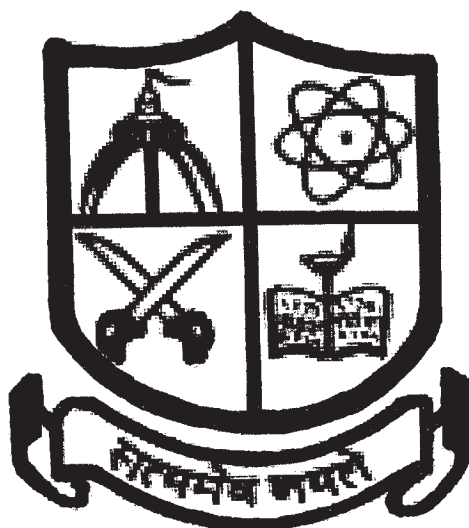


# COURSES OF STUDIES SCIENCE STREAM

## Admission Batch - 2017



**Buxi Jagabandhu Bidyadhar (Autonomous) College**

**Bhubaneswar - 751014**

Accredited at the 'A' Level by

National Assessment and Accreditation Council (NAAC)

College with Potential for Excellence (UGC)

Telephone/Fax : 0674-2436971, Website : [www.bjbcollege.ac.in](http://www.bjbcollege.ac.in)

**Pattern of question papers for  
students under CBCS in the Semester-End  
Examination from the admission batch  
2016 onwards.**

1. In the semester-end examination there will be two groups of questions. Group A will be compulsory comprising 10 short answer type questions covering all units. Group B will comprise long answer type questions covering all units with unit-wise alternatives to each question.
2. For practical subjects, out of 50 marks in semester-end exam, Group A will have 10 marks (1x10) and Group B will have 40 marks (8x5). Alternative questions will be set unit-wise for long answer type questions in Group B.
3. For non-practical subjects, out of 80 marks, Group A will have 20 marks (2x10) and Group B will have 60 marks (12x5). Alternative questions will be set unit-wise for long answer type questions in Group B.



## General Instructions

### CBCS SYLLABUS

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

<b>Courses</b>	<b>Credits</b>	<b>Credits</b>
	<b>Theory + Practical</b>	<b>Theory + Tutorial</b>
I. Core Course (14 Papers)	14 x 4 = 56	14 x 5 = 70
Core Course Practical/Tutorial (14 Papers)	14 x 2 = 28	14 x 1 = 14
II. Elective Course		
A.1 Discipline Specific Elective (3 Papers)	3 x 4 = 12	3 x 5 = 15
A.2 Discipline Specific Elective Practical/Tutorial (3 Papers)	3 x 2 = 6	3 x 1 = 3
A.3. Discipline Specific Elective Project (Report and Presentation) (1 Papers)	6	6
III. Generic Elective/Interdisciplinary 2 papers/2 subjects (GE-1 & GE-2 in 1 <sup>st</sup> year) and Generic Elective (GE-3 & GE4 in 2 <sup>nd</sup> year) Practical/Tutorial (4 Papers each from GE - 1, GE - 2, GE - 3, GE - 4)	4 x 4 = 16	4 x 5 = 20
	4 x 2 = 8	4 x 1 = 4
IV. Ability Enhancement Compulsory Course(AECC) (2 Papers of 2 Credit each)	4 x 2 = 8	4 x 2 = 8
(i) Environmental Studies		
(ii) Odia/Hindi/Communicative English		
V. SEC (Skill Enhancement Course) (2 Papers of 2 Credit each) Refer to 18.4,18.5,18.6.	4 x 2 = 8	4 x 2 = 8
<b>Total Credit</b>	<b>148</b>	<b>148</b>

**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 1<sup>st</sup> year (1<sup>st</sup> and 2<sup>nd</sup> Semester) to enhance their credit points.**

- 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
Skill Enhancement Course	2x100=200

Total Mark = 2600, Total number of Papers = 26

Subjects with Practical: Theory-70 Marks, Practical-30 Marks

Mid Semester Theory-20 Marks, End Semester Theory-50 Marks

There is no Practical Exam. in Mid Semester.

Subjects without Practical : 100 Marks

Mid Semester-20 Marks, End Semester-80 Marks

(In Indian Music Theory – 40+10 , Practical – 50 Marks)

SEMESTER	COURSE	COURSE NAME	Credits
<b>I.</b> 4 Papers  (400 Marks)  22 credits	Ability Enhancement Compulsory Course-I	Environmental Studies	4
	Core course-I		4/5
	Core Course-I Practical/Tutorial		2/1
	Core course-II		4/5
	Core Course-II Practical/Tutorial		2/1
	Generic Elective -1	GE-1	4/5
	Generic Elective -1 Practical/Tutorial		2/1
<b>II.</b> 4 Papers  (400 Marks)  22 credits	Ability Enhancement Compulsory Course-II	Communicative English/Odia/Hindi	4
	Core course-III		4/5
	Core Course-III Practical/Tutorial		2/1
	Core course-IV		4/5
	Core Course-IV Practical/Tutorial		2/1
	Generic Elective -2	GE-2	4/5
	Generic Elective -2 Practical/Tutorial		2/1
<b>III.</b> 5 Papers  (500 Marks)  28 credits	Core course-V		4/5
	Core Course-V Practical/Tutorial		2/1
	Core course-VI		4/5
	Core Course-VI Practical/Tutorial		2/1
	Core course-VII		4/5
	Core Course-VII Practical/Tutorial		2/1
	Skill Enhancement Course -1	SEC-1	4
	Generic Elective -3	GE-3	4/5
<b>IV.</b> 5 Papers  (500 Marks)  28 credits	Generic Elective -3 Practical/Tutorial		2/1
	Core course-VIII		4/5
	Core Course-VIII Practical/Tutorial		2/1
	Core course-IX		4/5
	Core Course-IX Practical/Tutorial		2/1
	Core course-X		4/5
	Core Course-X Practical/Tutorial		2/1
	Skill Enhancement Course -2	SEC -2	4
<b>V.</b> 4 Papers  (400 Marks)  24 credits	Generic Elective -4	GE-4	4/5
	Generic Elective -4 Practical/Tutorial		2/1
	Core course-XI		4/5
	Core Course-XI Practical/Tutorial		2/1
	Core course-XII		4/5
	Core Course-XII Practical/Tutorial		2/1
	Discipline Specific Elective -1	DSE-1	4/5
<b>VI.</b> 4 Papers  (400 Marks)  24 credits	Discipline Specific Elective -1 Practical/Tutorial	DSE-1 Practical/Tutorial	2/1
	Discipline Specific Elective -2	DSE-2	4/5
	Discipline Specific Elective- 2 Practical/Tutorial	DSE-2 Practical/Tutorial	2/1
	Core course-XIII		4/5
	Core Course-XIII Practical/Tutorial		2/1
	Core course-XIV		4/5
	Core Course-XIV Practical/Tutorial		2/1
24 credits	Discipline Specific Elective3	DSE-3	4/5
	Discipline Specific Elective -3 Practical/Tutorial	DSE-3 Practical/Tutorial	2/1
	Discipline Specific Elective-4	DSE-4 (Project Work)	6
<b>Total Credits</b>			<b>148</b>

**Draft Model Regulation for Under Graduate Programme  
(BA/B.Com/B.Sc) under Utkal University,  
(Applicable to Autonomous Colleges/ Affiliated Colleges/DDCE)  
(with suitable modification)**

- **Compulsory Registration for 1st Semester :**
  - Registration for 1<sup>st</sup> semester is compulsory. A candidate admitted to +3 Course but not registered for 1<sup>st</sup> semester examination, his/her admission will be automatically cancelled .
  - A candidate may take a blank Semester : A blank Semester has to be clubbed with next Odd or Even Semester as the case may be i.e. 2<sup>nd</sup> , 4<sup>th</sup> and 6<sup>th</sup> / 1<sup>st</sup>, 3<sup>rd</sup> and 5<sup>th</sup> . The Hostel policy for blank semester is to be decided by colleges as per their suitability. Hostel accommodation cannot be claimed as a right for a blank semester. (Blank semester is not to be confused as repetition due to failure).

- **GRADING SYSTEM**

Grade		Mark Secured from 100	Points
Outstanding	'O'	90-100	10
Excellent	'A+'	80-89	9
Very Good	'A'	70-79	8
Good	'B+'	60-69	7
Above average	'B'	50-59	6
Fair	'C'	45-49	5
Pass	'D'	33-44	4
Failed	'F'	Below 33	0

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

- A transitory letter grade I ( carrying points 2) shall be introduced for cases where the results are incomplete. However in practical subjects, a student has to secure minimum of 33% marks (Grade-D separately in theory and practical in order to clear the paper. This grade shall automatically be converted into appropriate grade(s) as and when the results are complete.
- 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** -  $\sum \text{CREDIT POINT}$  of course items in each semester.

**GRADE POINT AVERAGE** -  $\frac{\text{CREDIT INDEX}}{\sum \text{CREDIT}}$

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

**CUMULATIVE GRADE POINT AVERAGE(CGPA) =**

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

- 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 1<sup>st</sup> appearance
  - In addition to the points marks/percentage would also be awarded and shall also be reflected in the Mark Sheet.
  - The details of grading system shall be printed on the backside of University Mark-sheet.
  - **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.
    - A student after passing out may appear in improvement in any number of papers in the consecutive two examinations. The higher marks shall be retained.
    - Improvement has to be completed within 6 years from the date of admission.
- Arts, Science and Commerce students can also opt for NCC as additional Generic Elective in the 1<sup>st</sup> year ( 1<sup>st</sup> and 2<sup>nd</sup> Semester) to enhance their credit points.**
- **In Commerce stream each student shall offer :**
    - (a) For Commerce stream the students have to opt for Accountancy as the core subject.
    - (b) There will be two AECC compulsory papers (100-marks each) in 1<sup>st</sup> and 2<sup>nd</sup> Semesters. Commerce students shall have to opt for EVS in 1<sup>st</sup> Semester and Communicative English/ in 2<sup>nd</sup> Semester.
    - (c) There will be four Generic Elective papers with 100 marks each. Students will opt for Micro economics in GE-1 and Macro Economics for GE-2 papers in 1<sup>st</sup> and 2<sup>nd</sup> Semesters respectively and Business Statistics in GE-3 and Indian Economy: Performance and Policies in GE-4 in 3<sup>rd</sup> and 4<sup>th</sup> Semesters respectively.
    - (d) There will be one SEC course comprising of two papers (100 marks each) in for which "E.Commerce" has been chosen to be taught.
    - (e) There are four DSE papers (100 marks each) two in 5<sup>th</sup> Semesters and two in 6<sup>th</sup> Semesters to be chosen from syllabus related to core subjects. The fourth DSE paper is a project work to be submitted by the student.

* 1 <sup>st</sup> and 2 <sup>nd</sup> Semester		3 <sup>rd</sup> and 4 <sup>th</sup> Semester	SEC
Core	Generic Elective 1,2	Generic Elective 3,4	ICT
Physics	Chemistry	Mathematics	ICT
Chemistry	Physics	Mathematics	ICT
Mathematics	Physics	Chemistry	ICT
Computer Science	Mathematics	Physics	ICT
Statistics	Mathematics	Physics	ICT
Bio-Technology	Chemistry	Mathematics	ICT
Botany	Zoology	Chemistry	Horticulture
Zoology	Botany	Chemistry	Horticulture
1. University/Institute can add/delete some experiments of similar nature in the Laboratory Papers.			

2. The size of the practical group for practical papers is recommended to be 12-15 students.
3. College can add up to 20 additional credits if required. For Example if a certificate course in Vocational Subjects is to be taken, 18 credits can be added.

