
- Understand the properties of characteristic roots and various types of quadratic forms.

UNIT-I

Theory of equations, statement of the fundamental theorem of Algebra and its consequences. Relation between roots and coefficients of any polynomial equations. Vector spaces, Subspaces, sum of subspaces, Span of a set, Linear dependence and independence, dimension and basis.

UNIT-II

Algebra of matrices - A review, theorems related to triangular, symmetric and skew symmetric matrices, idempotent matrices, Hermitian and skew Hermitian matrices, orthogonal matrices, singular and non-singular matrices and their properties. Trace of a matrix, unitary, involutory and nilpotent matrices.

UNIT-III

Determinants of Matrices: Definition, properties and applications of determinants for 3rd and higher orders, evaluation of determinants of order 3 and more using transformations. Adjoint and inverse of a matrix and related properties. Use of determinants in solution to the system of linear equations, row reduction and echelon forms, the matrix equations AX=B, solution sets of linear equations. Applications of linear equations.

UNIT-IV

Rank of a matrix, row-rank, column-rank, standard theorems on ranks, rank of the sum and the product of two matrices. Characteristic roots and Characteristic vector, Properties of characteristic roots, Cayley Hamilton theorem and Quadratic forms.

TEXT BOOKS:

1. Gorakh Prasad: Differential Calculus, Pothishala Pvt. Ltd., Allahabad.
2. Gorakh Prasad: Integral Calculus, Pothishala Pvt. Ltd., Allahabad.

SUGGESTED READINGS:

1. Zafar Ahsan: Differential Equations and their Applications, Prentice-Hall of India Pvt. Ltd., New Delhi (2nd Edition-2004).
2. Piskunov, N: Differential and Integral Calculus, Peace Publishers, Moscow.
3. Differential calculus by Das & Mukherjee, U.N Dhar Publication, Kolkatta, 2010.
4. Integral Calculus by Das & Mukherjee, U.N Dhar Publication, Kolkatta,2010.
5. Advanced Differential Equations by Md Raisinghania, S Chand & Company Pvt Ltd

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS:

1. Finding roots of an algebraic equations
2. Solution of linear equations by matrix method.
3. Rank and Inverse of a matrix
4. Characteristics roots and characteristic vectors of a matrix.
5. Applications of matrices.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 3

PROBABILITY AND PROBABILITY DISTRIBUTIONS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Linear about the different approaches to the theory of probability.
- Understand various theorems on probability and their use in solving problems in various diversified situations.
- Demonstrate the concepts of conditional probability, pairwise independence and mutual independence of events.
- Understand the concept of prior and posterior probability used in Bayes theorem and their use in decision making.
- Illustrate the concept of p.m.f, p.d.f and distribution function.
- Demonstrate the concept of joint, marginal, and conditional probability distribution involving two random variables.
- Understand use of m.g.f, c.g.f and characteristic functions.
- Demonstrate the concepts of conditional expectations and conditional variance.
- Derive moments, cumulants, m.g.f and various constants of discrete probability distributions.
- Apply probability distributions to variety of problems in various diversified fields.
- Enumerate various characteristics of several important continuous probability distributions.

UNIT-I

Probability: Introduction, random experiments, sample space, events and algebra of events. Definitions of Probability – classical, statistical, and axiomatic. Conditional Probability, laws of addition and multiplication, independent events, theorem of total probability, Bayes' theorem and its applications.

UNIT-II

Random variables: discrete and continuous random variables, p.m.f., p.d.f. and c.d.f., illustrations and properties of random variables, univariate transformations with illustrations. Two dimensional random variables: discrete and continuous type, joint, marginal and conditional p.m.f, p.d.f., and c.d.f., independence of variables.

UNIT-III

Mathematical Expectation and Generating Functions: Expectation of single and bivariate random variables and its properties. Moments and Cumulants, moment generating function, cumulant generating function and characteristic function. Uniqueness and inversion theorems (without proof) along with applications. Conditional expectations.

UNIT-IV

Standard discrete probability distributions: Uniform, binomial, poisson, geometric, along with their properties and limiting/approximation cases. Standard continuous probability distributions: uniform, normal, exponential, beta and gamma along with their properties and limiting/approximation cases.

TEXT BOOKS:

1. Hogg,R.V.,Tanis,E.A.andRaoJ.M.(2009):ProbabilityandStatisticalInference, Seventh Ed, Pearson Education, NewDelhi.
2. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals Of Mathematical Statistics, 4th Edition (Reprint), Sultan Chand &Sons

SUGGESTED READINGS:

1. Miller,Irwin and Miller, Marylees(2006): John E.Freund's Mathematical Statistics with Applications, (7th Edn.), Pearson Education,Asia.
2. Mood, A.M. Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn., (Reprint), Tata McGraw-Hill Pub. Co.Ltd.
3. Goon A.M., Gupta M.K. and Dasgupta B. (2002): Fundamentals of Statistics, Vol. I, 8th Edn. The World Press,Kolkata.
4. Myer, P.L. (1970): Introductory Probability and Statistical Applications, Oxford & IBH Publishing, NewDelhi

PRACTICAL

Credit : **02** — **25** Marks

LIST OF PRACTICALS:

1. Fitting of Binomial distributions
2. Fitting of Poisson distributions
3. Fitting of Normal distributions
4. Application problems based on Binomial, Poisson and Normal distributions.

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 4

CALCULUS

Time : **3** Hrs. — End Semester Theory : **60** Marks

Credit : **04** — Mid Semester Theory : **15** Marks

Course outcomes:-

- Know about limits and properties of continuous functions.
- Find maxima and minima of functions of one and two variables.
- Learn about beta and gamma functions and the relationship between them.
- Understand several types of differential equations and their applications.
- Know about formation and solution of various types of partial differential equations.

UNIT-I

Differential Calculus: Limits of function, continuous functions, properties of continuous functions, partial differentiation and total differentiation (two variables). Indeterminate forms: L-Hospital's rule, Leibnitz rule for successive differentiation. Euler's theorem on homogeneous functions. Maxima and minima of functions of one and two variables. Transformations and Jacobians.

UNIT-II

Integral Calculus: Review of integration and definite integral. Differentiation under integral sign, double integral. Beta and Gamma functions: properties and relationship between them.

UNIT-III

Differential Equations: Exact differential equations, Integrating factors, change of variables, Total differential equations, Differential equations of first order and first degree, Differential equations of first order but not of first degree, Equations of the first degree in x and y, Clairaut's equations. Higher Order Differential Equations. Homogeneous differential equations of order n with constant coefficients.

UNIT-IV

Formation and solution of partial differential equations. Equations easily integrable. Linear partial differential equations of first order. Homogeneous linear partial differential equations with constant coefficients. Different cases for complementary functions and particular integrals.

TEXT BOOKS:

1. Krishnamurthy V., Mainra V.P. and Arora J.L.: An Introduction to Linear Algebra (II, III, IV, V).

SUGGESTED READINGS:

1. Biswas, S. (1997): A Textbook of Matrix Algebra, New Age International,1997.
2. Gupta S.C.: An Introduction to Matrices (Reprint). Sultan Chand & Sons,2008.
3. Datta K.B.: Matrix and Linear Algebra. Prentice Hall of India Pvt. Ltd.,2002.
4. Hadley G.: Linear Algrbra. Narosa Publishing House (Reprint),2002.
5. Searle S.R.: Matrix Algebra Useful for Statistics. John Wiley &Sons.,1982.
6. Schaum'sOutlines : Linear Algebra, Tata McGraw-Hill Edition, 3rdEdition,2006.

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. Determination of Maxima & Minima.
2. Using definite integral obtain the area under curve.
3. Applications of differential equations.
4. Applications Partial Differential Equations.
5. Applications of Beta and Gamma function.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 5
SAMPLING DISTRIBUTIONS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:-

- Develop the proof of Chebyshev's inequality and understand its use in statistics.
- Discuss the concepts relating to various forms of WLLN and SLLN.
- Know about CLT and its applications.
- Explain the various steps involved in testing hypothesis problems.
- Understand the various concepts, theorems and properties of chi-square distribution, t and F distributions.
- Discuss various concepts, theorems and properties of chi square distribution, t and F distributions.
- Emphasize the need for various applications of t, F, and chi square distributions.

UNIT-I

Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their interrelations, Chebyshev's inequality, W.L.L.N., S.L.L.N.and their applications, De-Moivre Laplace theorem, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T.

UNIT-II

Definitions of random sample, parameter and statistics, sampling distribution of a statistic, sampling distribution of sample mean, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Large sample tests for testing single proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations by classical and p-value approaches.

UNIT-III

Exact sampling distribution: Definition and derivation of p.d.f. of χ^2 with n degrees of freedom (d.f.) using m.g.f., nature of p.d.f. curve for different degrees of freedom, mean, variance, m.g.f., cumulant generating function, mode, additive property and limiting form of χ^2 distribution. Tests of significance and confidence intervals based on χ^2 distribution.

UNIT-IV

Exact sampling distributions: Student's and Fisher's t-distribution, Derivation of its p.d.f., nature of probability curve with different degrees of freedom, mean, variance, moments and limiting form of distribution. Snedecore's F-distribution: derivation of p.d.f., nature of p.d.f. curve with different degrees of freedom, mean, variance and mode. Relationship between t, F and χ^2 distributions. Test of significance and confidence Intervals based on t and F distributions.

TEXT BOOKS:

1. Goon, A.M., Gupta, M.K. and Dasgupta, B. (2003): An Outline of Statistical Theory, Vol. I, 4th Edn. World Press, Kolkata.

SUGGESTED READINGS:

1. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probabilityand Statistics. 2ndEdn. (Reprint) John Wiley andSons.
2. Hogg, R.V. and Tanis, E.A. (2009): A Brief Course in Mathematical Statistics. Pearson Education.
3. Johnson, R.A. and Bhattacharya, G.K. (2001): Statistics-Principles and Methods, 4th Edn. John Wiley andSons.
4. Mood, A.M., Graybill, F.A. and Boes, D.C. (2007): Introduction to the Theory of Statistics, 3rd Edn. (Reprint).Tata McGraw-Hill Pub. Co.Ltd.

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS:

1. Testing of significance and confidence intervals for single proportion and difference of two proportions
2. Testing of significance and confidence intervals for single mean and difference of two means and paired tests.
3. Testing of significance and confidence intervals for difference of two standard deviations.
4. Exact Sample Tests based on Chi-Square Distribution.
5. Testing if the population variance has a specific value and its confidence intervals.
6. Testing of goodness of fit.
7. Testing of independence of attributes.
8. Testing based on 2 X 2 contingency table without and with Yates'corrections.
9. Testing and confidence intervals of equality of two population variances.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 6

SURVEY SAMPLING & INDIAN OFFICIAL STATISTICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Distinguish between population parameter sample statistics.
- Know various procedure of sampling that provide estimates, variances allocations and comparisons.
- Know about various methods of estimation.
- Know about methods of collection of official statistics, role of MOSPI, CSO, NSSO etc.