<b>CBCS Syllabus (Science Stream)</b>							
<b>SEMESTER -I</b>			<b>SEMESTER -II</b>				
AECC-1	EVS	:	100 (80 + 20)	Aecc-2	Odia	:	100 (80 + 20)
Core - 1	(Theory)	:	70 (50 + 20)		Hindi		
	(Lab)	:	30		Communicative English		
Core - 2	(Theory)	:	70 (50 + 20)	Core - 3	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
Ge - 1	(Theory)	:	70 (50 + 20)	Core - 4	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
				Ge - 2	(Theory)	:	70 (50 + 20)
					(Lab)	:	30
<b>SEMESTER -III</b>			<b>SEMESTER -IV</b>				
SEC -1	ICT / Horticulture	:	100(80 + 20)	SEC -2	ICT / Horticulture	:	100 (80 + 20)
Core - 5	(Theory)	:	70 (50 + 20)	Core - 8	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
Core - 6	(Theory)	:	70 (50 + 20)	Core - 9	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
Core - 7	(Theory)	:	70 (50 + 20)	Core -10	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
GE - 3	(Theory)	:	70 (50 + 20)	GE - 4	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
<b>SEMESTER -V</b>			<b>SEMESTER -VI</b>				
Core-11	(Theory)	:	70 (50 + 20)	Core-13	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
Core-12	(Theory)	:	70 (50 + 20)	Core-14	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
DSE -1	(Theory)	:	70 (50 + 20)	DSE -3	(Theory)	:	70 (50 + 20)
	(Lab)	:	30		(Lab)	:	30
DSE -2	(Theory)	:	70 (50 + 20)	DSE -4	(Project)	:	100
	(Lab)	:	30				
Parentheses in the tables indicate marks for Semester End and Mid Semester Examinations evaluation							

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05.	Computer Science	-	100
06.	Mathematics	-	116
07.	Physics	-	136
08.	Statistics	-	172
09.	Zoology	-	186



## **+3 FIRST YEAR FIRST SEMESTER AECC - I (ENVIRONMENTAL STUDIES)**

Time : **3 Hours**

Full Mark : **100 Marks**

Credit : **4**

End Semester : **80 Marks**

Mid Semester : **20 Marks**

Ability Enhancement Compulsory Course (AECC-I)

### **Unit 1 : Ecosystems (Botany)** ( to be taught by Department of Botany)

**Ecosystem** : Structure and function of ecosystem, Energy flow in an ecosystem : Food Chain, Food webs,

Ecological Pyramid.

**Ecological Succession** : Hydrosere, Xerosere

Forest Ecosystem, Grassland Ecosystem, Aquatic ecosystem (Pond)

Biogeochemical cycles (Carbon cycle and Nitrogen cycle)

### **Unit 2 : Natural Resources :**

Renewable and Non-renewable Resources (Geography) (to be taught by Geography Departments)

- Land Resources & Landuse change ; - Land degradation, Soil erosion and desertification. .
- Deforestation : Causes and impacts due to mining , dam building on environment, forests , biodiversity & tribal populations.
- Water - Use and over exploitation of surface and ground water, floods, droughts, conflicts over water (International & Inter-state).
- Energy resources : Renewable and Non-renewable energy sources, use of alternate energy sources, growing energy needs, Case studies.

### **Unit 3 : Biodiversity and Conservation (Zoology)** (to be taught by Department of Zoology)

- Levels of biological diversity : genetic, species and ecosystem diversity, bio-diversity patterns and global biodiversity hot spots.
- India as a mega-biodiversity nation ; Endangered and endemic species of India.
- Threats to biodiversity : Habitat loss, poaching of wildlife , man-wildlife conflicts, biological invasions ; Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
- Ecosystem and biodiversity services : Ecological, economic, social , ethical, aesthetic and informational value.

### **Unit 4 : Environmental Pollution (Chemistry)** ( to be taught by Department of Chemistry)

- Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution.
- Nuclear hazards and human health risks.
- Solid waste, management: Control measures of urban and industrial waste.
- Pollution case studies.
- Climate change , global warming, ozone layer depletion, acid rain and impacts on human communities and agriculture.

### **Unit 5 : EVS** (to be taught by Economics Department)

- Economic Development and Environment.
  - Sustainable Development.
  - Human population Growth : Impact on Environment, Human health and welfare.
  - Resettlement and Rehabilitation of project affected people.
  - Disaster management : Floods , Earthquakes, cyclones and landslides .
  - Environmental managements : Chipko, Silent valley, Bishnois of Rajasthan.
-

**+3 FIRST YEAR  
FIRST SEMESTER  
AECC - I [COMMUNICATIVE ODIA]**

Time : **3 Hours**  
Full Mark : **100 Marks**  
Credit : **04**

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

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୧ମ ଏକକ	:	ପ୍ରବନ୍ଧ ଚୟନ ( ୨ୟ ଭାଗ) - ଉତ୍କଳ ବିଶ୍ୱବିଦ୍ୟାଳୟ ପ୍ରକାଶନ ୧) ବିଦ୍ୟା ଓ ବିଦ୍ୟାର୍ଥୀ - ଚିତ୍ତରଞ୍ଜନ ଦାସ ୨) ସଭ୍ୟତା - ନିତ୍ୟାନନ୍ଦ ମହାପାତ୍ର	-	୨୦
୨ୟ ଏକକ	:	କବିତା ଚୟନ ( ୨ୟ ଭାଗ) - ଉତ୍କଳ ବିଶ୍ୱବିଦ୍ୟାଳୟ ପ୍ରକାଶନ ୧) ଶ୍ରୀକୃଷ୍ଣଙ୍କ ମହାପ୍ରୟାଗ - ଜଗନ୍ନାଥ ଦାସ ୨) ଆକାଶ ପ୍ରତି - ମଧୁସୂଦନ ରାଓ	-	୨୦
୩ୟ ଏକକ	:	ସମସ୍ୟାଧର୍ମୀ ସମ୍ବାଦ ପ୍ରସ୍ତୁତି	-	୧୪
୪ର୍ଥ ଏକକ	:	ବିଜ୍ଞାପନ ପ୍ରସ୍ତୁତି	-	୧୨
୫ମ ଏକକ	:	ପତ୍ରଲିଖନ	-	୧୪

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## +3 FIRST YEAR FIRST SEMESTER AECC - I [COMMUNICATIVE HINDI]

Time : 3 Hrs.  
Full Mark : 100  
Credit : 4

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

**UNIT-I : कविता**

- (1) कबीर - साखी : 1 से 10
- (2) तुलसी - विनयपत्रिका - पद 1 और 2
- (3) प्रसाद - मधुमय देश
- (4) निराला - भिक्षुक
- (5) अज्ञेय - हिरोशिमा

**UNIT-II : गद्य**

- (1) रामचन्द्र शुक्ल - उत्साह
- (2) हजारी प्रसाद द्विवेदी - कुटज
- (3) हरिशंकर परसाई - सदाचार का तावीज

**UNIT-III : शब्द ज्ञान**

- (1) शब्द शुद्धि
- (2) वाक्य शुद्धि
- (3) पर्यायवाची शब्द
- (4) विलोम शब्द

**UNIT-IV : हिन्दी : विविध रूप**

- (1) व्यावहारिक हिन्दी भाषा (बोलचाल की हिन्दी)
- (2) राजभाषा हिन्दी (कार्यालयी हिन्दी)
- (3) श्रव्य - दृश्य माध्यम की भाषा (फिल्म और टेलीविजन की हिन्दी)

**UNIT-V : सामान्य ज्ञान**

- (1) निबंध लेखन (Essay Writing)

**अंक विभाजन :**

विभाग -	(क)	युनिट III से दश वस्तुनिष्ठ प्रश्न पूछे जाएँगे	10 x 2 = 20
विभाग-	(ख)	(i) युनिट 1 से 02 तथा युनिट II से 2 व्याख्या पूछी जाएँगी 1+1=02 का उत्तर लिखना होगा	12 x 2 = 24
		(ii) युनिट I, II, IV और V से 06 प्रश्न पूछे जाएँगे जिनमें 3 का उत्तर लिखना होगा	12 x 3 = 36
			End Semester 80
			Internal 20
			Total 100

**पाठ्य पुस्तक :** 1. हिन्दी प्रसून - सं. डॉ अंजुमन आरा, प्लानेट भी, कटक

**सहायक ग्रन्थ :** 1. जनसंचार और हिन्दी - गुलाम मोइनुद्दीन खान, शवनम, कटक

**+ 3 FIRST YEAR SECOND SEMESTER**  
**AECC - 2**  
**ENGLISH COMMUNICATION (Science)**

**Time: 3 Hours**

**Credits : 4**

**End Semester : 80 Marks**

**Mid Semester : 20 Marks**

The purpose of this course is twofold: to train students in communication skills and to help develop in them a facility for communicative English.

Since language is which binds society together and serves as a crucial medium of interaction as well as interchange of ideas and thoughts, it is important that students develop a capacity for clear and effective communication, spoken and written, at a relatively young age. The need has become even more urgent in an era of globalization and the increasing social and cultural diversity that comes with it.

English, being a global language par excellence, it is important that any course in communication is tied to an English proficiency programme. The present course will seek to create academic and social English competencies in speaking, listening, arguing, enunciation, reading, writing and interpreting, grammar and usage, vocabulary, syntax, and rhetorical patterns.

Students, at the end of the course, should be able to unlock the communicator in them by using English appropriately and with confidence for further studies or in professional spheres where English is the indispensable tool of communication.

**Unit 1**

**[20]**

**Introduction**

1. What is communication?
2. Types of communication
  - Horizontal
  - Vertical
  - Interpersonal
  - Grapevine
3. Uses of Communication

**Prescribed Reading:** Chapter 1 *Applying Communication Theory for Professional Life: A Practical Introduction* by Dainton and Zelle

<http://tsime.uz.ac.zw/claroline/backends/download.Dhp?url=LOIudHJvX3RvX2NvbW HbmlYXRpb25fVGhlb3J5LnBkZa%3D%3D&cidReset=true&cidReq=MBA563>

**Unit 2**

**[20]**

**Language of Communication**

1. Verbal: spoken and written
2. Non-verbal
  - Proxemics
  - Kinesics
  - Haptics
  - Chronemics
  - Paralinguistics
3. Barriers to communication

#### 4. Communicative English

### Unit 3

**[20]**

#### Reading Comprehension

- Locate and remember the most important points in the reading
- Interpret and evaluate events, ideas, and information
- Read “between the lines” to understand underlying meanings
- Connect information to what they already know

#### Texts to be studied

(The following texts are available in the book *Vistas and Visions: An Anthology of Prose and Poetry*)

#### Prose

- The Gold Frame
- Lifestyle English
- Need for Excellence

#### Poetry

- The Felling of the Banyan Tree
- Another Woman
- Meeting Poets

### Unit 4

**[20]**

#### Writing

- Expanding an Idea
- Note Making
- Information Transfer
- Writing a Memo
- Writing Formal Email
- Writing a Business Letter
- Letters to the Editor
- CV & Resume Writing
- Covering Letter
- Report Writing
- News Story

### Unit 5

**[20]**

#### (a) Language functions in listening and conversation

- Discussion on a given topic in pairs
- Speaking on a given topic individually
- Group Discussion
- Interview
- Dialogue

#### (b) Grammar and Usage

- Phrasal Verbs
  - Collocation
  - Using Modals
  - Use of Prepositions
-

- Use of Passive Forms
- Subject-Verb Agreement.
- Common Errors in English Usage

Sample writing and grammar activities are available in ***Vistas and Visions: An Anthology of Prose and Poetry..***

### Books Recommended:

1. *Vistas and Visions: An Anthology of Prose and Poetry.* (Ed.) Kalyani Samantray, Himansu S. Mohapatra, Jatindra K. Nayak, Gopa Ranjan Mishra, Arun Kumar Mohanty. Orient BlackSwan
2. *Fluency in English - Part II*, OUP, 2006
3. *Business English*, Pearson, 2008
4. *Communicative English.* E. Suresh Kumar and P. Sreehari
5. *Language, Literature and Creativity*, Orient BlackSwan, 2013
6. *Language through Literature*, (forthcoming) ed. Gauri Mishra, Dr. Ranajan Kaul, Dr. Brati Biswas

### Examination pattern Midterm test

Unit 1 One long question with choice	01 qn x 12 = 12 marks
Two short notes with choice	02 qns x 04 = 08 marks
<b>Total</b>	<b>20 marks</b>

### Final Semester Examination

Unit 2 One long question with choice	01 qn x 10 = 10 marks
Two short notes with choice	02 qns x 05 = 10 marks
Unit 3 Four Reading Comprehension questions	04 qns x 05 = 20 marks
(2 prose and 2 poetry questions meant to test the given reading skills prescribed under unit 3; <b>extracts from the prescribed texts to be used</b> )	
Unit 4 Writing: Two Long questions with choice	02 qns x 10 = 20 marks
Unit 5 (a) Listening & Conversation	01 qn x 10 = 10 marks
(b) Grammar & Usage	01 qn x 10 = 10 marks

**(Grammar question must be set in contexts; not as isolated sentences.)**

**Total = 80 marks**

**+3 FIRST YEAR FIRST SEMESTER  
GENERIC ELECTIVE - I  
NCC**

Time : **3 Hours**

Full Mark : **70**

Credit : **6**

**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.

**Unit-5**

- (a) Structure & functioning of the Human Body, Hygiene & Sanitation.
- (b) Preventable diseases, First Aid in Common Medical Emergencies.