UNIT-I

Concept of population and sample, complete enumeration versus sampling, sampling and non-sampling errors. Types of sampling: non-probability and probability sampling, basic principle of sample survey, simple random sampling with and without replacement, definition and procedure of selecting a sample, estimates of: population mean, total and proportion, variances of these estimates, estimates of their variances and sample size determination.

UNIT-II

Stratified random sampling: Technique, estimates of population mean and total, variances of these estimates, proportional and optimum allocations and their comparison with SRS. Practical difficulties in allocation, estimation of gain in precision. Systematic Sampling: Technique, estimates of population mean and total, variances of these estimates (N=nxk). Comparison of systematic sampling with SRS and stratified sampling in the presence of linear trend and corrections.

UNIT-III

Introduction to Ratio and regression methods of estimation, first approximation to the population mean and total (for SRS of large size), variances of these estimates and estimates of these variances, comparison with SRSWOR. Cluster sampling (equal clusters only) estimation of population mean and its variance.

UNIT-IV

Present official statistical system in India, methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), and National Statistical Commission. Government of India's Principal publications containing data on the topics such as population, industry and finance.

TEXT BOOKS:

1. Sukhatme,P.V., Sukhatme,B.V. Sukhatme,S. Asok,C.(1984). Sampling Theories of Survey With Application, IOWA State University Press and Indian Society of Agricultural Statistics

2. Guide to current Indian Official Statistics, Central Statistical Office, GOI, New Delhi.

SUGGESTED READINGS:

1. Cochran W.G. (1984):Sampling Techniques(3rd Ed.), Wiley Eastern.
2. Murthy M.N. (1977): Sampling Theory & Statistical Methods, Statistical Pub. Society, Calcutta.
3. Des Raj and Chandhok P. (1998): Sample Survey Theory, Narosa Publishing House.
4. Goon A.M., Gupta M.K. and Das gupta B. (2001): Fundamentals of Statistics (Vol.2), World Press.

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS:

1. To select a SRS with and without replacement.
2. For a population of size 5, estimate population mean, population mean square and population variance. Enumerate all possible samples of size 2 by WR and WOR and establish all properties relative to SRS.

3. For SRSWOR, estimate mean, standard error, the sample size
4. Stratified Sampling: allocation of sample to strata by proportional and Neyman's methods. Compare the efficiencies of above two methods relative to SRS.
5. Estimation of gain in precision in stratified sampling.
6. Comparison of systematic sampling with stratified sampling and SRS in the presence of a linear trend.
7. Ratio and Regression estimation: Calculate the population mean or total of the population. Calculate mean squares. Compare the efficiencies of ratio and regression estimators relative to SRS.
8. Cluster sampling: estimation of mean or total, variance of the estimate, estimate of intra-class correlation coefficient, efficiency as compared to SRS.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 7

MATHEMATICAL ANALYSIS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Learn about various terms associated with sets.
- Know about various tests of convergence and divergence.
- Understand limit, continuity, and differentiability.
- Discuss series expansions.
- Understand the meaning and the uses of interpolation and extrapolation.
- Define and understand the use of different operators like D,E
- Derive various formulas of interpolation for equal and unequal intervals of arguments.
- Derive various formulas for numerical, integration along with their applications.

UNIT-I

Real Analysis: Representation of real numbers as points on the line and the set of real numbers as complete ordered field. Bounded and unbounded sets, neighbourhoods and limit points, Supremum and infimum, open and closed sets, sequences and their convergence. Infinite series, positive term series and their convergence, Comparison test, D'Alembert's ratio test, Cauchy's nth root test, Raabe's test. Gauss test, Cauchy's condensation test and integral test (Statements and Examples only).

UNIT-II

Review of limit, continuity and differentiability, uniform Continuity and boundedness of a function. Rolle's and Lagrange's Mean Value theorems. Taylor's theorem with lagrange's and Cauchy's form of remainder (without proof). Taylor's and Maclaurin's series expansions.

UNIT-III

Numerical Analysis: Factorial, finite differences and interpolation. Operators, E and divided difference. Newton's forward, backward and divided differences interpolation formulae.

Lagrange's interpolation formulae. Central differences, Gauss and Stirling interpolation formulae.

UNIT-IV

Numerical integration. Trapezoidal rule, Simpson's one-third rule, three-eighth rule, Weddle's rule with error terms. Stirling's approximation to factorial n. Solution of difference equations of first order.

TEXT BOOKS:

1. Malik S.C. and Savita Arora: Mathematical Analysis, Second Edition, Wiley Eastern Limited, New Age International Limited, New Delhi,1994.
2. Goel B. S. and Mittal S. K. : Numerical Analysis, Pragati Prakashan, ND,2008

SUGGESTED READINGS:

1. Somasundram D. and Chaudhary B.: A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi,1987.
2. Shanti Narayan: A course of Mathematical Analysis, 12th revised Edition, S. Chand & Co. (Pvt.) Ltd., New Delhi,1987.
3. Singal M.K. and Singal A.R.: A First Course in Real Analysis, 24th Edition, R. Chand & Co., New Delhi,2003.
4. Bartle,R.G.andSherbert,D.R.(2002):Introduction to Real Analysis(3rdEdition), John Wiley and Sons (Asia) Pte. Ltd.,Singapore.
5. Jain,M. K., Iyengar, S. R. K. and Jain, R. K. (2003): Numerical methods for scientific and engineering computation, New age International Publisher, India.

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. Interpolation with equal and unequal intervals.
2. Problems on Lagrange's interpolation
3. Numerical Integration (Trapezoidal, Simpson's and Weddle's method)
4. Stirling's approximation

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 8

STATISTICAL INFERENCE

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Understand and discuss various characteristics of estimators.
- Understand various methods of estimation.
- Know about the procedure to construct the most powerful test (Neyman Pearson Lemma).
- Know and understand about Crammer Rao inequality.
- Understand various concepts related to the testing of hypothesis.
- Elaborate the concept of Likelihood Ratio test, its properties.
- Explain and develop sequential probability ratio test (SPRT).

UNIT-I

Estimation: Concepts of point estimation, Criterion of a good estimator, unbiasedness, sufficiency, consistency and efficiency. Factorization theorem. Complete statistics. Minimum variance unbiased estimator (MVUE), Rao-Blackwell and Lehmann-Scheffe theorems and their applications. Cramer-Rao inequality and MVB estimators (statement and applications).

UNIT-II

Methods of Estimation: Method of moments, method of maximum likelihood estimation, method of minimum Chi-square, basic idea of Baye's estimators.

UNIT-III

Principles of test of significance: Null and alternative hypotheses (simple and composite), Type-I and Type-II errors, critical region, level of significance, size and power, best critical region, most powerful test, uniformly most powerful test, Neyman Pearson Lemma (statement and applications to construct most powerful test). Likelihood ratio test, properties of likelihood ratio tests (without proof).

UNIT-IV

Sequential Analysis: Sequential probability ratio test (SPRT) for simple vs simple hypotheses. Fundamental relations among α, β, A and B, determination of A and B in practice. Wald's fundamental identity and the derivation of operating characteristics (OC) and average sample number (ASN) functions, examples based on binomial and normal distributions.

TEXT BOOKS:

1. Goon A.M., Gupta M.K.: Das Gupta.B. (2005), Fundamentals of Statistics, Vol. I, World Press, Calcutta.
2. Goon, A.M., Gupta, M.K. and Dasgupta, B.: An Outline of Statistical Theory, Vol.II, (4th ed.), World Press.

SUGGESTED READINGS:

1. Rohatgi V. K. and Saleh, A.K. Md. E. (2009): An Introduction to Probability and Statistics. 2ndEdn. (Reprint) John Wiley and Sons.
2. Miller, I. and Miller, M. (2002) : John E. Freund's Mathematical Statistics (6th addition, low price edition), Prentice Hall ofIndia.
3. Dudewicz, E. J., and Mishra, S. N. (1988): Modern Mathematical Statistics. John Wiley &Sons.
4. Mood A.M, Graybill F.A. and Boes D.C,: Introduction to the Theory of Statistics, McGrawHill.
5. Bhat B.R, Srivenkatramana T and Rao Madhava K.S. (1997) Statistics: A Beginner's Text, Vol. I, New Age International (P)Ltd.

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS:

1. Unbiased estimators (including unbiased but absurd estimators)
2. Consistent estimators, efficient estimators and relative efficiency of estimators.
3. Maximum Likelihood Estimation
4. Most powerful critical region (MP Lemma)
5. Uniformly most powerful critical region
6. Unbiased critical region
7. Power curves
8. OC function and OC curve , ASN function and ASN curve

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 9

LINEAR MODEL

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Know the procedure of estimability of linear parametric functions and estimation of error variance.
- Learn estimation and hypothesis testing in case of regression models.
- Understand ANOVA and ANCOVA for fixed effect models.
- Know about prediction from a fitted model, homoscedasticity, and collinearity.

UNIT-I

Gauss-Markov set-up: Theory of linear estimation, Estimability of linear parametric functions, Method of least squares, Gauss-Markov theorem, Estimation of error variance.

UNIT-II

Regression analysis: Simple regression analysis, Estimation and hypothesis testing in case of simple and multiple regression models, Concept of model matrix and its use in estimation.

UNIT-III

Analysis of variance: Definitions of fixed, random and mixed effect models, analysis of variance and covariance in one-way classified data for fixed effect models, Analysis of variance and covariance in two-way classified data with one observation per cell for fixed effect models.

UNIT-IV

Model checking: Prediction from a fitted model, Violation of usual assumptions concerning normality, Homoscedasticity and collinearity, Diagnostics using quantile- quantile plots.

TEXT BOOKS:

1. Draper, N.R. and Smith, H.: Applied Regression Analysis, John Wiley &Sons.
2. Sengupta, D, Linear model: an integrated approach, World Scientific Pub.