**PRACTICAL-1**

Mark - **30**

- |    |                  |   |    |
|----|------------------|---|----|
| 1. | Foot-Drill       | - | 20 |
| 2. | Health & Hygiene | - | 10 |

**+3 FIRST YEAR SECOND SEMESTER  
GENERIC ELECTIVE - II  
NCC**

Time : **3 Hours**  
Full Mark : **70**  
Credit : **6**

End Semester : **50 Marks**,  
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) Scout and Patroe
- 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

**Unit-5**

- a) Weapon training
- b) Adventure activities

**PRACTICAL-2**

Mark - **30**

- |    |                  |   |    |
|----|------------------|---|----|
| 1. | Map Reading      | - | 20 |
| 2. | Judging Distance | - | 10 |



**+ 3 SECOND YEAR THIRD SEMESTER**  
**SEC- 1**  
**HORTICULTURE**

**Time: 3 Hours**  
**Credit: 4**

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

**INTRODUCTION :**

Horticulture is the mainstream of agriculture. It is an applied science dealing with fruits, vegetables and ornamental flowers. It is an extremely diversified field with nearly unlimited career opportunities in a variety of job settings. A large number of jobs require knowledge and training in horticulture.

**OBJECTIVES:**

- To know about concept and division of Horticulture
- To have understanding on plantation of crops, spices, Medicinal and Aromatics crops
- To study details of cultivation aspects of different divisions of horticulture

**Expected outcome:**

- The students can have a good foundation on horticulture which will help them to be employed in different department of Agriculture
- They can be self-employed and can have their own entrepreneurship

**UNIT-I : Horticulture:**

Meaning & definition and division of Horticulture

**UNIT-II : Plantation crops, spices, medicinal and aromatic crops**

- Importance of plantation crops, spices, medicinal and aromatic crops grown in India as well as in Odisha
- Scope of plantation crops, classification of spices, medicinal and aromatic plants

**UNIT-III : Details of cultivation aspects Plantation crops: (With reference to origin, climate, soil, varieties, land preparation and propagation and transplantation)**

Coconut, Cashewnut and Arecanut

**Spices: (With reference to origin, climate, soil, varieties, land preparation and propagation and transplantation)**

Blackpeper, Coriander, Cinnamon and Cardamom

**UNIT-IV : Medicinal Plants: (With reference to origin, climate, soil, varieties, land preparation and propagation and transplantation)**

Aloevera, Brahmi, Aswagandha, Aromatic, Lemongrass and Pamarosa

**UNIT- V : Aftercare of Plantation of variety of crops:**

Interculture, Nutrient management, Irrigation, Moisture conservation, Integrated pest and disease management, Intercropping, Harvest and post-harvest care, Storage and processing and Value addition and byproduct utilization

**+ 3 SECOND YEAR FOURTH SEMESTER**  
**SEC- 2**  
**HORTICULTURE**

**Time: 3 Hours**  
**Credit: 4**

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

**OBJECTIVES:**

- To have understanding on different fruits and vegetables cultivated in india
- To study the management and preparation of soil with reference to nutrient management
- To have knowledge on integrated pest and disease control

**UNIT-I : Fruit cultivation in India with special reference to Odisha Cultivation aspects - Major fruit crops:**

**(With reference to climate, soil, land preparation, propagation & transplantation, inter-culture and nutrient management)**

Mango, Banana, Citrus fruits, Guava, Sapota, Litchi, Papaya, Pine apple, Amla, Jack fruit

**UNIT-II** Introduction, role of vegetables in human nutrition, importance of vegetable cultivation, Present status and future prospects of vegetable cultivation in India as well as in Odisha, Classification of vegetable gardens and Off season vegetable cultivation.

**Unit III : Detail of vegetable cultivation of different vegetable**

**(With reference to climate, soil, land preparation, propagation & transplantation, inter-culture and nutrient management)**

Potato, Brinjal, Tamato, Cabbage, Curly flower, Beans and Different gourds

**Unit IV : Detail of Spice cultivation**

**(With reference to climate, soil, land preparation, propagation & transplantation, inter-culture and nutrient management)**

Chilly, Onion, Garlic, Turmeric and Ginger

**Unit-V : Integrated pest and disease control and management**

Irrigation, Harvest & post-harvest management and Assimilating marketing information jdyingMifferent problems of plantation



**+3 SECOND YEAR THIRD SEMESTER**  
**SEC - 1**  
**INFORMATION & COMMUNICATION TECHNOLOGY**

**Time : 3 Hrs.**  
**Credit : 4**

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

**INTRODUCTION:**

Graduate students in the Information and Communications Technology program will develop in-depth specialized skills and can have work a future career growth in IT sector.

**OBJECTIVES:**

- Students can learn the fundamentals of computer for digital literacy.
- Students can have knowledge on Internet, browsing web pages and navigate websites.
- Students can learn the use of different search engines and media devices.

**EXPECTED OUTCOMES:**

Students can have better opportunities in the services like Data entry operators, System Analysts, Web Designers and Computer programmers, Students can understand the use of ICT in Classrooms, Offices and Managements.

**UNIT.I Digital Literacy:**

Understand the fundamentals of computing, Identify the components of a computer, Identify the steps for starting & shutting down a computer, Use a mouse & keyboard, Understanding the Operating System and features, Manage files & folders and Perform basic file operations

**UNIT-II Connect to the Internet**

Browse web pages, Navigate websites, Creating and using email, Use search engines

**UNIT-III**

Design, create and modify a range of business documents, Displaying Different Views of a Document, Creating and Saving a Document, Selecting, Modifying, Finding and Replace Text, Align Text Using Tabs, Display Text as List Items, Apply Borders and Shading, Preview a document, and adjust its margins and orientation, Insert & Format a Table, Convert Text to a Table, Check Spelling and Grammar, Use the Thesaurus, Print with default or custom settings.

**UNIT-IV Identify elements of the user interface, view a presentation,**

Save a presentation, use Microsoft PowerPoint help, Creating a Basic Presentation, Select a presentation type, enter text, edit text, format text placeholders, add slides to a presentation, arrange slides, work with themes, Formatting text on slides, apply character styles, format paragraphs, Adding Graphical Objects to a presentation, Insert images into a presentation, add shapes, Adding visual style to text in a presentation

**UNIT-V E-Mail Messaging:**

Getting Started with Messaging, identify the user interface, identify the outlook ribbon, identify the tabs and commands in the message form, using help, Creating an email message, formatting, check spelling and grammar, attach a file, enhance an email, Sending and receiving email messages, read, reply to and forward, delete and print an email message, Organizing Email Messages, move email messages into folders, open and save an attachment, Managing contacts, add a contact, sorting and finding contacts, find the geographical location of a contact, update contacts

**+3 SECOND YEAR FOURTH SEMESTER**  
**SEC - 2**  
**INFORMATION & COMMUNICATION TECHNOLOGY**

**Time : 3 Hrs.**  
**Credit : 4**

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

**UNIT-I: DIGITAL LITERACY**

Exploring OS Accessibility features, Going Wireless and setting up devices Networking Fundamentals, Use instant messaging, perform online transactions, Understand security settings, Identify best practices for securing online and network transactions, Identify measures to protect privacy, Create& publish web pages

**UNIT-II Computer Networks:**

Network Infrastructure - Internet, intranet, and extranet, Understand the OSI model, TCP/IP, Local area networks (LANs), Wide area networks (WANs) Network topologies and access methods, Network Hardware – Switches, Routers, media types, Protocols and Services, Understand IPv4 & IPv6, Addressing names resolution & networking services.

**UNIT-III Web Design:**

Basics of web page design using HTML - Create and view the web pages in browser,HTML Basic tags, Image tags, Frames, Forms, JavaScript and VBScript, Microsoft Expression Web, Web Site Design Scripting Tools,

Hypertext, Authoring tools, E- Commerce

**UNIT-IV Word Processing:**

Templates for Document Creation, Use the Mail Merge Feature including Envelopes and Labels, Creating Macros and Automating Tasks

**UNIT-V Excel Worksheets:**

Linking Word Documents to Data in an Excel Worksheet, Send a Document Outline to Microsoft Office PowerPoint, Save and Share a Document for Review, understanding Track Changes and Comments, Comparing and Merging Document Changes



# BIOTECHNOLOGY

## + 3 FIRST YEAR FIRST SEMESTER

### CORE COURSE -I (C-1)

### CYTOLOGY AND CELL BIOLOGY

Time: 3 Hours

Credit: 6

End Semester Theory : 50 Marks

Mid Semester : 20 Marks

#### UNIT - I

**The Cell:** Historical background of cell. Cell Theory, Prokaryotic and Eukaryotic cell organization. Structure of eukaryotic cell. Structure and function of cell wall and cell membrane. Models of membrane organization. Cytoskeleton system: Role and structure of Microtubules, Microfilaments and intermediate filaments.

#### UNIT - II

**Components of Cell:** Origin, structure and functions of Mitochondria and Chloroplast. Structure and function of Endoplasmic reticulum, Golgi bodies, Ribosome, Lysosome, Peroxisome and Vacuole.

#### UNIT - III

**Structure and function of Nucleus:** Nuclear envelope, Nuclear pore complex, Molecular organization of chromatin, Nucleolus.

#### UNIT - IV

**Chromosome:** Chromosome structure, Euchromatin, Heterochromatin. Organization of chromatin fibres (Nucleosome concept). Karyotype, Giant chromosome, Lamp brush and Polytene chromosome.

#### UNIT - V

**Cell Division (Plant and Animal) :** Chromosomal events during different stages of Mitosis and Meiosis. Role of spindle in chromosomal movement. Genetic recombination during meiosis. Cytokinesis- Distribution of cytoplasmic components. Cell cycle, regulation of cell cycle.

#### PRACTICAL- C-I

Time : 3 hours

Full Mark -30 Marks

1. Study of mitosis in onion root tip cells by squashing technique.
2. Study of meiosis in onion anther by squashing technique/insect gonad.
3. Study of meiosis in the testis of grasshopper/sand-hopper by squashing technique.
4. Karyotypic study of chromosome
5. Detection of barr bodies in buccal mucosal epithelial cells.
6. Study of plasmolysis and deplasmolysis
7. Effect of temperature and organic solvents on semi permeable membrane.
8. Study of Prokaryotic and Eukaryotic cell structure.

#### Suggested Books

1. The Cell- A. Molecular Approach- G.M. Cooper, R.E. Housman.
  2. Cell and Molecular Biology -E.D.P. DeRobertis and E.M. F. DeRobertis.
  3. Cell Biology- G. Karp. John Wiley & Sons (USA).
  4. Cell Biology - S.C. Rastogi
-

**+ 3 FIRST YEAR FIRST SEMESTER  
CORE COURSE -II (C-2) - BIOTECHNOLOGY  
BIOMOLECULES**

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

**UNIT-I**

**Molecular Interactions:** Introduction To Biomolecules, Molecular Interactions As A Basis Of Biological Function - Covalent and Non-Covalent interactions, Hydrogen bonds, Electrostatic interactions, Van der Waall forces and their significance. Structure and properties of water and its biological significance.