SUGGESTED READINGS:

1. Weisberg, S. (2005). Applied Linear Regression (Third edition).Wiley.
2. Wu, C. F. J. And Hamada, M. (2009). Experiments, Analysis, and Parameter Design Optimization (Second edition), John Wiley.
3. Renchner, A. C. And Schaalje, G. B. (2008). Linear Models in Statistics (Second edition), John Wiley and Sons

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS:

1. Estimability when X is a full rank matrix and not a full rank matrix
2. Simple Linear Regression
3. Multiple Regression
4. Tests for Linear Hypothesis
5. Orthogonal Polynomials
6. Analysis of Variance of a one way classified data
7. Analysis of Variance of a two way classified data with one observation per cell
8. Analysis of Covariance of a one way classified data

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 10

STATISTICAL QUALITY CONTROL

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Understand the concepts of quality control and inspections.
- Exercise quality control at product as well as process level.
- Learn how control charts of different types are constructed and are used to monitor quality standards.
- Use of acceptance sampling for making measurements and taking corrective action as a product or service is being produced.
- Know about organizational structure and six sigma training plans, importance of voice of customers (VOC) and total quality management.

UNIT-I

Quality: Definition, dimensions of quality, historical perspective of quality control and improvements starting from World War II, historical perspective of Quality Gurus and Quality Hall of Fame. Quality system and standards: Introduction to ISO quality standards, Quality registration. Statistical Process Control - Seven tools of SPC, chance and assignable Causes of quality variation. Statistical Control Charts- Construction and Statistical basis of 3-σ Control charts, Rational Sub-grouping.

UNIT-II

Control charts for variables: $\overline{X}$ & R-chart, & s-chart. Analysis of patterns on control chart, estimation of process capability. Control charts for attributes: np-chart, p-chart, c-chart and u-chart. Comparison between control charts for variables and control charts for attributes.

UNIT-III

Acceptance sampling plan: Principle of acceptance sampling plans. Single and Double sampling plan, Their OC, AQL, LTPD, AOQ, AOQL, ASN, ATI functions with graphical interpretation, use and interpretation of Dodge and Romig's sampling inspection plan tables.

UNIT-IV

Introduction to Six-Sigma: Overview of Six Sigma, Lean Manufacturing and Total Quality Management (TQM). Organizational Structure and Six Sigma training plans- Selection Criteria for Six-Sigma roles and training plans. Voice of customers (VOC): Importance and VOC data collection.

TEXT BOOKS:

1. Montogomery, D. C. (2009): Introduction to Statistical Quality Control, 6th Edition, Wiley India Pvt. Ltd.

SUGGESTED READINGS:

1. Goon A.M., Gupta M.K. and Das gupta B. (2002): Fundamentals of Statistics, Vol. I & II, 8th Edn. The World Press, Kolkata.
2. Mukhopadhyay,P(2011):Applied Statistics,2nd edition revised reprint, Booksand Allied(P)Ltd.
3. Montogomery, D. C. and Runger, G.C. (2008): Applied Statistics and Probability for Engineers, 3rd Edition reprint, Wiley India Pvt.Ltd.
4. Ehrlich, B.Harris(2002):Transactional Six Sigma and Lean Servicing,2ndEdition, St. Lucie Press.
5. Hoyle, David (1995): ISO Quality Systems Handbook, 2nd Edition, Butterworth Heinemann Publication.

PRACTICAL

Credit : **02** | **25** Marks

LIST OF PRACTICALS:

1. Construction and interpretation of statistical control charts
2. X-bar &R-chart
3. X-bar &s-chart
4. np-chart, p-chart, c-chart and u-chart
5. Single sample inspection plan: Construction and interpretation of OC, AQL, LTPD, ASN, ATI, AOQ, AOQL curves

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 11

STOCHASTIC PROCESS & QUEUING THEORY

Time : **3** Hrs. — End Semester Theory : **60** Marks
Credit : **04** — Mid Semester Theory : **15** Marks

Course outcomes:-

- Understand the concepts of Generating functions, stationary process, Stochastic process, Poisson process, Pure birth process, Pure death process and birth-death process, Yule fury process.
- Understand classification of states of Markov chain.
- Derive the differentials- difference equations for various processes.
- Know about the characteristics of queuing theory models and waiting time distributions.

UNIT-I

Probability Distributions: Generating functions, Bivariate probability generating function. Stochastic Process: Introduction, Stationary Process.

UNIT-II

Markov Chains: Definition of Markov Chain, transition probability matrix, order of Markov chain, Markov chain as graphs, higher transition probabilities. Generalization of independent Bernoulli trials, classification of states and chains.

UNIT-III

Poisson Process: postulates of Poisson process, properties of Poisson process, inter-arrival time, pure birth process, Yule Furry process, birth and death process, pure death process.

UNIT-IV

Queuing System: General concept, Characteristics of queuing models, steady state distribution, queuing model, M/M/1 with finite and infinite system capacity, waiting time distribution (without proof).

TEXT BOOKS:

1. Medhi, J. (2009): Stochastic Processes, New Age International Publishers.
2. Kanti Swarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.

SUGGESTED READINGS:

1. Basu, A.K. (2005): Introduction to Stochastic Processes, Narosa Publishing.
2. Bhat,B.R.(2000): Stochastic Models: Analysis and Applications, New Age International Publishers.
3. Taha, H. (1995): Operations Research: An Introduction, Prentice- Hall India.
4. Karlin, S and Taylor H.M, A first course in Stochastic Process. Academic Press;

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. Calculation of transition probability matrix
2. Identification of characteristics of reducible and irreducible chains.
3. Identification of types of classes
4. Calculation of probabilities for given birth and death rates and vice-versa
5. Calculation of Probability and parameters for (M/M/1) model and change in behaviour of queue as N tends to infinity.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 12

STATISTICAL COMPUTING USING C & R PROGRAMMING

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Understand data types, operators and expressions, library functions relating to C program.
- Learn about decision making and branching.
- Know about category of functions and user-defined functions in C program.
- Learn about running R program and constructing data objects.

UNIT-I

History and importance of C, Components, basic structure programming, Keywords and Identifiers and execution of a C program. Data types: Basic data types, Enumerated data types, derived data types. Constants and variables: declaration and assignment of variables, Symbolic Constants, overflow and underflow of data. Operators and Expressions: Arithmetic, relational, logical, assignment, increment/decrement, operators, precedence of operators in arithmetic, relational and logical expression. Implicit and explicit type conversions in expressions, library functions. Managing input and output operations: reading and printing formatted and unformatted data

UNIT-II

Decision making and branching - if…else, nesting of if…else, else if ladder, switch, conditional operator. Looping in C: for, nested for, while, do…while, jumps in and out of loops. Arrays: Declaration and initialization of one-dim and two-dim arrays. Character arrays and strings: Declaring and initializing string variables, reading and writing strings from Terminal (using scanf and printf only).

UNIT-III

User- defined functions: A multi-function program using user-defined functions, definition of functions, return values and their types, function prototypes and calls. Category of Functions no arguments and no return values, arguments but no return values, arguments with return values, no arguments but returns a value, functions that return multiple values.

UNIT-IV

Introducing R: Getting R, Running R program, Finding your way in R, Command packages, Starting Out: Reading and Getting Data into R, Viewing Named Objects, Types of Data Items, Structure of Data Items, Examining Data Structure, Saing Your Work in R, Working with objects: Manipulating objects, Viewing Objects, Constructing data objects, Different forms of Data Objects. Descriptive Statistics and Tabulation.

TEXT BOOKS:

1. Kanetkar Y. P. Let us C ; BPB Publications; 15thedition.
2. Gardener, M. Beginning R: The Statistical Programming Language, WileyIndia

SUGGESTED READINGS:

1. Balagurusamy, E. (2011): Programming in ANSI C, 6th Edition, Tata McGraw Hill.
2. Kernighan, B.W. and Ritchie, D. (1988): C Programming Language, 2nd Edition, Prentice Hall.
3. Gottfried,B.S.(1998): Schaum's Outlines: Programming with C, 2nd Edition,Tata Mc Graw Hill

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. Plot of a graph y= f(x)
2. Roots of a quadratic equation (with imaginary roots also)
3. Sorting of an array and hence finding median
4. Mean, Median and Mode of a Grouped Frequency Data
5. Variance and coefficient of variation of a Grouped Frequency Data
6. Value of n! using recursion
7. Matrix addition, subtraction, multiplication Transpose and Trace
8. t-test for difference of means
9. Paired t-test
10. F-ratio test

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 13

DESIGN OF EXPERIMENTS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Understand how the total variation in a data set can be partitioned into different components.
- Learn how to summarize F ratio in the form of ANOVA table.
- Be able to compare the means of more than two samples simultaneously.
- Understand commonly used experimental designs.
- Know about factorial experiment, total and partial confounding in Design of experiments.

UNIT-I

Analysis of variance (ANOVA) for one way and two way classified data (one observation per cell) Experimental designs: Role, historical perspective, terminology, experimental error, basic principles, uniformity trials, fertility contour maps, choice of size and shape of plots and blocks.

UNIT-II

Basic designs: Completely Randomized Design (CRD), Randomized Block Design (RBD), Latin Square Design (LSD) – layout, model and statistical analysis, relative efficiency, analysis with missing observations.

UNIT-III

Factorial experiments: advantages and disadvantages , notations and concepts, 2^2, 2^3, … 2^n and 3^2 factorial experiments, design and its analysis and applications.

UNIT-IV

Total and Partial confounding for 2^n (n=5), 3^2 and 3^3, factorial experiments in a single replicate. Advantages and disadvantages. Balanced Incomplete Block Design (BIBD) – parameters, relationships among its parameters.

TEXT BOOKS:

1. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4 (Reprint), Sultan Chand &Sons
2. Goon, A.M., Gupta, M.K.and Das gupta, B.(2005):Fundamentals of Statistics. Vol. II, 8thEdn. World Press, Kolkata.

SUGGESTED READINGS:

1. Cochran, W.G. and Cox, G.M. (1959): Experimental Design. Asia Publishing House.
2. Das, M.N. and Giri, N.C. (1986): Design and Analysis of Experiments. Wiley Eastern Ltd.
3. Kempthorne, O. (1965): The Design and Analysis of Experiments. John Wiley.
4. Montgomery, D. C. (2008): Design and Analysis of Experiments, John Wiley.

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. Analysis of a CRD
2. Analysis of an RBD
3. Analysis of an LSD
4. Analysis of an RBD with one missing observation
5. Analysis of an LSD with one missing observation
6. Analysis of 2^2 and 2^3 factorial in CRD and RBD
7. Analysis of a completely confounded two level factorial design in 2 blocks
8. Analysis of a completely confounded two level factorial design in 4 blocks
9. Analysis of a partially confounded two level factorial design

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 14

MULTIVARIATE ANALYSIS AND NON PARAMETRIC METHODS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

· Learn how a non-parametric statistical test is conducted when variables are measured on a nominal scale and measurements are of independent nature.

· Know about multivariate data and various terms with it.