**UNIT-II**

**Solutions, pH and Buffers :** Standard solutions - Normal, Molar, Molal solutions. Ionic strength, Ionization of water, weak acids and weak bases. pH and its biological significance, pH scale, pKa, Buffers, Henderson and Hasselbalch equation, biological buffers and its significance.

**UNIT-III**

**Carbohydrates:** Nomenclature and classification of carbohydrates. Structure and function of: Monosachharides- glucose and fructose Disachharides- sucrose and lactose Polysaccharides Cellulose and starch. Elementary idea of Artificial Sweeteners.

**UNIT-IV**

**Lipids:** General classification and function of lipids. Structure and function of Triglycerides, Phospholipids, Glycolipids, Prostaglandins and Cholesterol. Biosynthesis and Beta oxidation of Fatty acids.

**UNIT-V**

**Amino Acid and Proteins:** General structure properties and classification of amino acids. Peptide bonds. Primary secondary, tertiary and quaternary Structure of proteins. Denaturation and functions of proteins.

**PRACTICAL- C-II**

Time : 3 hours

Full Mark -30 Marks

1. Preparation of normal, molar & molal solutions.
2. Qualitative test for sugar.
  - a. Molisch's Test
  - b. Iodine Test
  - c. Fehling's Test
  - d. Bendeict's Test
  - e. Test for non reducing sugars such as sucrose.
3. Qualitative test for lipids.
4. Estimation of free Fatty Acids.
5. Qualitative test for proteins.
  - a. Biuret Reaction.
  - b. Ninhydrin Test.
  - c. Xanthoproteic reaction
6. Estimation of Blood sugar

**Suggested Books**

1. Lehninger Principles of Biochemistry- D.L. Nelson & M.M. Cox.
2. Fundamentals of Biochemistry- Donald Voet, J.G. Voet and C. W. Pratt.
3. Outlines of Biochemistry- Eric E. Conn, P.K. Stumpf, G. Bruening & R.H. Doi.
4. Biochemistry- J.L. Jain, S. Jain & Nitin Jain.
5. Biochemistry- U. Satyanarayanan

**+ 3 FIRST YEAR SECOND SEMESTER  
CORE COURSE -III (C-3) - BIOTECHNOLOGY  
BIOCHEMISTRY AND ENZYMOLOGY**

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

**UNIT-I**

**Nucleic Acids:** Physico-chemical properties of nucleic acids, primary structure of DNA, Watson-Crick model of DNA, structural variations in DNA. Types of RNA and their functions.

**UNIT-II**

**Enzymes:** Nomenclature and classification of enzymes. Structure of enzyme (Holoenzyme, Apoenzyme, Cofactors, Coenzymes and Prosthetic group, active site). Substrate specificity. Mechanism of enzyme action (Activation energy, Lock and Key hypothesis, Induced-fit theory, Michaelis-Menten equation). Enzyme inhibition. Factors affecting enzyme activity.

**UNIT-III**

**Plant and Animal Hormones:** Physiological role and mechanism of action of auxins, gibberellins, cytokinins, abscisic acid and ethylene, Physiological role of mammalian hormones, types of hormones and their mode of actions.

**UNIT-IV**

**Photosynthesis:** Conversion of light into chemical energy in green plants, photoelectron transport and ATP synthesis, CO<sub>2</sub> fixation pathways (C-3, C-4 and CAM pathways) in plants, Biosynthesis of sucrose and starch.

**UNIT-V**

**Cellular respiration:** Conversion of starch, glycogen and sucrose into simple sugars, Glycolysis, Krebs cycle, Pentose phosphate pathways, mitochondrial electron transport and ATP synthesis. Gluconeogenesis.

**PRACTICAL- C-III**

Time : 3 hours

Full Mark -30 Marks

1. Extraction and estimation of photosynthetic pigments.
2. To study the effect of light intensity on the rate of photosynthesis
3. To study the CO<sub>2</sub> Conc. on the rate of photosynthesis.
4. Estimation of Urease
5. Estimation of Catalase
6. Extraction of IAA
7. Estimation of Starch by Anthrone Reagent.
8. Effect of PH and temp on activity of salivary amylase
9. Verification of Beer's Lambert's law.
10. Demonstration of the activity of Nitric reductase and catalase activity.
11. Demonstration of absorption spectrum of photosynthetic pigments.
12. To study the induction of amylase activity on germinating seeds.

**Suggested Books**

1. Lehninger Principles of Biochemistry- D.L. Nelson & M.M. Cox.
  2. Fundamentals of Biochemistry- Donald Voet, J.G. Voet and C. W. Pratt.
  3. Outlines of Biochemistry- Eric E. Conn, P.K. Stumpf, G. Bruening & R.H. Doi.
  4. Biochemistry- J.L. Jain, S. Jain & Nitin Jain.
  5. Biochemistry- U. Satyanarayanan
  6. Biochemistry by J.M. Berg, J.L. Tymoczko & Lubert Stryer
-

**+ 3 FIRST YEAR SECOND SEMESTER  
CORE COURSE -IV (C-4) - BIOTECHNOLOGY  
BIOTECHNIQUES**

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

**End Semester Theory : 50 Marks**  
**Mid Semester : 20 Marks**

**UNIT-I**

**Microscopy:** Microscopy: Principle of operation and instrumentation of light microscopy, Bright field, Phase-contrast, Fluorescence, Electron microscopy. Microtomy and histological techniques.

**UNIT-II**

**pHmetry & Chromatography :** pH Meter- Principles & working Mechanism. Chromatography- Principles, types, working mechanisms, factor influencing the pH measurement. Chromatography: principle types working mechanisms and application of paper chromatography, Column chromatography, Thin layer chromatography ion exchange chromatography, Affinity chromatography, High performance liquid chromatography (HPLC).

**UNIT-III**

**Spectroscopy:** Ultraviolet-visible absorption spectroscopy: Principle, instrumentation and application. Fluorescence spectrophotometry: Principle and application, colorimeter and calibration of the colorimeter. ELISA- Principles, Mechanism and applications.

**UNIT-IV**

**Centrifugation Techniques:** Basic principles of sedimentation. Centrifugation: types of rotors (fixed and angle rotors and swinging bucket rotors vertical rotors) centrifuges tubes Ultra centrifugation.

**UNIT-V**

**Electrophoretic, Radioisotope Techniques:** General principles, Modes, support media, electrophoresis of proteins and nucleic acids. (Agrose gel electrophoresis and pulse filed gel electrophoresis). Radioisotope techniques: Nature of radioactivity, isotopes in biochemistry, measurement of radioactivity, autoradiography.

**PRACTICAL- C-IV**

Time : 3 hours

Full Mark -30 Marks

1. To study the different parts of a simple and compound microscope and Principles of Microscopy.
2. To determine the pH of acid and base.
3. To determine pKa of acetic acid.
4. To determine pKa of Glycine.
5. Principles of spectro photometry and determination of validity of Beer and Lambert's law.
6. Determination of absorption maxima of a compound and determination of extinction coefficient.
7. Separation of amino acids by paper chromatography.
8. Thin layer chromatography.

**Suggested Books**

1. Physical Biochemistry by David Freifelder.
  2. Practical Biochemistry by Keith Wilson and John Walker.
  3. Modern Experimental Biochemistry by Rodney Boyer.
  4. Molecular Techniques in Biochemistry and Molecular Biology by S. Srivastava
-



**+ 3 SECOND YEAR THIRD SEMESTER  
CORE COURSE -V (C-5) - BIOTECHNOLOGY  
MICROBIOLOGY**

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

**UNIT-I**

**Microbial characteristics & Methods:** Introduction and developments in the microbial world: General characteristics of different groups of microbes. Abiogenesis, Biogenesis, Pasteurization, Germs theory of disease. Classification of microorganism: Five kingdom, eight kingdom, three domain classification. General methods of classification of bacteria, Bergey's system of classification.

**UNIT-II**

**Methods in Microbiology:** Sterilization methods-(Physical, chemical, Gaseous), Culture media: (Natural, Semi synthetic), selective, differential. Isolation by streaking plate technique and pure culture methods (Using enrichment media), Microbial growth, parameters of growth, Growth in continuous culture, batch culture and synchronous growth.

**UNIT-III**

**Bacteria :** General characteristics, Morphology & fine structure of Eubacteria (Flagella, pili, capsule, cellwall, Plasma Membrane, Mesosome, cytoplasmic inclusions, plasmids, Episome, Nucleoide). Gram +ve and Gram-ve bacteria. Reproduction -Vegetative and Asexual.Genetic Recombination: Conjugation, transformation and transduction.

**UNIT-IV**

**Viruses and Economic importance Of Micro-Organisms:** Discovery, General characteristics and classification of viruses based on host and nucleic acids. Structure of TMV, and Bacteriophages. Multiplication of viruses-Lytic Cycle, Lysogenic cycle and transmission of viruses. General account of viroids and prions. Economic importance of viruses.

**UNIT-V**

**Cyanobacteria, Mycoplasma and Archeobacteria:** Cell structure of cyanobacteria: Sheath, Cellwall, plasma membrane, cytoplasm, cytoplasmic inclusions. Special structures: Heterocysts, Hormogones, Akinetes, Cell structure and Reproduction of Fungi-*Penicillium* and Yeast (cell structure). General characteristics of Rickettsiae, Mycoplasma, Archeobacteria, protozoa..

**PRACTICAL  
C - 5**

Time : 3 hours

Full Mark -30 Marks

1. Sterilization and preparation of culture media.
2. Techniques of pure culture.
3. Culture of bacteria from water and soil.
4. Identification and observation of bacteria by Gram staining.
5. Counting of bacteria by colony counter method and Haemocytometer method.
6. Determination of bacteria sensitivity to antibiotics.

**Suggested Books**

1. Microbiology : L.M. Prescott, J.P. Harley & D.A. Klein.
  2. Microbiology : M.J. Pelezar, E.C.S. Chan & N.R. Krieg.
  3. Introduction to microbiology J.L. Ingraham and C.A. Ingraham.
  4. Microbiology by R.P. Singh.
  5. A Text book of microbiology -R.C. Dubey & D.K. Maheswari
-

**+ 3 SECOND YEAR THIRD SEMESTER  
CORE COURSE -VI (C-6) - BIOTECHNOLOGY  
IMMUNOLOGY**

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

**UNIT-I**

**Introduction and Immunosystem :-** Introduction, Phylogeny of immune system, Innate and acquired immunity. Factor of innate immunity, cell mediated immunity, active and passive immunity, clonal nature of immune response. Haematopoiesis and differentiation, organs and cell of the immune system. Stem cells, B and T Lymphocytes and their types, differences, Lymphocytic trafficking

**UNIT-II**

**Antigens and Antibodies :-** Nature and biology of antigens, chemical nature, factors of antigenicity. Heterogenous antigens, T-cell dependent and independent antigens. Structure, properties and function of antibody molecules, Antigen-antibody interaction.

**UNIT-III**

**MHC and Tumour technology :-** Major Histocompatibility complex (MHC), MHC antigens, HL antigens, functions, Antigen processing and presentation, Monoclonal antibodies and their uses. Tumour technology - Types, properties, causes, tumour antigens, immune response, immune surveillance, immune diagnosis and therapy

**UNIT-IV**

**Complement system :-** Activation and regulation of B and T Lymphocytes. Complement system. Salient features, complement activations, classification and alternative pathways and their significance. Biological functions, complement fixation test. Cytokine.

**UNIT-V**

**Hypersensitivity and immunodeficiency Diseases :-** Hypersensitivity and factors of hypersensitivity, common reactions, Types (I,II,III and IV) and their mechanism. Immunological disorders: Autoimmune disorders, immunodeficiency disorders - congenital immunodeficiency Acquired immunodeficiency syndrome. (AIDS).

**PRACTICAL**

**C - 6**

Time : 3 hours

Full Mark -30 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.
7. Blood group determination in a population (ABO system)
8. Rh Test
9. Viva- Voce
10. Spotting

**Suggested Books**

1. Kuby immunology, 5th edition, By R.A. Golds by etal.
2. Immunology by Roitt
3. The elements of immunology by Khan, pearson education.
4. Principles of immunology by N.V Shastri, Himalaya Publishing house.

5. Immunology (Concept and mechanism) - A Sharma.
6. Cellular and molecular immunology- R. Taneja
7. Medical immunology -G. Virella.
8. Immunology A Text Book- C.V. Rao
9. Immunology -Lal Tydd.
10. A Test Book of immunology and immune technology- B. Annaduraj
11. Principles of Immunology- N. V. Shastri
12. Immunology : Pasteurs Heritage- P.A. cazeuve & G. P. Talwar
13. Immunology: Introduction -Nandini Shetty.

**+3 SECOND YEAR THIRD SEMESTER  
CORE COURSE -VII (C-7) - BIOTECHNOLOGY  
MOLECULAR BIOLOGY**

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

**End Semester Theory : 50 Marks**  
**Mid Semester : 20 Marks**

**UNIT-I**

**DNA Structure and replication:** DNA as genetic material, Structure, types of DNA, 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, factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation. RNA splicing and processing : processing of pre-mRNA : 5' - cap formation, polyadenylation, spliceosome mediated splicing, rRNA and tRNA splicing.

**UNIT-IV**

**Gene Expression:** Genetic code and its characteristics, prokaryotic and eukaryotic translation, ribosome structure and assembly, charging of tRNA, aminoacyl tRNA synthetase, mechanism of initiation, elongation and termination of polypeptides, posttranslational modifications of proteins.

**UNIT-V**

**Regulation of Gene Expression:** Regulation of gene expression in prokaryotes, Operon concept (Inducible and repressible system): Lac Operon and Tryptophan Operon, positive and negative control, post transcriptional regulation.

**PRACTICAL  
C - 7**

Time : 3 hours

Full Mark -30 Marks

1. Preparation of solutions for Molecular Biology experiments.
2. Isolation of chromosomal DNA from bacterial cells.
3. Isolation of Plasmid DNA by alkaline lysis method.
4. Agarose gel electrophoresis of genomic DNA and plasmid DNA.

**Suggested Books:**

1. Watson. J.D. Baker, T.A. Bell, S.P. Gann, A. Leine, M. Losick, R. (2007), Molecular Biology of the

- Gene, Pearson Benjamin Cummings, CSHL press, New York, U.S.A., 6th edition.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. John Wiley and sons Inc. U.S.A. 5th Edition.
  - Klug, W.S. Cummings, M.R. Spencer, C.A. (2009), Concepts of Genetics. Benjamin Cummings. U.S.A. 9th edition.
  - Russell, P. J. (2010). IGenetics- A Molecular Approach. Benjamin Cummings, U.S.A., 3rd edition.
  - Griffiths, A.J.F., Wessler, S.R. Carroll, S.B. Doebley, J. (2010), introduction to Genetic Analysis W. H. Freeman and Co, U.S.A 10th edition.
  - Pal, Jayanta, K. Ghaskdbi (2009) Fundamental of molecular biology Oxford University press New Delhi.

## +3 SECOND YEAR FOURTH SEMESTER CORE COURSE -VIII (C-8) - BIOTECHNOLOGY GENETIC ENGINEERING

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

### UNIT-I

**INTRODUCTION AND TOOLS OF GENETIC ENGINEERING:** Introduction and brief history of Genetic engineering. (Restriction endonuclease, DNAligase; DNA modifying enzymes). Molecular tools of genetic engineering, vectors (plasmid vectors), Bacteriophage vectors, cosmid, phagemid, BAC, shuttle vectors, yeast vectors) steps in Gene cloning, isolation of the desired gene, (c-DNA library, genome library, chemical synthesis of gene, Gene amplification through PCR), integration of the DNA insert into the vector, introductions of the vector into suitable host, selection of recombinant clones, sequence dependent screening (Colony hybridization, positional cloning, screening by PCR, Gene tagging) expression -Based screening.

### UNIT-II

**BLOTTING TECHNIQUES:** Basic techniques in genetic engineering Agarose gel electrophoresis, isolation and purification of nucleic acids, Nucleic acid blotting techniques. (Southern blotting, Northern blotting, western blotting) DNA sequencing (Maxam and Gilbert technique) Chromosome walking in DNA sequencing, automated DNA sequencing.

### UNIT-III

**DNA AMPLIFICATION BY PCR:** inverse PCR, Reverse transcription PCR, RAPD, AFLP, RACE application of PCR, genetic maps: (Linkage Maps, cytogenetic Maps, physical Maps Genetic markers, linkage mapping of DNA markers, human genome project.

### UNIT-IV

**BIOTECHNOLOGY IN HEALTH CARE:** Gene therapy methods of DNA assay, DNA in the diagnosis of infectious diseases and genetic diseases. DNA finger printing . monoclonal antibodies and its application.

### UNIT-V

**TRANSGENIC PLANTS AND ANIMALS:** Genetic engineering in plants and animals, methods and development of transgenic plants and animal and their application, Biosafety, intellectual property rights.

### PRACTICAL

C - 8

Time : 3 hours

Full Mark -30 Marks

- SDS-poly acrylamide gel electrophoresis (SDS-page) of given protein samples.
- DNA isolation from animal/plant source and agarose gel electrophoresis.
- Storage techniques, revival and culture of bacteria.
- Spreading and plating techniques.

5. Isolation of plasmid and detection by electrophoresis.
6. Amplification of DNA by PCR.
7. Viva-voce
8. Spotting.

### Suggested Books

1. Plant Biotechnology by B.D. Singh.
2. Biotechnology by B.D. Singh & R.P. Singh
3. Biotechnology by U. Satyanarayan.
4. Molecular cloning: A laboratory manual by J. Sambrook and E.F. Fritsch.
5. Genome by T.A. Brown.
6. Molecular biotechnology by Glick.
7. Molecular Biology by Weaver.
8. DNA science: A first course in recombinant technology by Mickloss and freyer.
9. Molecular Biotechnology by S.B. Primrose.
10. Genes and Genomes by Singer and Berg.

## +3 SECOND YEAR FOURTH SEMESTER CORE COURSE -IX (C-9) - BIOTECHNOLOGY PLANT BIOTECHNOLOGY

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

### UNIT-I

**Plant cell and Tissue culture :-** Historical back ground; General idea about root and shoot meristems. Concept of totipotency. Equipments and basic techniques of plant tissue culture. Nutrient media and growth regulators. Callus culture and suspension culture. Application of tissue culture in agriculture, horticulture and forestry.

### UNIT-II

**Culture of explants:** Organogenesis and embryogenesis: Production of haploid plants: Androgenesis, Cytogenesis. Diploidization of haploid plants. Application and Limitations of haploids. Protoplast isolation and culture. Somatic hybridization. Cybrids. Applications and limitation of somatic hybridization

### UNIT-III

**Mass propagation and germplasm conservation:** Somaclonal variations; isolation and application of somaclonal variants. Clonal propagation; Technique of micro propagation. Application of micro propagation. Insitu and ex-situ germplasm conservation. Cryopreservation. Applications of germplasm storage

### UNIT-IV

**Plant genetic engineering:** Agrobacterium -Mediated gene transfer technique in plants. Virus- mediated gene transfer. Direct gene transfer methods in plant. Marker genes for plant transformation. Promoters and terminators. Transgene stability and expression. Chloroplast transformation. Molecular marker. Marker based DNA hybridization.

### UNIT-V

**Application of plant transformation:** Environmental stress to plant. Transgenic plants, resistance to biotic stresses. Insect (pest) resistance Bt genes; its application, advantages and disadvantages of Bt crops. Resistance genes from higher plants (proteinase inhibitors alpha Amylase inhibitors, Lecitins) virus resistance. Resistance to fungal & bacterial disease. Resistance to abiotic stresses. Application of transgenic plants for improvement of crop yield and qualities. Transgenic plants as bioreactors.

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**PRACTICAL****C - 9**

Time : 3 hours

Full Mark -30 Marks

1. (a) Preparation of MS medium.  
(b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of, *Datura, Brassica* etc.
2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer thorough photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Restriction digestion and gel electrophoresis of plasmid DNA.
8. Preparation of artificial seeds (by taking root or shoot apex).

**Suggested 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. Paternak, J.J. (2003). Molecular Biotechnology-Principles and Applications of recombinant DNA, ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P (2011). The Embryology of Angiosperms. Vikas Publication house Pvt. Ltd. New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, MJ. (2010), Principles of Genetics, John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N Jr. (2008) Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
6. Chawla, H.S (2010). Introduction to plant Biotechnology. Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.
7. Singhy, B.D. (2010) Biotechnology: Expanding Horizon, Kalyani Publishers New Delhi.
8. Satyanarayan U (2012). Biotechnology. Books and allied (P), Kolkata.
9. De, Kalyan Kumar and introduction to plant tissue culture New Central Book Agency (P) Ltd. Kolkatta.

**+3 SECOND YEAR FOURTH SEMESTER  
CORE COURSE -X (C-10) - BIOTECHNOLOGY  
ANIMAL BIOTECHNOLOGY**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**UNIT-I**

**Cell culture and culture media:** Equipments and materials used in cell culture, sterilization and aseptic techniques. Culture media: General considerations in media design, Natural media, synthetic media, Nutritional compounds of media, Role of serum in cell culture, serum free medium.

**UNIT-II**

**Primary culture and cell line:** Primary culture and its maintenance: Monolayer and suspension cultures. Growth curve, Establishment, selection of cell line cell counting. Anchorage dependent cell culture and suspension culture.



**UNIT-III**

**Organ culture:** Growth, advantage and limitations, techniques, procedure, Histotypic and organotypic culture. In vitro fertilization: History, types and causes of infertility in males and females, collection of sperm and ovum, treatment for IVF, procedure.

**UNIT-IV**

**Necrosis and apoptosis:** Meaning, difference, purpose, mechanism, Role of caspases etc. Cryopreservation: Meaning, Mechanism, Precautions, Techniques, Cryoprotectants, Transgenic animals - Importance, production of transgenic mice and its procedure, difficulties, limitations, Applications of transgenesis of domesticated animals.

**UNIT-V**

**Embryo Transfer-Fresh & Frozen Embryo, Procedure:** Hybridoma Technology And Production Of Monoclonal Antibodies. Stem Cell Culture And Its Application (Embryonic And Epithelial), Vaccine: Technology And Recombinant Vaccines. Types (Hepatitis, Aids, DNA Vaccines) Gene Therapy: Gene Therapy Techniques, Diseases Amenable to Gene Therapy- Cancer, Haemophilia. Human Genome Project. Forensic Science- DNA Finger Printing & its application. Writing Various Methods Of DNA Finger Printing, Uses of Marker gene. Transgenic animal produced by cloning fetal cells. Transgenic organism to interrupt disease cycle.

**PRACTICAL****C - 10**

Time : 3 hours

Full Mark -30 Marks

1. Estimation of BOD in sewage
2. Protoplast isolation and fusion.
3. Study of Explants
4. Study of structure of a fermentor
5. Study and preparation of *Nostoc* colony
6. Preparation of Liquid MS medium
7. Sterilization of liquid MS medium
8. Callus culture from carrot explants.

**Suggested Books**

1. Culture of animal cells by R.I. Freshney
2. Tissue culture-methods and applications by Paul F. Kruse Jr. and M.K. Paterson.
3. Cell culture Lab Fax by Butler and Dawson.
4. Cell and tissue culture: Laboratory procedures by Doyle and Griffiths.

**+ 3 FINAL YEAR FIFTH SEMESTER  
CORE COURSE -XI (C-11) - BIOTECHNOLOGY  
BIOSTATISTICS**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**UNIT-I**

**Biostatistics:** Definition, Characteristics, limitation and uses of biostatistics statistical terms, collection and classification of data, sampling and statistical error, methods of presentation of statistical data.

**UNIT-II**

**Frequency Distribution:** Introduction, types and terms associated with frequency distribution (class, class interval, class limit, class width, class frequency, total frequency, percentage frequency, frequency density), cumulative frequency). Graphical representation of data. Types and modes of graphical representation

of ungrouped and grouped data. (Line diagram, Bar diagram, pie chart, Histogram, Frequency, Polygon, Ogives)..