· Derive marginal and conditional distribution of MVND.

· Understand random vector, mean vector, dispersion matrix and variance-covariance matrix relating to MVND.

· Know about the properties of partial and multiple correlation coefficients.

UNIT-I

Bivariate Normal Distribution (BVN): p.d.f. of BVN, properties of BVN, marginal and conditional p.d.f. of BVN. Multivariate Data: Random Vector: Probability mass/density functions, Distribution function, Mean vector & Dispersion matrix, Marginal & Conditional distributions.

UNIT-II

Multivariate Normal distribution and its properties. Sampling distribution for mean vector and variance- covariance matrix. Multiple and partial correlation coefficient and their properties.

UNIT-III

Nonparametric Tests: Introduction and Concept, Parametric versus non-parametric tests, advantages and disadvantages of non-parametric tests. Test for randomness based on total number of runs, Empirical distribution function, Kolmogrov Smirnov test for one sample, Sign tests- one sample.

UNIT-IV

Kolmogrov Smirnov two samples test, Wilcoxon signed rank tests, Wilcoxon-Mann- Whitney Utest, Kruskal-Wallis test.

TEXT BOOKS:

1. Bhuyan, KC., Multivariate Analysis and its Applications, New Central Book Agency (P) Limited
2. Gun, A.M., Gupta, M.K. and Das gupta, B.: An Outline of Statistical Theory, Vol.II, (4thed.), World ress.

SUGGESTED READINGS:

1. Johnson, R.A. and Wichern, D.W. (2007): Applied Multivariate Analysis, 6thEdn., Pearson & Prentice Hall
2. Anderson, T.W. (2003): An Introduction to Multivariate Statistical Analysis, 3 JohnWiley
3. Kshirsagar, A.M. (1972):Multivariate Analysis, 1stEdn. Marcel Dekker.

4. Mukhopadhyay, P.: Mathematical Statistics. Books and Allied (P)Ltd
5. Gibbons, J.D. and Chakraborty, S(2003):Non parametric Statistical Inference.4th Edition. Marcel Dekker, CRC.

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. Multiple Correlation
2. Partial Correlation
3. Bivariate Normal Distribution
4. Test for randomness based on total number of runs.
5. Kolmogrov Smirnov test for one sample.
6. Sign test: one sample, two samples, large samples.
7. Wilcoxon-Mann-Whitney U-test.
8. Kruskal-Wallis test

+3 THIRD YEAR FIFTH SEMESTER

DSE - 1

OPERATIONS RESEARCH

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Understand maximization and minimization problem (LPP) using different methods.
- Have an idea about to minimax-maximin principle in game theory.
- Be able to know the details about inventory management, its characteristics and various models associated with it.
- Learn about networking using shortest route.
- Be able to find optimal solution in case of transportation and assignment problem.

UNIT-I

Introduction to Operations Research, phases of O.R., model building, various types of O.R. problems. Linear Programming Problem, Mathematical formulation of the L.P.P, graphical solutions of a L.P.P. Simplex method for solving L.P.P. Charne's M-technique for solving L.P.P. involving artificial variables. Special cases of L.P.P. Concept of Duality in L.P.P: Dual simplex method.

UNIT-II

Transportation Problem: Initial solution by North West corner rule, Least cost method and Vogel's approximation method (VAM), MODI's method to find the optimal solution, special cases of transportation problem. Assignment problem: Hungarian method to find optimal assignment problem.

UNIT-III

Game theory: Rectangular game, minimax-maximin principle, solution to rectangular game using graphical method, dominance and modified dominance property to reduce the game matrix and solution to rectangular game with mixed strategy. Networking: Shortest route and minimal spanning tree problem.

UNIT-IV

Inventory Management: ABC inventory system, characteristics of inventory system. EOQ Model and its variations, with and without shortages, Quantity Discount Model with price breaks.

TEXT BOOKS:

1. KantiSwarup, Gupta, P.K. and Manmohan (2007): Operations Research, 13th Edition, Sultan Chand and Sons.

SUGGESTED READINGS:

1. Taha, H. A. (2007): Operations Research: An Introduction, 8th Edition, Prentice Hall ofIndia.
2. Hadley, G: (2002) : Linear Programming, Narosa Publications
3. Hillier, F.A and Lieberman, G.J. (2010): Introduction to Operations Research Concepts and cases, 9th Edition, Tata Mc Graw Hill

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. Mathematical formulation of L.P.P and solving the problem using graphical method, Simplex technique and Charne's Big M method involving artificial variables.
2. Identifying Special cases by Graphical and Simplex method and interpretation (Unbounded, Infeasible and alternate solution)
3. Allocation problem using Transportation model
4. Allocation problem using Assignment model
5. Problems based on game matrix

+3 THIRD YEAR FIFTH SEMESTER

DSE - 2

TIME SERIES ANALYSIS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Learn how to decompose time series data into their various components.
- Know various methods of measurement of trend, seasonal, cyclical, and random components.
- Understand a stationary timeseries and exponential smoothing methods.

UNIT-I

Introduction to times series data, application of time series from various fields, Components of a time series, Decomposition of time series. Trend: Estimation of trend by free hand curve method, method of semi averages, fitting various mathematical curve, and growth curves.

UNIT-II

Trend Cont.: Method of moving averages. Detrending. Effect of elimination of trend on other components of the time series. Seasonal Component: Estimation of seasonal component by Method of simple averages, Ratio to Trend.

UNIT-III

Seasonal Component cont: Ratio to Moving Averages and Link Relative method, Deseasonalization. Cyclic Component: Harmonic Analysis. Some Special Processes: Movingaverage (MA) process and Autoregressive (AR) process of orders one and two, Estimation of the parameters of AR (1) and AR (2) – Yule-Walker equations.

UNIT-IV

Stationary Time series: Weak stationarity, auto correlation function and correlogram of moving average; its applications. Random Component: Variate component method. Forecasting: Exponential smoothing methods.

TEXT BOOKS:

1. Kendall M.G. (1976): Time Series, Charles Griffin.
2. Brockwell, P.J. and Davis, R. A. (2003). Introduction to Time Series Analysis, Springer

SUGGESTED READINGS:

1. Gupta, S. C. and Kapoor, V.K. (2008): Fundamentals of Applied Statistics, 4 (Reprint), Sultan Chand &Sons
2. Chatfield C. (1980): The Analysis of Time Series –An Introduction, Chapman & Hall.
3. Mukhopadhyay P. (2011): Applied Statistics, 2nd ed. Revised reprint, Books and Allied

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. Fitting and plotting of modified exponential curve
2. Fitting and plotting of Gompertz curve
3. Fitting and plotting of logistic curve
4. Fitting of trend by Moving Average Method
5. Measurement of Seasonal indices Ratio-to-Trend method
6. Measurement of Seasonal indices Ratio-to-Moving Average method
7. Measurement of seasonal indices Link Relative method
8. Forecasting by exponential smoothing

+3 THIRD YEAR SIXTH SEMESTER

DSE - 3

DEMOGRAPHY AND VITAL STATISTICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course outcomes:-

- Know about the use of various indices to check computeness of registration data.
- Understand various measures of morality and fertility.
- Learn about construction of life table and abridged life tables.
- Know about the measurement of population growth.

UNIT-I

Population Theories: Coverage and content errors in demographic data, use of balancing equations and Chandrasekharan-Deming formula to check completeness of registration data. Adjustment of age data, use of Myer and UN indices, Population composition, dependency ratio.

UNIT-II

Introduction and sources of collecting data on vital statistics, errors in census and registration data. Measurement of population, rate and ratio of vital events. Measurements of Mortality: Crude Death Rate (CDR), Specific Death Rate (SDR), Infant Mortality Rate (IMR) and Standardized Death Rates.

UNIT-III

Stationary and Stable population, Central Mortality Rates and Force of Mortality. Life (Mortality)Tables: Assumption, description, construction of Life Tables and Uses of Life Tables.

UNIT-IV

Abridged Life Tables; Concept and construction of abridged life tables by Reed-Merrell method, Measurements of Fertility: Crude Birth Rate (CBR), General Fertility Rate (GFR), Specific Fertility Rate (SFR) and Total Fertility Rate (TFR). Measurement of Population Growth: Crude rates of natural increase, Pearl's Vital Index, Gross Reproduction Rate (GRR) and Net Reproduction Rate (NRR).

TEXT BOOKS:

1. Pathak, K.B. and Ram, F.: Techniques of Demography Analysis, Himalayan Publishers
2. Gun,A.M., Gupta,M.K. and Dasgupta, B.(2008):Fundamentals of Statistics, Vol. II, 9th Edition, World Press.

SUGGESTED READINGS:

1. 9Mukhopadhyay P. (1999): Applied Statistics, Books and Allied (P)Ltd.
2. Biswas, S. (1988): Stochastic Processes in Demography & Application, Wiley Eastern Ltd.
3. Croxton, Fredrick E., Cowden, Dudley J. and Klein, S. (1973): Applied General Statistics, 3rd Edition. Prentice Hall of India Pvt. Ltd.
4. Keyfitz N., Beckman John A.: Demography through Problems S-Verlag Newyork.

PRACTICAL

Credit : **02** **25** Marks

LIST OF PRACTICALS

1. To calculate CDR and Age Specific death rate for a given set of data
2. To find Standardized death rate by:- (i) Direct method (ii) Indirect method
3. To construct a complete life table
4. To fill in the missing entries in a life table
5. To calculate probabilities of death at pivotal ages and use it construct a bridged life table
6. To calculate CBR, GFR, SFR, TFR for a given set of data
7. To calculate Crude rate of Natural Increase and Pearle's Vital Index for a given set of data
8. Calculate GRR and NRR for a given set of data and compare them

+3 THIRD YEAR SIXTH SEMESTER

DSE - 4

PROJECT WORK

Objective:

The aim of the course is to initiate students to write and present a statistical report, under the supervision of a faculty, on some area of social interest. The project work will provide hands-on training to the students to deal with data emanating from some real-life situation and propel them to do well on some theory or relate it to some theoretical concepts. The project should be prepared basing on the own idea and interpretation of the student. It should not be copied from anywhere. A student has to consult his / her supervisor for the preparation of the project. While writing a project, a student has to present two seminars before the faculties / supervisor from the department.

Seminar - I (Based on Introduction and Review of literature, Methodology) - 10 Marks

Seminar - II (Based on Analysis, Interpretation and Conclusion) - 10 Marks

Project Report - 60 Marks

Viva- Voce (after submission of Project Report)- 20 Marks

OR

+3 THIRD YEAR SIXTH SEMESTER

DSE - 4

ECONOMETRICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **20** Marks

Course outcomes:-

- Learn about the analysis of economic data using linear regression model
- Understand the statistical foundations of regression analysis with OLS

UNIT-I

Introduction: Objective behind building econometric models, nature of econometrics, model building, role of econometrics, structural and reduced forms. General linear model (GLM). Estimation under linear restrictions.