#### UNIT-III

**Central Tendency:** Measures of central tendency, arithmetic mean, median, mode, its merits and demerits, others measures of central tendency, quartiles, deciles and percentiles, measures of variation-Dispersion, Range, Mean deviation, standard deviation, merits and demerits, Co-efficient of variation, standard error of mean.

#### UNIT-IV

**Normal Distribution:** Definition and properties of normal distribution, uses of normal distribution. Correlation and Regression: Types and methods studying correlation, types and methods of studying regression. Difference between correlation and regression.

#### UNIT-V

**Statistical inference:** Comparison of means of two small sample (Student's t'-test comparison of means of two large sample chi-square test, Null hypothesis, degrees of freedom, level of significance, Test for goodness of fit (pearsonian-  $\chi^2$ )

### PRACTICAL

#### C - 11

Time : 3 hours

Full Mark -30 Marks

1. Calculation of mean, standard deviation and standard error.
2. Calculation of correlation coefficient values
3. Student's t'-test
4. Chi square test
5. Calculation of different measures of central tendency, dispersion skewness and kurtosis.
6. Calculation of simple correlation and regression lines, rank correlation.
7. Construction of frequency distribution table, histogram & frequency polygon.
8. Calculation of multiple and partial correlation coefficients.
9. Tests of significance based on Normal t and  $\chi^2$  distribution.

#### Suggested Books:

1. Biostatistics, Dannel, W.W. 1987, New York, John Wiley Sons.
  2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S. and Richards, J. Christian Medical College, Vellore.
  3. Statistical Analysis of epidemiological data, Selvin, S. 1991, New York University press.
  4. Statistics for biology, Boston, Bishop, O.N. Houghton, Mifflin.
  5. The Principles of Scientific research, freedman, P. New York, Pergamon Press.
  6. Statistics for Biologists, Campbell, R.C. 1998, Cambridge University press.
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**+3 FINAL YEAR FIFTH SEMESTER  
CORE COURSE -XII (C-12) - BIOTECHNOLOGY  
BIOINFORMATICS**

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

**End Semester Theory : 50 Marks**  
**Mid Semester : 20 Marks**

**UNIT-I**

**Introduction to Bioinformatics:** Introduction, Branches of Bioinformatics, Areas of research and Scope of Bioinformatics

Search engines in Bioinformatics: NCBI, ENTREZ, UNIPROT(KB), Biological information retrieval system.

**UNIT-II**

**Biological Sequence Database:** National Center for Biotechnological Information , Sequence submission and retrieval system, Introduction and resources of biological databases( PDB, Protein Data Bank(PDB), EBI, DDBJ, Gen Bank, OMIM,OMIA, Swiss Prot, PIR,KEGG)

**UNIT-III**

**Sequence Alignment:** Concept of Alignment, Needleman Wunsch Algorithm, Smith Watermann Algorithm, Basic Local Alignment Search Tool (BLAST),types of BLAST, FASTA, Types of FASTA, Multiple Sequence Alignment

**UNIT-IV**

**Molecular Phylogeny:** Phylogenetic Analysis, Methods of Phylogenetic Prediction, Method of prediction. UPGMA and MJ method of prediction.

**UNIT-V**

**Application of Bioinformatics:** Computer Aided Drug Design, Steps in Drug Discovery, Quantitative Structure and Activity relationship (QSAR), Human Genome Project, Application of Bioinformatics in Health sector, Agriculture and Medicines.

**PRACTICAL**

**C - 12**

Time : 3 hours

Full Mark -30 Marks

1. Biological Databaes: NCBI, SWISS PROT, EMBL, KEGG
2. Pairwise Sequence alignment Tools (BLAST, PSI-BLAST, FASTA, LALIGN)
3. Multiple Sequence Alignment (Clustal W, T Coffee)
4. Building Phylogenetic Trees (PHYLIP)
5. Homology Modeling : GENO3D, 3D JIGSAW
6. Molecular Visualizing tool: Swiss PDB, RASMOL

**Suggested Books:**

1. David W. Mount- Bioinformatics : Sequence and Genome Analysis- CBS Publishers
  2. A.D. Barevanis,B.F.F.Ouellelte-Bio-informatics ,a practical guide to the analysis of genes and proteins - wily interscience
  3. S.C.Rastogi, N.Mendiralta, P.Rastogi - Bioinformatics Methods and applications - Genomics, Proteomics and Drug Discovery - Prentice Hall of India
  4. A Text Book of Bio-informatics - Singhal and Singhal (Pragati Prakashan)
  5. Bioinformatics : Databases, Tools & Algorithms - Orpita Bosu and Simminder Kaur Thukral (Oxford Higher Education)
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**+3 FINAL YEAR SIXTH SEMESTER  
CORE COURSE -XIII (C-13) - BIOTECHNOLOGY  
INDUSTRIAL & MICROBIAL BIOTECHNOLOGY**

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

**End Semester Theory : 50 Marks**  
**Mid Semester : 20 Marks**

**UNIT-I**

**Fermentation Technology:** Fermentation types of fermentation, fermentation process, Bioreactors, operation of a conventional Bioreactor, Media for industrial fermentation, sterilization of culture media, isolation of microorganism, Principles of microbial growth and culture system- Batch culture, fed batch culture, semi continuous culture, continuous culture, growth kinetics of microorganism, recovery of industrial products by downstream processing.

**UNIT-II**

**Microbes in Biotechnology:** Microbial production of Alcohol, organic acids, Antibiotics, vitamins & foods and beverages; single cell protein; Biomass and Bioenergy; Bioleaching. Enzyme production and its therapeutic application.

**UNIT-III**

**Air and Water pollution :** Global environmental problems (Green house effect, Acid rain, Ozone depletion) Environment pollution, Biotechnological method for pollution monitoring and management of Air pollution, water pollution, sewage and waste water management.

**UNIT-IV**

**Sludge and solid waste treatment:** landfill, composting and vermicomposting Biodegradation and bioremediation, Bioremediation of contaminated soils and wastelands treatment of ground water.

**UNIT-V**

**Biofertilizer Biogas:** Biofertilizer, Biogas and its production bio transformation treatment of waste gases, Biosafety during industrial production.

**PRACTICAL  
C - 13**

Time : 3 hours

Full Mark -30 Marks

1. Estimation of BOD in sewage.
2. Study of staining techniques
3. Maintenance and preservation of cultures.

**Suggested Books:**

1. Introduction microbiology by P. Kaushik.
  2. Concepts in Biotechnology by D. Balasubramanyan and others. .
  3. Language of Biotechnology by Ashutosh Debata, D. Panda.
  4. Principles of Microbiology & Immunology by B.D. Singh and R.P. Singh.
  5. A.T.B. of Microbiology by R.C. Dubey & D.K. Maheswari.
  6. Schawm's swages in Microbiology by I.E. Alcamo. ?
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**+3 FINAL YEAR SIXTH SEMESTER  
CORE COURSE -XIV (C-14) - BIOTECHNOLOGY  
MEDICAL AND ENVIRONMENTAL BIOTECHNOLOGY**

**Time: 3 Hours**

**End Semester Theory : 50 Marks**

**Credit: 6**

**Mid Semester : 20 Marks**

**UNIT-I**

**Medical Biotechnology:** Gene therapy: Ex vivo and in vivo gene therapy, Antigen and antisense therapy. DNA in disease diagnosis; Infectious disease: Tuberculosis, AIDs. Genetic disease: sickle-cell anemia, Alzheimer's disease, cancer and diabetes. Pharmaceutical product of DNA technology: Human protein replacement (insulin, human growth hormone, clotting factor -VIII); Therapeutic agents of human disease (Interferons and Erythropoietin). Recombinant vaccines : Hepatitis-B, Meningitis, foot and mouth diseases.

**UNIT-II**

**Issues and scope of Environmental Biotechnology :** Basic concepts and issues of global environmental problems - Ozone depletion, UV radiation, Greenhouse effect and acid rain. An overview of atmosphere, hydrosphere, and lithosphere. Types and sources of environmental pollution. Bio-concentration and Biomagnification.

**UNIT-III**

**Bioaccumulation of Toxicants:** Organic and inorganic xenobiotic compounds. Bioremediation of xenobiotic compounds in environment. Molecular techniques in bioremediation. Biopesticides, bioreactors, bioleaching, biomining, biosensors. Policies for environmental protection. Natural environmental protection acts.

**UNIT-IV**

**Management of solid waste, water and Biodiversity conservation:** Biotechnology for solid waste management. Biological treatment of waste water from various sources. Threats to biodiversity conservation, management of biodiversity, hot spots. Biotechnology in ex-situ conservation of biodiversity.

**UNIT-V**

**Biotechnology and Society:** Benefits of biotechnology, ethical, legal and social implication of biotechnology. Recombinant foods and religious beliefs. Safety of GM foods. Release of genetically engineered organisms. Human cloning. Human embryonic stem cell research. Patenting of biotechnology inventions. Biotechnology in developing countries.

**PRACTICAL**

**C - 14**

Time : 3 hours

Full Mark -30 Marks

1. Study prophylaxis cube of use conventional and recombinant vaccines.
2. Measurement of blood sugar in human blood.
3. Study of blood groups & clotting mechanism.
4. Study of water sample by Winkler's method.
5. Study of solid waste management by different method.
6. Study of biological treatment of waste water.

**Suggested Books:**

1. Medical Biotechnology by S.N. Jogland
2. Language of Biotechnology by A. Debata, D.Panda & A. Debata
3. Biotechnology-4 by S. Mahesh and A.B. Vedamurthy
4. Elements of Biotechnology by P.K. Gupta.
5. A text-Book of Biotechnology by H.D. Kumar
6. Biotechnology and Genomics by P.K. Gupta.
7. Biotechnology by Dr. U. Satyanarayana.

**+ 3 FINAL YEAR FIFTH SEMESTER  
DSE-1 - BIOTECHNOLOGY  
PLANT DIVERSITY**

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

**End Semester Theory : 50 Marks**  
**Mid Semester : 20 Marks**

**UNIT-I**

**Algae:** General characteristic, classification (Fritsch's), Range of thallus organization in algae, economic important of algae. Range of thallus structure in Chlorophyta, general character, occurrence, cell structure and reproduction of followings: Chlorophyta- *Volvox*, *Oedogonium* Xanthophyta: *Vanicheria* Phaeophyta - *Ectocarpus* Rhodopyta - *Polysiphonia*.

**UNIT-II**

**Fungi:** General characteristic classification (Ainsworth) Thallus organization : Cell wall composition, Nutrition. Oomycota : *Phytophthora* Zygomycota: *Mucor*, Ascomycata - *Saccharomyces*, Basidiomycota: *Puccinia* Deuteromyctes: *Cercospora* Economic importance of fungi, Pathology - General symptoms of plant diseases, mode of infection host pathogen relationship. Diseases - Late blight of potato, Stem rust of wheat.

**UNIT-III**

**Lichens and Bryophyta :** Classification, General structure, reproduction and economic important of lichen. Bryophyta - General characteristics, classification by Bower. Distribution and life cycle of *Marchantia* and *Anthoceros*.

**UNIT-IV**

**Pteridophyta :** General characteristics and classification by smith. Morphology, anatomy and reproduction of *Psilotum* and *Equisetum*. Types of stele and stelar evolution.

**UNIT-V**

**Gymnosperm & ICN.:** General characteristic classification by Chamberlain. Morphology, Anatomy and reproduction of *Pinus* and *Gnetum*. ICN: Basic concept, principle and rule of ICN, typification, author citation, principle of priority, rejection of names and synonyms

**PRACTICAL**

**DSE - I**

Time : 3 hours

Full Mark -30 Marks

1. Study of the morphology, Anatomy of the genera belonging to Algal, Fungi, Bryophyta, pteridophyta and Gymnosperms
2. Study of growth forms of Lichens (Crustose, foliose and fruiticose).
3. Study of different types of plant diseases caused by pathogene belonging to different classes of fungi, T.S of infected plant parts (leaf stem).

**Suggested Books:**

1. Cryptogamic Botany-Vol. I & Vol. II-G.M. Smith.
2. A. Textbook of Botany- V. Singh, P.C. Pandey and D.K. Jain.
3. Studies in Botany Vol. 1- J.N. Mitra and S.K. Choudhury Mouluk publication.
4. Modern college Botany Vol. 1 & II- Rabindra Nath, Kalyani Publication.

**+ 3 FINAL YEAR FIFTH SEMESTER**

## DSE - II - BIOTECHNOLOGY ANIMAL DIVERSITY

Time: 3 Hours  
Credit: 6

End Semester Theory : 50 Marks  
Mid Semester : 20 Marks

### UNIT-I : Protozoa, Porifera and Coelenterata

- (a) Outline classification of Non-chordates upto sub-classes.
- (b) Protozoa- Locomotion, reproduction, life history of *paramaecium*, pathogenic protozoans- *Trypanosoma*, *Entamoeba* and *plasmodium*
- (c) Porifera-General characters, canal system, skeleton.
- (d) Coelenterate- General characters, polymorphism, metagenesis, coral reefs and their formation.

### UNIT-II : Platyhelminthes, Aschelminthes, Annelida

- (a) Platyhelminthes- Characters, classification, pathogenic flatworms, parasitic adaptations.
- (b) Aschelminthes- General features, classification, round worms, parasitic adaptations.
- (c) Annelida- General features, classification, coelom, Metamerism, Earth Worm, Vermicomposting

### UNIT-III : Anthropoda, Mollusca, Echinodermata & Hemichordates

- (a) Arthropoda-General feature, classification, Larval forms in crustacea, Respiration in Anthropods, social insects, apiculture, Sericulture.
- (b) Mollusca- General features, classification, Torsion in gastropods.
- (c) Echinodermata -General features, classification, Larval forms.
- (d) Hemichordates - Phylogeny, Affinities & *Balanoglossus*

### UNIT-IV : Protochordates, Origin of Chordates, Asces & Amphibia

- (a) Protochordates- General features, salient features of Herdmania and Branchiostomata. Affinities of *Amphioxus*.
- (b) Origin of Chordates.
- (c) Pisces -Classification, Migration in fishes.
- (d) Amphibia- Classification (Upto orders), Origin, parental care, paedogenesis

### UNIT-V : Reptiles, Aves, Mammals and Comparative anatomy

- (a) Reptiles - Classification (Upto orders), Origin.
- (b) Aves -Origin, flight adaptation, migration.
- (c) Mammals- Classification (Upto sub-classes), Origin
- (d) Comparative anatomy- Integumentary, Heart, Kidney and Brain.

### PRACTICAL DSE - II

Time : 3 hours

Full Mark -30 Marks

1. Dissection - Students are required to dissect and display.
2. Digestive system, Nervous system
3. Spottings- students are required to study permanent slides and museum specimens related to syllabus.
4. Viva-voce
5. Record
6. Museum specimens

Porifera : Spongilla, Euspongia, Sycon

Coelenterate	:	Gorgonia, Physalia, Porpita, Penatulla
Annelida	:	Nereis, Heteronereis, Apharodite, Chitopterus, Arenicola
Arthropoda	:	Kingcrab, Sacculina, Peripatus, Balanus, Eupagurus
Mollusca	:	Chiton, Aplysia, Teredo, Sepia, Loligo, Octopus, Nautilus
Echinodermata	:	Starfish, Antedon, Sea-urchin, Sea Cucumber

### Suggested Books:

1. Invertebrate Zoology - P.A. Meglitsch
2. Invertebrate Zoology- E.L. Jordan
3. Invertebrate Phyla (Series)-R.L. Kotpal
4. Invertebrate Zoology-Jordan & Verma
5. Invertebrate Zoology- T.C. Majpuria
6. Invertebrate Zoology-V.B. Rastogi
7. A test book of comparative anatomy of vertebrates-R. Puri
8. Wadate zoology- Jordan and Verma
9. Life of vertebrates -J. young
10. Comparative Anatomy-O.P. Jasra

## + 3 FINAL YEAR SIXTH SEMESTER DSE - III - BIOTECHNOLOGY BIOFERTILIZERS & MUSHROOM CULTURE

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

### UNIT-I

**General Account of the microbes used as biofertilizers *Rhizobium*** : Isolation, identification, mass multiplication, Actinorrhizal symbiosis.

Cyanobacteria (Blue Green algae), *Azolla* and *Anabaena azollae* association, nitrogen fixation, blue green algae and *Azolla* in rice cultivation.

### UNIT-II

**Azospirillum**: Isolation and mass multiplication *Azotobacter* - Classification, characteristics-crop resistance to *Azotobacter* inoculum. Mycorrhizal association, Colonization of VAM-its influence on growth and yield of crop plants.

### UNIT-III

**Organic farming** : Green manuring and organic fertilizers, Recycling of biodegradable Municipal, Agricultural and industrial wastes- biocompost making methods, types and methods of vermicomposting.

### UNIT-IV

**Nutritional and medicinal value of edible mushrooms** : Poisonous mushrooms, types of edible mushrooms available in India, *Volvariella volvacea*, *Pleurotus Citrinopileatus*, *Agaricus bisporus*.

### UNIT-V

**Cultivation Technology** : Infrastructure, substrates, polythene bag, inoculation, mushroom unit (Thatched house), water sprayer etc. Pure culture-Medium, sterilization, multiplication mushroom bed preparation - Paddy straw, sugarcane trash, maize straw, banana leaves etc.

## PRACTICAL

### DSE - III

Time : 3 hours

Full Mark -30 Marks

1. Preparation of synthetic compost for mushroom cultivation.
2. Collect the mushroom draw morphological structure.
3. Procedure for collection of spawn.
4. Preparation of Bacterial biofertilizer.
5. Preparation of Algal biofertilizer (Cyan bacterial)
6. Cultivation of Azolla.

**Suggested Books:**

1. Dubey, R.C., 2005 A.T.B. of Biotechnology, S. Chand & C, New Delhi.
2. Kumaresan, V. 2005 Biotechnology, Saras Publication
3. Sathe, T.V, 2004 Vermiculture and organic farming, Daya Publishers.
4. Subharao, N.S. 2000, Soil Microbiology, Oxford & IBH publishers, New Delhi.
5. Vayas, S.C. Vayas, S. and Modi, H.A. 1998 Biofertilisers and Organic farming Atka Prakashan, Naidival,
6. Tewari, Pankaj Kapoor, S.C (1988). Mushroom cultivation, Mittal Publications Delhi.
7. Nita Bahl (1984-1988), Hand Book of Mushrooms, II Edition, Vol. . I & II.
8. Marimuthw, T.Krishnamorthy, A.S, Sivaprakasam and Jayaragan. R. (1991) Oyster Mushrooms, Department of Plant pathology, Tamilnadu, Agricultural University, Coimbatore.

**+ 3 FINAL YEAR SIXTH SEMESTER  
DSE - IV - BIOTECHNOLOGY****(PROJECT)****Credit : 6****Mark : 100**



# BOTANY

## +3 FIRST YEAR FIRST SEMESTER

### CORE COURSE - I (C-1)

### MICROBIOLOGY AND PHYCOLOGY

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

#### UNIT-I

**Microbial Characteristics and Methods:** Introduction and developments in the Microbial world: General characteristic of different groups of microbes. Spontaneous generation or Abiogenesis Biogenesis, pasteurization, Germ theory of disease. Methods of sterilization, (Physical, Chemical, Gaseous), Culture media (Natural, Semi synthetic, Synthetic, Selective, Differential, Enrichment, Transport). Pure culture techniques, maintenance and preservation of pure culture.

#### UNIT-II

**Bacteria, Archea & Mycoplasma:** Discovery, general characteristics, distribution & classification of bacteria. Morphology & fine structure of eubacteria (Flagella, Pili, Capsule, Cell Wall, Plasma membrane, Mesosome, Cytoplasmic inclusions, Plasmid, Episome, Nucleoid) Gram positive & Gram. negative bacteria.

Reproduction: Vegetative and Asexual.

Genetic recombination: Conjugation, transformation and transduction.

General account of Archaeobacteria and Mycoplasma.

#### UNIT-III

**Viruses & Economic importance of Microorganisms:** Discovery, General characteristics and classification of viruses based on host and nucleic acid. Structure of Tobacco Mosaic Virus and Bacteriophage. Multiplication of viruses: Lytic cycle and Lysogeny. Transmission of viruses.

General Account of Viroids and Prions

Economic importance of viruses. Fermentor and Fermentation. Role of microorganism In production of Biofertilisers, Pesticides, Alcohol, organic acids, Antibiotics and Vaccines.

#### UNIT-IV

**Algae:** General characteristics, distribution; range of thallus organization, classification; Fritsch, and Lee systems (only upto groups); significant contributions of important phycologists (F.E. Fritsch, M.O.P. Iyengar). Origin and evolution of sex in algae. Economic importance of algae.

**Cyanophyta:** General characters and occurrence, cell structure, heterocyst, reproduction & economic importance. Morphology and life-cycle of *Nostoc* and *Anabaena*.

**Chlorophyta:** General characters, occurrence, structure & reproduction. Morphology and life-cycle of *Chlamydomonas*, *Volvox*, *Ulothrix*, *Oedogonium*.

#### UNIT-V

**Charophyta:** General characters, structure life-cycle of *Chara*.

**Xanthophyta:** General characters occurrence, structure life-cycle of *Vaucheria*.

**Phaeophyta:** characteristics, structure and reproduction. Life-cycles and affinities of *Ectocarpus* and *Fucus*.

**Rhodophyta:** General characteristics, occurrence, cell structure and reproduction. Life-cycle of *Polysiphonia*.

#### Books Recommended :

1. Phycology- R.E.Lee. Cambridge University Press, Cambridge.
  2. Microbiology- L.M. Prescott, J.P. Harley and D.A. Klein.
  3. Microbiology- M.J. Pelczar, E.C.S. Chan and N.R. Krieg.
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4. Introduction to Microbiology - J.L. Ingraham and C.A. Ingraham.
5. Microbiology - R.P Singh, Kalyani Publishers.
6. Cryptogamic Botany Vol. I- G.M Smith
7. Algae- O.P Sharma.
8. A. Text Book Of Microbiology-R.C. Dubey and D.K. Maheswari S.Chand Publications.
9. Microbiology and Plant Pathology- P.D. Sharma, Rastogi Publications.
10. Microbiology Vol. I & II, C.B. Power and Dajinawlla.

## PRACTICAL

### C- 1 : LAB - 1

Time : 3 hours

Full Mark -30 Marks

1. Study of the morphology and life cycle of the various genera of Algae belonging to the syllabus.
2. Preparation of permanent slides of Algae.
3. Identification and observation of bacteria by Gram Staining.
4. Sterilization and preparation of culture media.
5. Preparation of pure culture
6. Students have to submit slides of algae.

## +3 FIRST YEAR FIRST SEMESTER CORE COURSE - II (C-2) - BOTANY BIOMOLECULES AND CELL BIOLOGY

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

### UNIT-I

#### Biomolecules-I

**Water:** Structure and properties of water; pH and buffers.

**Carbohydrates:** Nomenclature and classification of carbohydrates. Structure and function of: Monosaccharides- glucose and fructose Disaccharides- sucrose and lactose Polysaccharides Cellulose and starch.

**Lipids:** Definition and classification of lipids. Structure and function of Fatty acids and Triacylglycerol.

**Amino Acids:** General structure and classification of amino acids.

### UNIT-II

#### Biomolecules-II

**Proteins:** peptide bonds. Primary secondary, tertiary and quaternary structure of proteins. Denaturation and functions of proteins.

**Enzymes:** Nomenclature and classification of enzymes. Structure of enzyme(Holoenzyme, Apoenzyme, Cofactors, Coenzymes and Prosthetic group, active site). Substrate specificity. Mechanism of enzyme action (Activation energy, Lock and Key hypothesis, Induced-fit theory, Michaelis-Menten equation). Enzyme inhibition. Factors affecting enzyme activity.

### UNIT-III

**The Cell:** Introduction to Cell Biology. Evolution of Cell. Characteristics of prokaryotic and eukaryotic cells:

**Cell wall and plasma membrane:** Structure, chemical composition & function of cell wall. Cell membrane: Models of membrane organization.