UNIT-II

Multi collinearity: Introduction and concepts, detection of multicollinearity, consequences, tests and solutions of multicollinearity, specification error.

UNIT-III

Generalized least squares estimation, Aitken estimators. Autocorrelation: concept, consequencesof auto correlated disturbances, detection and solution of autocorrelation.

UNIT-IV

Hetero scedastic disturbances: Concepts and efficiency of Aitken estimator with OLS estimator under hetero scedasticity. Autoregressive models, Dummy variables, Qualitative data.

TEXT BOOKS:

1. Gujarati, D. and Sangeetha, S. (2007): Basic Econometrics, 4th Edition, McGraw Hill Companies.
2. Maddala, G.S. and Lahiri, K. (2009): Introduction to Econometrics, 4th Edition, John Wiley &Sons.

SUGGESTED READINGS:

1. Johnston,J.(1972):Econometric Methods, 2nd Edition, Mc Graw Hill International.
2. Koutsoyiannis, A. (2004): Theory of Econometrics, 2nd Edition, Palgrave Macmillan

PRACTICAL

Credit : **02** **25** Marks

1. Problems based on estimation of General linear model
2. Testing of parameters of General linear model
3. Forecasting of General linear model
4. Problems related to consequences of Multicollinearity
5. Diagnostics of Multicollinearity
6. Problems related to consequences of Autocorrelation(AR(I))
7. Diagnostics of Autocorrelation
8. Problems related to consequences Hetero scedasticity
9. Diagnostics of Hetero scedasticity

ZOOLOGY

Program Outcome :

After successful completion of this program the students will be able to gain knowledge in the multifaced field of bioscience, especially Zoology.

The program also works across related majors within the UG zoology.

Distinguish between the Structure, Function, Behaviors and evolution of different animals.For instance, if you major in zoology, you can also still take courses from across the other complementary. UG majors of conservation biology and ecology, giving you an in-depthknowledge of those most closely related programs. Apply the wide range of subject based skills to various fields that provide a base for future career in disciplines such as Health Sciences, Agriculture, Environmental Management, Biotechnology, Publishing, Teaching and Research. Perform, Assess and implement practical techniques and procedures to solve biological problems and analyze and quantify data collected during any project.Understand the applications of Biological techniques to various fields of biology.When you graduate you will have learned how to work at a high level of academic achievement.Work to deadlines under pressure and communicate effectively for their academic excellence.

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 1

NON-CHORDATES I : PROTISTA TO PSEUDOCOELOMATES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

It includes basics of classification about non-chordates and along with studies on various physiological functions and interactions of various non-chordates and with type specimens.

Unit 1:

Protista, Parazoa, Metazoa and Porifera

General characteristics and Classification up to classes. Study of Euglena, Amoeba. Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica. Locomotion and Reproduction in Protista.General characteristics and Classification up to classes, Canal system and spicules in sponges.

Unit 2:

Cnidaria & Ctenophora

General characteristics and Classification up to classes, Metagenesis in Obelia, Polymorphism in Cnidaria, Corals and coral reefs. General characteristics and Evolutionary significance of Ctenophora.

Unit 3:

Platyhelminthes

General characteristics and Classification up to classes. Life cycle and pathogenicity of Fasciola hepatica and Taeniasolium.

Unit 4:

Nemathelminthes

General characteristics and Classification up to classes. Life cycle, and pathogenicity of Ascarislumbricoides and Wuchereriabancrofti. Parasitic adaptations in helminthes

Note: Classification to be followed from “Barnes, R.D. (1982).Invertebrate Zoology, V Edition”

PRACTICAL

Credit : **02** **25** Marks

1. Study of whole mount of Euglena, Amoeba and Paramecium, Binary fission and Conjugation in Paramecium.
2. Examination of pond water collected from different places for diversity in protista.
3. Study of Sycon (T.S. and L.S.), Hyalonema, Euplectella, Spongilla.
4. Study of Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora.
5. One specimen/slide of any ctenophore.
6. Study of adult Fasciola hepatica, Taeniasolium and their life cycles (Slides/microphotographs).
7. Study of adult Ascarislumbricoides and its life stages (Slides/micro-photographs).
8. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.

Note : Classification to be followed from “Ruppert and Barnes (2006)Invertebrate Zoology, 8th edition, Holt Saunders International Edition”.

TEXT BOOKS

1. Kotpal RL; Modern Textbook of Zoology – Invertebrates; Rastogi Publications - Meerut; 2016 edition
2. Richard Busca, W. Moore, Stephen M. Shuster. Invertebrates; OUP USA; 3 edition (19 January 2016)

SUGGESTED READINGS

1. Richard Fox , Robert D. Barnes, Edward E. Ruppert, Invertebrate Zoology: A Functional Evolutionary Approach, Brooks/Cole; 7th edition 2003
2. Barrington, E.J.W. Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
3. Hyman, L.H. Invertebrate Series (Recent edition)
4. Verma P. S. A Manual of Practical Zoology: Invertebrates. S Chand Publication
5. Parker JJ and WA Haswel Textbook of Zoology. Vol I and II

+3 FIRST YEAR FIRST SEMESTER

Core Paper - 2

PRINCIPLES OF ECOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Acquire deep understanding of the structure and basic components of the ecosystem and their interactions and inter-relationships to sustain life on earth. This course provides intense knowledge about the basic types of ecology, applied ecology, population ecology, life of community and related statistical analysis.

Unit 1:

Ecosystem and Applied Ecology

Ecology: Autecology and synecology, Types of ecosystems with one example in detail, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids Nutrient and biogeochemical cycle with one example of Nitrogen cycle. Ecology in Wildlife Conservation and Management. Laws of limiting factors, Study of physical factors- (Light, temperature).

Unit 2:

Population

Attributes of population: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion Exponential and logistic growth, equation and patterns, r and K strategies. Population regulation - density-dependent and independent factors, Population interactions, Gause's Principle with laboratory and field examples.

Unit 3:

Community

Community characteristics: species richness, dominance, diversity, abundance,vertical stratification, Ecotone and edge effect; Ecological succession with one example. Theories pertaining to climax community.

Unit – 4:

Biometry

Biological data, graphical representation of data (frequency polygon and histogram), sampling techniques, measures of central tendency (Mean, median and mode), Measures of dispersion (range, quartile deviation, mean deviation and standard deviation), Hypothesis and hypothesis testing (Chi-square test, t- test)

PRACTICAL

Credit : **02** **25** Marks

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.

2. Determination of population density in a natural/hypothetical community by quadrate method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton collection, preservation and mounting, Measurement of temperature, turbidity/penetration of light, determination of pH, Dissolved Oxygen content, (Winkler's method), BOD, COD, Free CO Hardness, TDS.
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.
5. Chi-square analysis using seeds/beads/Drosophila.
6. Problems on standard deviation.
7. Graphical representation of data (Frequency polygon and Histogram).

TEXT BOOK

1. Odum, E.P. and Barrett, G.W., (2018). Fundamentals of Ecology, 5th Edition
2. Smith and Smith, Elements of Ecology, Global Edition; Pearson Education India; ninth edition (14 May 2015)
3. Myra Samuels, J. Witmer,A. Schaffner, Statistics for the life sciences, Prentice Halls, Boston, 4th edition, 2012

SUGGESTED READINGS

1. Kormondy, (2017). Concepts of Ecology, Updated 4/e, Pearson
2. Colinvaux, P. A. (1993). Ecology. II Edition. Wiley, John and Sons, Inc. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
3. Ricklefs, R.E., (2000). Ecology. 5th Edition. Chiron Press
4. Dash M.C., Fundamentals of Ecology. Mc GrawHill
5. Smith TM and Smith RL, Elements of Ecology, 8th Edition,Pearson education INC, USA
6. Miller, G.T. and Spoolman, S.E. (2017) Environmental Science, 14th Edition. Cengage Publication, New Delhi.
7. Odum, E.P. and Barrett, G.W., (2018). Fundamentals of Ecology, 5th Edition.
8. Web site: https://www.cbd.int/
9. Baneerjee Pranab Kumar, Introduction to biostatistics, S Chand & Company; 3rd Rev. Edn. 2006 edition
10. Chainy GBN, Mishra G, MohantyPK, 2004, Basic Biostatistics, Kalyani Publisher

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 3

NON- CHORDATES II : COELOMATES

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

This course provides knowledge about classification of coelomates, Arthropods, Onychophora, Mollusca and Echinodermata with Study of Type specimens and specimen slides

Unit 1:

Coelomates and Annelids

Evolution of coelom and metamerism. General characteristics and Classification up to classes; Excretion in Annelida.

Unit 2:

Arthropoda and Onychophora

General characteristics and Classification up to classes. Vision and Respiration in Arthropoda. Metamorphosis in Insects. Social life in bees and termites. Onychophora: General characteristics and Evolutionary significance.

Unit 3:

Mollusca

General characteristics and Classification up to classes. Respiration in Mollusca. Torsion and detorsion in Gastropoda. Evolutionary significance of trochophore larva.

Unit 4:

Echinodermata

General characteristics and Classification up to classes. Water-vascular system in Asteroidea, Larval forms in Echinodermata, Affinities with Chordates.

Note: Classification to be followed from “Ruppert and Barnes (2006)Invertebrate Zoology,8th edition, Holt Saunders International Edition”

PRACTICAL

Credit : **02** **25** Marks

1. Study of following specimens:
2. Annelids - Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria
3. Arthropods – Tachypleus,Carcinoscorpious, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus,Bombyx,Periplaneta, termites and honey bees
4. Onychophora –Peripatus

5. Molluscs - Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus
6. Echinodermates - Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria and Antedon
7. Study of digestive system, nephridia of earthworm (Virtual).
8. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
9. Mount of mouth parts and dissection of digestive system and nervous system of Periplaneta.
10. To submit a Project Report on any related topic to larval forms (crustacean, mollusc and echinoderm)

TEXT BOOKS

1. Kotpal RL (2014) Text book of Zoology, Invertebrate, Rastogi Publication
2. Jordan and Verma PS (2009) Invertebrate Zoology. S Chand publication.

SUGGESTED READINGS

1. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.
2. Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
3. Verma P S. (2010) A Manual of Practical Zoology: Non-chordates. S Chand Publication

+3 FIRST YEAR SECOND SEMESTER

Core Paper - 4
CELL BIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Structural and functional aspects of basic unit of life i.e. cell and its organelles. Acquire detailed knowledge about membrane pumps and membrane transport with additional knowledge of Cell division, cell cycle regulation.

Unit 1:

Overview of cells and plasma membrane

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions, Various models of plasma membranestructure. Transport across membranes: Active and Passive transport, Facilitated transport. Cell junctions: Tight junctions, Desmosomes, Gap junctions.

Unit 2:

Cytoskeleton & Endomembrane System

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments; Structure and Functions: Endoplasmic Reticulum, Golgi apparatus, Lysosomes.

Unit 3:

Mitochondria and Peroxisomes

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis; Mitochondrial Respiratory Chain, Chemi-osmotic hypothesis. Peroxisomes.

Unit 4:

Nucleus, Cell Division and Cell signalling

Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus; Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome); Mitosis, Meiosis, Cell cycle and its regulation; GPCR and Role of second messenger (cAMP)

PRACTICAL

Credit : **02** **25** Marks

1. Preparation of temporary stained squash of onion root tip tostudy various stages of mitosis.
2. Study of various stages of meiosis.
3. Preparation of permanent slide to show the presence of Barr body in human female blood cells/ cheek cells.
4. Preparation of permanent slide to demonstrate:
   i. DNA by Feulgen reaction
   ii. DNA and RNA by MGP
   iii. Mucopolysaccharides by PAS reaction
   iv. Proteins by Mercuric bromophenol blue/Fast Green
5. Demonstration of osmosis (RBC/ Egg etc.).

TEXT BOOKS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. S Harisha (2007) Biotechnology procedures and experiments handbook., Infinity Science Press, Hingham

SUGGESTED READINGS

1. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008). MolecularBiology of the Cell, V Edition, Garland publishing Inc., New York and London.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
3. Suvarna S, Lyton C, Bancroft JD (2013) Theory and practice of histological techniques, Churchill Livingstone, Elsevier, UK
4. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 5

DIVERSITYAND DISTRIBUTION OF CHORDATES

Time : **3** Hrs. End Semester Theory : **60** Marks

Credit : **04** Mid Semester Theory : **15** Marks

Courses Outcomes:

Knowledge of classification about Chordates along with studies on various physiological functions and vertebrate adaptations in relation to their environments. Additional knowledge of zoogeography is included.

Unit 1:

Protochordates and Origin of Chordates

Protochordata: General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata. General characteristics and outline classification of Chordata. Dipleurula concept and the Echinoderm theory of origin of chordates.

Unit 2:

Agnantha, Pisces & Amphibia

General characteristics of Agnatha: General characteristics and classification of cyclostomes up to class Chondrichthyes and Osteichthyes: classification up to order, Migration, Parental care in fishes, Accessory respiratory organs in pisces, Evolutionary significance of Dipnoi. Amphibian: Origin of Tetrapoda (Evolution of terrestrial ectotherms); General characteristics and classification up to order. Parental care in Amphibia.

Unit 3:

Reptilia & Aves

General characteristics and classification up to order in reptiles; Affinities of Sphenodon; Poison apparatus and Biting mechanism in snakes. General characteristics and classification up to order in Aves Archaeopteryx- a connecting link; Flight adaptations and Migration in birds.

Unit 4:

Mammals & Zoogeography

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages. Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms.

PRACTICAL

Credit : **02** **25** Marks

1. Protochordata: Balanoglossus, Herdmania, Branchiostoma, Colonial Urochordata, Sections of Balanoglossusthrough proboscisand branchio-genital regions, Sections of Amphioxus through pharyngeal, intestinal and caudal regions. Permanent slides of Herdmania spicules.
2. Agnatha: Petromyzon and Myxine.

3. Fishes:Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas, Flat fish.
4. Amphibia: Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamander.
5. Reptilia: Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, CrocodylusKey for Identification of poisonous and non- poisonous snakes
6. Aves: Study of six common birds from different orders. Types of beaks and claws. Study of feathers.
7. Mammalia: Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceous.
8. Power point presentation on study of any two animals from two different classes by students. Submission of album of local species.

TEXT BOOKS

1. Kotpal RL; Modern Textbook of Zoology –Vertebrates; Rastogi Publications - Meerut; 2016 edition
2. Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford University Press.
3. Tiwari SK (2006) Fundamentals of World Zoogeography, Sarup & Sons

SUGGESTED READINGS

1. Pough H. Vertebrate life, VIII Edition, 2007 Pearson International.
2. Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.
3. Hickman CP, Roberts LS, Keen S, Larson A, I'AnsonH, Isenhour DJIntegrated Principle of Zoology, 14th edition, 2008, McGrawHill publication
4. Verma PS and Srivastava PC. (2011)Advanced Practical Zoology. S Chand Publication.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 6

PHYSIOLOGY : CONTROLLINGAND COORDINATING SYSTEMS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Develop an understanding about neurophysiology, hormones and reproductive systems, so that they can control their stress and emotions there by diverting their energy towards positive nation building activities

Unit 1:

Tissues & Tissue system

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue. Structure and types of bones and cartilages, Ossification, bone growth and resorption.

Unit 2:

Muscle & Nervous System

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction. Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; Reflex action and its types - reflex arc; Physiology of hearing and vision.

Unit 3:

Reproductive System

Histology of testis and ovary; Physiology of male and female reproduction; Hypothalamus-Pituitary & Gonadal axis. Puberty, Ovarian Cycle, Methods of contraception in male and female, Placental hormones.

Unit 4:

Endocrine System

Histology of endocrine glands – Hypothalamus (Neuroendocrine gland) pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their mechanism of action; Classification of hormones and mechanism of hormone action, (steroidal and non-steroidal hormones).

PRACTICAL

Credit : **02** **25** Marks

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
2. Study of permanent slides- Squamous epithelium, Striated muscle fibres and nerve cells.
3. Study of permanent slides-Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.
4. Microtomy: Preparation of permanent slides/photographs/computer models of any five types of mammalian (Goat/rat,etc) tissues

TEXT BOOKS

1. Marieb EN and Hoehn K, Human Physiology,(2013), 9th edition, Pearson Education, USA.
2. Endocrinology, Hadley ME and Levine JE (2009), Pearson Education India; 6 edition
3. Textbook of Medical Physiology, Guyton & Hall, Elsevier, 12th edition, 2016

SUGGESTED BOOKS

1. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition., Lippincott W. & Wilkins
2. Martini F H, Nath J L and Bartholomew E F.(2015) Fundamentals of Anatomy and Physiology. Pearson Education Publication,
3. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd./W.B. Saunders Company.
4. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons.

+3 SECOND YEAR THIRD SEMESTER

Core Paper - 7
FUNDAMENTALS OF BIOCHEMISTRY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Know the structure, classification and nomenclature of macromolecules such as carbohydrates, proteins and lipids and their metabolism and biological importance. Detailed understanding of enzymes, Mechanism of enzyme action, Enzyme kinetics and Enzyme regulation.

Unit 1:

Carbohydrates & Lipids

Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates; Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids.

Unit 2: Proteins

Amino acids: Structure, Classification and General properties of á-amino acids; Physiological importance of essential and non-essential á-amino acids. Proteins: Bonds stabilizing protein structure; Levels of organization in proteins; Renaturation, Denaturation; Introduction to simple and conjugate proteins Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants.

Unit 3:

Nucleic Acids

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids Cot Curves: Base pairing, Denaturation and Renaturation of DNA, Types of DNA and RNA, Complementarity of DNA, Hpyo- Hyperchromaticity of DNA.

Unit 4:

Enzymes

Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

PRACTICAL

Credit : **02** **25** Marks

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Paper chromatography of amino acids.

3. Action of salivary amylase under optimum conditions.
4. Effect of pH, temperature and inhibitors on the action of salivary amylase./Urease/acid or alkaline phosphatase
5. Demonstration of proteins separation by SDS-PAGE.

TEXT BOOKS

1. Satyanarayan and Chakrapani , (2017) Biochemistry, Elsevier; Fifth edition
2. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
3. Jeremy M. Berg, Lubert Stryer, John L. Tymoczko, Gregory J. Gatto, Biochemistry, 8th edition, 2015.
4. Victor W., Rodwell, David A., Bender, Kathleen M., Botham, Peter J., Kennelly, P. Anthony,Harper's Illustrated Biochemistry, 31st edition.

SUGGESTED READING

1. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Publication.
3. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
4. Devasena T. (2010). EnzymologyOxford University Press; 1 edition
5. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 8

COMPARATIVE ANATOMY OF VERTEBRATES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course of Outcomes:

Gains knowledge of functional anatomy of vertebrates from fishes to mammals with respect to evolution from simpler to complex organisms.

Unit 1:

Integumentary & Skeletal System

Structure, functions and derivatives of integument (Scale, claw, nail, hair, feather and dentition) in mammals. Axial and appendicular skeleton, Jaw suspensorium, Visceral arches.

Unit 2:

Digestive & Respiratory System

Alimentary canal and associated glands; Respiration through Skin, gills, lungs and air sacs;Accessory respiratory organs.

Unit 3 :

Circulatory and Urinogenital system

General plan of circulation, evolution of heart and aortic arches; Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

Unit 4 :

Nervous System & Sense Organs

Comparative account of brain; Nervous system, Spinal cord, Cranial nerves in mammals. Classification of receptors: Brief account of visual and auditory receptors in man. Chemo and mechano receptors

PRACTICAL

Credit : **02** **25** Marks

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs
2. Disarticulated skeleton of Frog, Varanus, Fowl, Rabbit.
3. Carapace and plastron of turtle /tortoise (Photographs, charts etc).
4. Mammalian skulls: One herbivorous and one carnivorous animal.
5. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted).
6. Project on skeletal modifications in vertebrates (may be included if dissection not permitted).

TEXT BOOKS

1. Kardong, K.V. (2005) Vertebrates'Comparative Anatomy, Function and Evolution. IV Edition. McGraw- Hill Higher Education
2. Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX Edition. The McGraw- Hill Companies
3. R. K. Saxena and Sumitra Saxena (2016). Comparative Anatomy of Vertebrates 2nd edition.

SUGGESTED READINGS

1. Hilderbrand, M and Gaslow G.E. Analysis of Vertebrate Structure, John Wiley and Sons
2. Walter, H.E. and Sayles, L.P; Biology of Vertebrates, Khosla Publishing House

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 9

PHYSIOLOGY : LIFE SUSTAINING SYSTEMS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Imparts knowledge about various metabolic and physiological mechanisms of the human body which are vital for sustenance of life.

Unit 1:

Physiology of Digestion

Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Hormonal control of secretion of enzymes in Gastrointestinal tract.

Unit 2:

Physiology of Respiration

Histology of trachea and lung; Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning; Control of respiration.

Unit 3 :

Renal Physiology and Blood

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance. Components of blood and their functions; Structure and functions of haemoglobin haemostasis: Haemopoiesis, Blood clotting system, Blood groups: Rh factor, ABO and MN.

Unit 4 :

Physiology of Heart

Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation.

PRACTICAL

Credit : **02** **25** Marks

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer

3. Estimation of haemoglobin using Sahli'shaemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of blood pressure using a sphygmomanometer
6. Examination of sections of mammalian slides: oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney.

TEXT BOOKS

1. Marieb E.N. and Hoehn K.N. (2009) Human Physiology. Pearson Education Publication , 9th edition
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI
3. Edition John Wiley & sons.
4. Guyton & Hall, (2016) Textbook of Medical Physiology. Elsevier, 12th edition,

SUGGESTED READINGS

1. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
2. Vander A Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills.
3. Moyes C.D., Schulte PM (2016), Principles of physiology, 2nd edition, Pearson education, 3rd.
4. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.

+3 SECOND YEAR FOURTH SEMESTER

Core Paper - 10
BIOCHEMISTRY OF METABOLIC PROCESSES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course of Outcomes:

A brief knowledge will be given about overview of metabolism of carbohydrates, lipids, proteins, and oxidative phosphorylation along with related practical

Unit 1:

Overview of Metabolism

Catabolism vsAnabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms.

Unit 2:

Carbohydrate Metabolism

Sequence of reactions and regulation of glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis.

Unit 3:

Lipid and protein Metabolism

Oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

Unit 4:

Oxidative Phosphorylation

Redox systems; Review of mitochondrial respiratory chain, Inhibitors and un-couplers of Electron Transport System

PRACTICAL

Credit : **02** **25** Marks

1. Estimation of total protein in given solutions
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin/ Lipase/ Salivary Amylase.
4. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
5. Dry Lab (Virtual): To trace the labelled C atoms of Acetyl-CoA till they evolve as CO in the TCA cycle.

TEXT BOOKS

1. Satyanarayan and Chakrapani , (2017) Biochemistry, Elsevier; Fifth edition.
2. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.

SUGGESTED READINGS

1. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007).Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 11
MOLECULAR BIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Courses of Outcomes:

Learners acquire detailed information on nucleic acid structure, their topology, organization of the genome, DNA Replication, repair and recombination. Acquire detailed knowledge on transcription and RNA processing, translation-gene expression and gene regulation mechanisms

Unit 1:

Nucleic Acids, DNA Replication & Repair

Salient features of DNA and RNA. Watson and Crick model of DNA. DNA Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication, RNA priming, Replication of circular and linear ds-DNA, replication of telomeres. Pyrimidine dimerization and mismatch repair.

Unit 2:

Transcription & Translation

RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes, synthesis of rRNA and mRNA, transcription factors and regulation of transcription. Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNAsynthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain; Inhibitors of protein synthesis; Difference between prokaryotic and eukaryotic translation.

Unit 3:

Post Transcriptional Modifications and Processing of Eukaryotic RNA

Structure of globin mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing, Processing of tRNA.

Unit 4:

Gene Regulation & Regulatory RNAs

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trp operon; Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements; Gene silencing, RNA interference, miRNA, siRNA.

PRACTICAL

Credit : **02** **25** Marks

1. Study of Polytene chromosomes from Chironomous / Drosophila larvae
2. Preparation of liquid culture medium (LB) and raise culture of E. coli

3. Estimation of the growth kinetics of E. coli by turbidity method
4. Preparation of solid culture medium (LB) and growth of E. coli by spreading and streaking
5. Quantitative estimation of salmon sperm/calf thymus DNA Bacteriausing colorimeter (Diphenylamine reagent) or spectrophotometer (A_{260} nm measurement)
6. Quantitative estimation of RNA using Orcinol reaction
7. Study and interpretation of electron micrographs/ photograph showing

   (a) DNA replication, (b) Transcription and (c) Split genes.

TEXT BOOKS

1. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. Lewin B. (2013). Gene XI, Jones and Bartlett.
3. De Robertis E.D.P. (2017) Cell and Molecular Biology 8th Edition.
4. Arnold Berk , Chris A. Kaiser, Harvey Lodish , Angelika Amon , Hidde Podegh, Anthony Bretscher, Monty Krieger Kelsey C. Martin(2016) Molecular Cell Biology. 8th edition.

SUGGESTED READINGS

1. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology ofthe Cell, IV Edition.
3. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
4. McLennan A., Bates A., Turner, P. and White M. (2015). Molecular Biology IV Edition. GS, Taylor and Francis Group, New York and London.

+3 THIRD YEAR FIFTH SEMESTER

Core Paper - 12
PRINCIPLES OF GENETICS

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Acquires deep understanding of Mendelian genetics and its applications, population genetics, human genetics and microbial genetics and concepts behind genetic disorder, gene mutations. Also an additional knowledge on sex-determination.

Unit 1:

Mendelian Genetics, Linkage, Crossing Over and Chromosomal Mapping

Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance. Polygenic inheritance with suitable examples; simple numericals based on it. Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two factor and three factor crosses, Interference and coincidence, Somatic cell hybridization.

Unit 2:

Mutations

Types of gene mutations (Classification), Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

Unit 3:

Sex Determination & Extra-chromosomal Inheritance

Chromosomal mechanisms of sex determination in Drosophila and Man; Criteria for extra-chromosomal inheritance, Antibiotic resistance in Chlamydomonas, Mitochondrial mutations in Saccharomyces, Infective heredity in Paramecium and Maternal effects.

Unit 4:

Recombination in Bacteria and Viruses & Transposable Genetic Elements

Conjugation, Transformation, Transduction, Complementation test in Bacteriophage. Transposons in bacteria, Ac-Ds elements in maize and P elements in Drosophila, Transposons in human.

PRACTICAL

Credit : **02** **25** Marks

1. Study of Mendelian laws and gene interactions.
2. Linkage maps based on data from conjugation, transformation and transduction.
3. Linkage maps based on data from Drosophila crosses.
4. Study of human karyotype (normal and abnormal).
5. Pedigree analysis of some human inherited traits.

TEXT BOOKS

1. Benjamin Pierce, (2015) Genetics- A Conceptual Approach, 5th edition, WH Freeman publication
2. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition.

SUGGESTED READINGS

1. Benjamin Cummings. Russell, P. J. (2009). Genetics- A Molecular Approach.III Edition.
2. Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc.
3. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B.Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co.
4. Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London.

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 13
DEVELOPMENTAL BIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Acquire knowledge in the embryological development of various animals like frog, chick and mammals. Acquire detailed knowledge about metamorphosis, regeneration, teratogenesis, medically assisted human reproductive technologies such as IVF and stem cell culture

Unit 1:

Introduction to Developmental Biology, Gametogenesis & Fertilization

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division. Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy.

Unit 2:

Early Embryonic Development

Cleavage: Planes and patterns of cleavage; Types of Blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers.

Unit 3:

Late Embryonic Development

Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta).

Unit 4:

Post Embryonic Development & Implications of Developmental Biology

Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories. Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis.

PRACTICAL

Credit : **02** **25** Marks

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages).

3. Study of the developmental stages and life cycle of Drosophila from stock culture.
4. Study of different sections of placenta (photomicropgraph/ slides).
5. Project report on Drosophila culture/chick embryo development.
6. Study of developmental stages by raising chick embryo in the laboratory

TEXT BOOKS

1. Lewis Wolpert (2010). Principles of Development. II Edition, Oxford University Press.
2. Gilbert, S. F. (2017). Developmental Biology, XI Edition, SinauerAssociates, Inc., Publishers, Sunderland, Massachusetts, USA.

SUGGESTED READINGS

1. Carlson, R. F. Patten's Foundations of Embryology.
2. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers.
3. Verma PS and Agrawal VK, Chordata Embryology (2010) (S Chand Publication).

+3 THIRD YEAR SIXTH SEMESTER

Core Paper - 14
EVOLUTIONARY BIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Acquires a scientific foundation about Cosmic evolution and Origin of life. Develops a deeper understanding about the probable concepts of Molecular and Biochemical Evolution.

Unit 1:

Theories, Evidences of Evolution and Extinction

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes. Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism.Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Sources of variations: Heritable variations and their role in evolution. Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction.

Unit 2:

Process of Evolutionary changes

Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population); Evolutionary forces upsetting H-W equilibrium; Natural selection (concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection). Genetic Drift (mechanism, founder's effect, bottleneck phenomenon); Role of Migration and Mutation in changing allele frequencies.

Unit 3:

Species concept and Speciation

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric,Parapatric. Adaptive radiation / macroevolution (exemplified by Galapagos finches);

Unit 4:

Concept of Origin and Evolution of man

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin. Phylogenetic trees, Multiple sequence alignment, construction and interpretation of phylogenetic trees.

PRACTICAL

Credit : **02** **25** Marks

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.
6. Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation.

TEXT BOOKS

1. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
2. Rastogi B.B., (2018). Organic Evolution, MedTech; 3rdedition

SUGGESTED READINGS

1. B.K. and Hallgrimson, B. (2008). Evolution IV Edition. Jones and Barlett Publishers.
2. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates. Snustad. S Principles of Genetics.
3. Ridley,M (2004) Evolution III Edition Blackwell publishing Hall.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 1

ANIMAL BEHAVIOUR AND CHRONOBIOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Understand Animal behavior and response of animals to different instinctsVarious kinds of Animal adaptation and Circadian Clock

Unit 1:

Animal Behaviour

Origin and history of Ethology; Brief profiles of Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate behavior; Objective of behaviour, Behaviour as a basis of evolution; Behaviour as a discipline of science; Innate behaviour, Instinct, Stimulus filtering, Sign stimuli and Code breakers.

Unit 2:

Patterns of Behaviour

Stereotyped Behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct vs. Learnt Behaviour; Associative learning, classical and operant conditioning, Habituation, Imprinting.

Unit 3:

Social and Sexual Behaviour

Social Behaviour: Concept of Society; Communication and the senses; Altruism; Insects'society with Honey bee as example; Foraging in honey bee and advantages of the waggle dance. Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Sexual conflict in parental care.

Unit 4:

Chronobiology

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks, Relevance of biological clocks, Types and characteristics of biological rhythms: Short- and Long-term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation seasonal reproduction of vertebrates; Role of melatonin.

PRACTICAL

Credit : **02** **25** Marks

1. To study nests and nesting habits of the birds and social insects.
2. To study the behavioural responses of wood lice in dry and humid condition.

3. To study geotaxis behaviour in earthworm.
4. To study the phototaxisbehaviour in insect larvae.
5. Study and actogram construction of locomotor activity of suitable animal models.
6. Study of circadian functions in humans (daily eating, sleep and temperature patterns).
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioral activities of animals and prepare a short report.

TEXT BOOKS

1. John A (2009) Animal Behaviour. 9th edition, Sinauer Associate Inc., USA.
2. Vinod Kumar (2002) Biological Rhythms: Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

SUGGESTED READINGS

1. AK Pati. Chronobiology: The Dimension of Time in Biology and Medicine. PINSA (Bilogical Sciences). Part B 67 (6). 323-372, Dec., 2001.
2. David McF. Animal Behaviour. Pitman Publishing Limited, London, UK.
3. Manning A and Dawkins MS. An Introduction to Animal Behaviour. Cambridge University Press, USA.
4. Paul WS and John A (2013) Exploring Animal Behaviour. 6th Edition. Sinauer Associate Inc., Massachusetts, USA.
5. Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey (ed). 2004, Chronobiology Biological Timekeeping: J, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.

+3 THIRD YEAR FIFTH SEMESTER

DSE - 2

IMMUNOLOGY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:;

Provides basics knowledge about immune system and allows the student to create insight as how to improve their immune system and good health. Types of immunity, antigens-antibodies and their properties, Complement system, MHC's and immune responses, types of hypersensitivity reactions and auto immune diseases

Unit 1:

Innate and Adaptive Immunity

Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system. Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

Unit 2:

Antigens and Immunoglobulins

Antigenicity and immunogenicity, Immunogens,Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes, Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen antibody interactions, Immunoassays (ELISA- Direct, Indirect, Competitive, Sandwich and RIA)

Unit 3:

Major Histocompatibility Complex, Cytokines and Complement system

Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation; Cytokines -Properties and functions of cytokines, Therapeutics Cytokines Complement System -Components and pathways of complement activation.

Unit 4:

Hypersensitivity and Vaccines

Gell and Coombs' classification and brief description of various types of hypersensitivities Vaccines -various types of vaccines, Advances in vaccine production.

PRACTICAL

Credit : **02** | **25** Marks

1. Study of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of White blood cells.
4. ABO blood group determination.
5. Total WBC counting.
6. Demonstration of ELISA.
7. Demonstration of Bone marrow smears to study Immune cells.

TEXT BOOKS

2. Abbas K.Abul and Lechtman H.Andrew (2017) Cellular and Molecular Immunology. V Edition. Saunders Publication.

3. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2017). Immunology, VI Edition. W.H. Freeman and Company.

SUGGESTED READINGS

1. Peter J. Delves and Seamus J. Martin (2017) Roitt2 s Essential Immunology, Wiley-Blackwell;

+3 THIRD YEAR SIXTH SEMESTER

DSE - 3
FISH AND FISHERIES

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

Knowledge about systematics, morphology and physiology of fish followed by laws and regulations related to fishery science. Here students will learn about aquaculture, fish pathology and transgenesis.

Unit 1:

Systematics, Morphology and Physiology

Systematic classification of native/exotic fishes(upto classes), Types of fins and their modification; Locomotion in fishes; Hydrodynamics; Types of scales, Use of scales in classification and determination of age of fish; Gills and gas exchange; Swim bladder; Reproductive strategies(Special reference to Indian fishes); Electric organs; Bioluminescence; Mechanoreceptors; Schooling; Migration

Unit 2:

Fisheries

Inland fisheries; Marine fisheries; Environmental factors influencing the seasonal variation in fish; Fishing crafts and Gears; Depletion of Fisheries resources; Fisheries laws and regulations.

Unit 3:

Aquaculture

Sustainable aquaculture; Extensive, semi-intensive and intensive culture of fish; Polyculture; Composite fish culture; brood stock management; Induced breeding of fish; Management of fin fish hatcheries; Preparation and maintenance of fish aquarium. Factors affecting aquaculture.

Unit 4:

Fish Pathology and Transgenesis

Fish diseases: bacterial, viral and parasites; Preservation, diagnosis and treatment, Processing of harvested fish, Fishery byproducts; Transgenic fish, zebrafish as a model organism in research.

PRACTICAL

Credit : **02** **25** Marks

1. Study of Petromyzon, Myxine, Pristis, Chimaera, Exocoetus, Hippocampus, Gambusia, Labeo, Heteropneustes, Anabas
2. Study of different types of scales(Through permanent slides and photographs)
3. Study of crafts and gears used in fisheries.

4. Water quality criteria for aquaculture: assessment of pH, conductivity, total solids and total dissolve solids.
5. Study of air breathing organs inChanna, Heteropneustes, Anabas and Clarias.
6. Demonstration of induced breeding in fishes(Virtual).
7. Demonstration of parental care in fishes(Virtual).
8. Project report on a visit to any fish farm/ pisciculture unit/ zebrafish rearing lab

TEXT BOOKS

1. Q Bone and R Moore (2008), Biology of fishes, Taylor and Francis group, CRC Press, UK
2. S.S. Khanna and H.R. Singh (2014) A textbook of fish biology and fisheries, Narendra Publishing House, 3rd edition.

SUGGESTED READINGS

1. D H Evans and J D Claiborne, The Physiology of fishes, Taylor and Francis group, CRC, UK
2. R J Mogdans and B G Kapoor, The senses of fish: Adaptations for the reception of natural stimuli, Springer, Natherland
3. C B L Srivastava, Fish biology, Narendra Publishing House
4. J R Norman, A History of fishes, Hill and Wang Publishers.

+3 THIRD YEAR SIXTH SEMESTER

DSE - 4
PROJECT WORK

Credit : **04** **100** Marks

Course Outcomes:

Students will be trained towards the complete knowledge of project preparation and presentation on related topics.

Each student has to undertake a project work under the guidance of a teacher and submit the project report in the form of a thesis. There will be a presentation of the project work before an external examiner.

+3 FIRST YEAR FIRST SEMESTER

GE - 1
ANIMAL DIVERSITY

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

A complete knowledge on classification on non-chordates and chordates with general characters.

Unit 1:

Protista, Porifera, Radiata, Aceolomates and Pseudocoelomates

General characters of Protozoa; Life cycle of Plasmodium, General characters and canal system in Porifera, General characters of Cnidarians and polymorphism, General characters of platy Helminthes; Life cycle of Taeniasolium, General characters of Nemethehelminthes; Parasitic adaptations in Nemat Helminthes.

Unit 2:

Coelomate Protostomes, Arthropoda, Mollusca and Coelomate Deuterostomes

General characters of Annelida, Metamerism, General characters of Anthropoda, Social life in insects,General characters of mollusca, torsion in gastropod, pearl formation, General characters of Echinodermata, larval form in Echinodermata.

Unit 3:

Protochordata , Pisces, Amphibia

Salient features, Protochordates, Pisces Amphibia, Osmoregulation, Migration of Fishes, Adaptations for terrestrial life, Parental care in Amphibia.

Unit 4:

Reptiles, Aves and Mammals

Amniotes, Origin of reptiles, Terrestrial adaptations in reptiles, Origin of Birds; Flight adaptations, early evolution of mammals; Primates; Dentition in mammals.

PRACTICAL

Credit : **02** **25** Marks

1. Study of following specimens :

   Non Chordates: Euglena, Noctiluca, Paramecium, Sycon, ,Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, T. gigas, Limulus, Hermitcrab, Daphnia, Millipede, Centipede, Beetle, Chiton, Dentalium, Octopus, Asterias and Antedon.

   Chordates: Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Icthyophis/ Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx, any three common birds-(Crow, duck, Owl), Squirrel and Bat.

2. Study of following Permanent Slides : Cross section of Sycon, Sea anemone and Ascaris(male and female). T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva
3. Temporary mounts ofSeptal & pharyngeal nephridia of earthworm. Unstained mounts of Placoid, cycloid and ctenoid scales.

TEXT BOOKS

1. Kotpal RL. (2016) Modern Textbook of Zoology –Vertebrates; Rastogi Publications – Meerut.
2. Kotpal RL.(2016) Modern Textbook of Zoology –Invertebrates; Rastogi Publications – Meerut.

SUGGESTED READINGS

1. Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.
2. Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.
3. Raven, P.H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications, New Delhi.
4. Kardong, K.V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.

+3 FIRST YEAR FIRST SEMESTER

GE - 2

FOOD, NUTRITION AND HEALTH

Time : **3** Hrs. End Semester Theory : **60** Marks
Credit : **04** Mid Semester Theory : **15** Marks

Course Outcomes:

This course will cover basic concepts on food and nutrition along with Health and hygine.

Unit 1:

Basic concept of food and nutrition

Food Components and food-nutrients, Concept of a balanced diet, nutrient needs and dietary pattern for various groups, adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

Unit 2:

Nutritional Biochemistry:

Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role Vitamins-Fat-soluble and Water-soluble vitamins- their dietary source and importance Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions

Unit 3 :

Health

Introduction to health- Definition and concept of health, Major nutritional Deficiency diseases-Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any. Life style related diseases- hypertension, diabetes mellitus, and obesity- their causes and prevention through dietary and lifestyle modifications, Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention, Common ailments- cold, cough, and fevers, their causes and treatment

Unit 4: Food hygiene:

Potable water- sources and methods of purification at domestic level Food and Water borne infections:

Bacterial infection: Cholera, typhoid fever, dysentery;

Viral infection: Hepatitis, Poliomyelitis,

Protozoan infection: amoebiasis, giardiasis;

Parasitic infection: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and preventionBrief account of food spoilage: Causes of food spoilage and their preventive measures

PRACTICAL

Credit : **02** **25** Marks

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric
3. Estimation of Lactose in milk
4. Ascorbic acid estimation in food by titrimetry
5. Estimation of Calcium in foods by titrimetry
6. Study of the stored grain pests from slides/ photograph (Sitophilus oryzae, Trogodermagranarium, Callosobruchuschinensisand Triboliumcastaneum): their identification, habitat and food sources, damage caused andcontrol. Preparation of temporary mounts of the above stored grain pests.
7. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups. OR Identify nutrient rich sources of foods **(fruits and vegetables),** their seasonal availability and price OR Study of nutrition labeling on selected foods

TEXT BOOKS

1. Mudambi, SR and Rajagopal, MV (2018). Fundamentals of Foods, Nutrition and Diet Therapy; Sixth Ed; New Age International Publishers.
2. Bamji MS, Rao NP, and Reddy V.(2017) Text Book of Human Nutrition; Oxford & IBH Publishing Co. Pvt Ltd., 4th edition

SUGGESTED READINGS

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