**Cytoskeleton system:** Role and structure of microtubules, microfilaments, intermediate filament.

### UNIT-IV

**Cell organelles: Nucleus:** Structure-nuclear envelope, nuclear pore complex, nuclear lamina, molecular organization of chromatin; nucleolus.

**Chloroplast, mitochondria and peroxisomes:** Structural organization; function; Semiautonomous nature of mitochondria and chloroplast.

Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

#### UNIT-V

**Cell division:** Chromosomal events during different stages of mitosis and meiosis. Role of spindle on chromosomal movement. Genetic recombination during meiosis. Cytokinesis. Distribution of cytoplasmic components. Cell cycle and its Regulation.

#### Books Recommended

1. Lehninger Principles of Biochemistry- D.L. Nelson & M.M. Cox.
2. Fundamentals of Biochemistry- Donald Voet, J.G. Voet and C. W. Pratt.
3. Outlines of Biochemistry- Eric E. Conn, P.K. Stumpf, G. Bruening & R.H. Doi.
4. Biochemistry- J.L. Jain, S. Jain & Nitin Jain.
5. Biochemistry- U. Satyanarayanan
6. The Cell- A. Molecular Approach- G.M. Cooper, R.E. Housman.
7. Cell and Molecular Biology -E.D.P. DeRobertis and E.M. F. DeRobertis.
8. Cell Biology- G. Karp. John Wiley & Sons (USA).
9. Cell Biology - S.C. Rastogi.

#### PRACTICAL

Time : 3 hours

Full Mark -30 Marks

1. Preparation of normal, molar & molal solutions.
2. Hydrogen ion concentration and determination of pH of acid and base.
3. Qualitative test for sugar.
4. Qualitative test for lipids.
5. Qualitative test for proteins.
6. Study of mitosis in onion root tip cells by squashing technique.
7. Study of meiosis in onion anther by squashing technique.
8. Karyotypic study of chromosome.

### +3 FIRST YEAR FIRST SEMESTER GENERIC ELECTIVE - I (GE-1) - BOTANY PLANT DIVERSITY

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

#### UNIT-I

**Algae:** General characteristics, classification proposed by Fritsch. Occurrence, structure, reproduction and life cycle of:

- |                                      |  |
|--------------------------------------|--|
| (i) Cyanophyta - <i>Nostoc</i>       | (ii) Chlorophyta - <i>Chlamydomonas</i> , <i>Oedogonium</i> and <i>Chara</i> |
| (iii) Xanthophyta - <i>Vaucheria</i> | (iv) Phaeophyta - <i>Ectocarpus</i>  |
| (v) Rhodophyta - <i>Polysiphonia</i> |  |

Range of thallus organization in algae. Origin and evolution of sex in algae. Economic importance of algae.

#### UNIT-II

**Fungi & Lichen:** Fungi -General Characteristics, Classification Proposed By Ainsworth. Occurrence, Structure, Reproduction And Life Cycle of:

- (i) Mastigomycotina: *Phytophthora*, Symptoms And Disease Control of Late Blight of Potato.

- (ii) Zygomycotina: *Mucor*                      (iii) Ascomycotina: *Saccharomyces, Penicillium*  
 (iv) Basidiomycotina: *Puccinia, Agaricus*. Symptoms And Disease Control of Rust of Wheat.  
 Economic Importance Of Fungi  
 Lichen-Classification, occurrence, structure, reproduction and economic importance.

**UNIT-III**

**Bryophyta** : General Characteristics, Classification Proposed By Bower. Morphology, Anatomy and Reproduction of :

- (i) Hepaticopsida: *Marchantia*.                      (ii) Anthocerotopsida: *Anthoceros*  
 (iii) Bryopsida : *Sphagnum*  
 Economic importance of bryophytes.

**UNIT -IV**

**Pteridophyta**: General Characteristics, Classification Proposed By Smith. Morphology, Anatomy and Reproduction and life cycle of :

- (i) Psilophytopsida: *Rhynia*                      (ii) Lycopsida: *Selaginella*  
 (iii) Sphenopsida: *Equisetum*                      (iv) Pteropsida: *Marsilea*

Stelar system and evolution of stele In pteridophytes. Heterospory and seed habit In pteridophytes.

**UNIT-V**

**Gymnosperms and Paleobotany**: General Characteristics and Classification Proposed By Chamberlain. Distribution, Morphology, Anatomy, Reproduction and Life Cycle of:

- (i) Cycadophyta: *Cycas*  
 (ii) Coniferophyta: *Pinus*  
 (iii) Gnetophyta: *Gnetum*

Economic importance

Fossil and Fossilization Process : Fossilization Process, morphology, anatomy and affinities of *Lepidodendron, Lyginopteris, cycadeoidea*.

**Books Recommended**

1. Cryptogamic Botany- Vol. I & Vol. II-G.M. Smith
2. A. Textbook of Botany- V. Singh, P.C. Pandey and D.K. Jain.
3. Studies in Botany Vol. 1- J.N. Mitra and S.K. Choudhury Moulik Publication.
4. Modern College Botany Vol. I & II- Rabindra Nath, Kalyani Publication.

**PRACTICAL**

Time : 3 hours

Full Mark -30 Marks

1. Study of the morphology and anatomy of the various genera belonging to Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms belonging to the syllabus.
2. Study of different types of plant diseases caused by pathogens belonging to different classes of fungi T.S. of infected parts.
3. Study of growth forms of Lichens (Crustose, Foliose, Fruticose)

**+3 FIRST YEAR SECOND SEMESTER  
 CORE COURSE - III (C-3) - BOTANY  
 MYCOLOGY AND PHYTOPATHOLOGY**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**UNIT-I**

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

**Zygomycota** : General Characteristics: Thallus organization: life cycle with reference to *Mucor*.

**Oomycota:** General characteristics; Life cycle of *Phytophthora*, *Albugo*.

#### UNIT-II

**Ascomycota :** General characteristics. Heterokaryosis and parasexuality; life cycle of *Saccharomyces*; *Penicillium*, and *Aspergillus*.

**Basidiomycota :** General characteristics: life Cycle of *Puccinia*, *Agaricus*:

#### UNIT-III

**Deuteromycota & Lichen :** *Alternaria*, *Cercospora*, Lichen- Occurrence; General characteristics, growth forms and range of thallus organization, Nature of association of algal and fungal partners. Reproduction and Economic importance.

#### UNIT-IV

**Applied Mycology :** Role of fungi In Biotechnology, Application of fungi In food industry (Flavour and texture, fermentation, baking, organic acids), pharmaceutical preparations, Mycotoxins, Biological control.

#### UNIT-V

**Phytopathology:** General symptoms of plant diseases; mode of infection; Host-Pathogen relationships; disease cycle; prevention and control of plant diseases, Fungal diseases - Late blight of potato, Blast of rice, Tikka Disease of Ground nut, Red Rot of Sugarcane. General Account of plant disease management.

#### Books Recommended

1. Introductory Mycology- C.J. Alexopoulos, C.W. Mims and M. Blackwell. John Wiley & Sons. (USA).
2. Plant Diseases - R.S. Singh.
3. Plant Pathology- P.D. Sharma, Rastogi Publications
4. Fungi- a.p. Sharma

## PRACTICAL

Time : 3 hours

Full Mark -30 Marks

1. Study of the morphology and anatomy of the genera belonging to Fungi included in the syllabus.
2. Study of different types of plant diseases caused by pathogens belonging to different classes of Fungi. T.S. of infected plant parts (Leaf, Stem.)
3. Study of growth forms of lichens (Crustose, Foliose and Fruticose).

## +3 FIRST YEAR SECOND SEMESTER CORE COURSE - IV (C-4) - BOTANY ARCHEGONITAE

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

#### UNIT-I

**Bryophytes :** General characteristics; Classification by Bower; Distribution and life Cycle of *Marchantia*, *Porella*, *Anthoceros* and *Sphagnum*. Progressive sterilization of sporogenous tissue.

#### UNIT-II

**Pteridophytes-I :** General characteristics, classification by Smith, morphology, anatomy and reproduction of *Psilotum*, *Isoetes*, *Equisetum*. and *Marsilea*.

#### UNIT-III

**Pteridophytes-II :** Morphology, anatomy and reproduction of *Selaginella*, Heterospory & Seed Habit. Telome theory, Stellar Evolution.

**UNIT-IV**

**Gymnosperms** : General characteristics, classification by Chamberlain. Morphology, anatomy and reproduction of *Pinus*, *Ginkgo* and *Gnetum*.

**UNIT-V**

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

**Books Recommended**

1. Pteridophyta - P.C. Vasistha, A.K. Sinha & A. Kumar S. Chan Publications, Delhi, India.
2. An Introduction to Embryophyta Vol. I & II- N.S. Parihar Central Book Department, Allahbad.
3. A Text Book of Botany- V. Singh, P.C. Pandey & D.K. Jain, Rastogi Publications.
4. Gymnosperms - C.J. Chamberlain.

**PRACTICAL**

Time : 3 hours

Full Mark -30 Marks

1. Study of the morphology and anatomy of *Marchantia*, *Anthoceros* and *Sphagnum*.
2. Study of the morphology and anatomy of *Psilotum*, *Isoetes*, *Equisetum*, *Selaginella* and *Marsilea*.
3. Study of the morphology and anatomy of *Pinus*, *Ginkgo* and *Gnetum*.
4. Preparation of permanent slides of the above genera belonging to Bryophyta, Pteridophyta & Gymnosperms in the syllabus.
5. Study of slides of fossils included in the syllabus.

**+3 FIRST YEAR SECOND SEMESTER  
GENERIC ELECTIVE - II (GE-2) - BOTANY  
ANGIOSPERMS AND DEVELOPMENTAL BOTANY**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**UNIT-I**

**Taxonomy of Angiosperms** : Taxonomic categories, concept of species, Nomenclature, Elementary idea about ICN, classification of flowering plants proposed by (i) Bentham and Hooker (2) Engler & Prantle. General Account and floral character of the following families: Magnoliaceae, Lamiaceae, Apocyanaceae, Euphorbiaceae, Asclepiadaceae, Musaceae, Poaceae.

**UNIT-II**

**Embryology of Angiosperms and Plant breeding** : Microsporogenesis, Male gametophytes, Female gametophytes and megasporogenesis. Process of fertilization, structure and development of different types of endosperms, structure and development of monocot and dicot embryo. General account of plant breeding, pure line and mass selection.

**UNIT-III**

**Anatomy and Tissue culture**: Meristematic and permanent tissue, Epidermal, Fundamental, conductive tissue systems. Secondary growth in dicot stem and root. Adaptive and non -adaptive anomalous secondary growth in stem: *Bignonia*, *Bougainvillea*, *Amaranthus* and *Boerhaavia*. Concept of totipotency, principles and procedure of plant tissue culture.

**UNIT -IV**

**Economic Botany** : Origin and diversification of domesticated plants. General account of botany, cultivation and economic importance of Rice, Jute, Sugarcane, Green gram, Coconut. General account of the following medicinal and timber yielding plants; *Azadirachta*, *Ocimum*, *Aloe*, *Rauwolfia*, *Shorea* Tectona.

**UNIT -V**

**Plant Physiology:** Osmosis, plasmolysis, concept of water potential, Transpiration, water absorption, ascent of sap. Enzyme & enzyme action. Photosynthesis, translocation of photosynthates. Biological nitrogen fixation phytohormones (Auxins, Gibberellins, Cytokinins, Abscisic Acid).

**Books Recommended**

1. Plant Systematics- Theory and practice -G. Singh. Oxford & IBH Pvt. Ltd New Delhi..
2. Current concepts in plant Taxonomy -V.H Heywood.
3. An Introduction to plant Taxonomy -C Jeffery. Cambridge Press, Cambridge.
4. Taxonomy of Angiosperms-A.V.S.S. Sambamurty.
5. Modern Plant Taxonomy-N.S Subramaniam.
6. Taxonomy of Angiosperms - V. Singh & D. K. Jain Rastogi Publications.
7. Embryology of Angiosperms- S.S. Bhojwani & S.P. Bhatnagar.
8. Embryology of Angiosperms - V. Singh, P.C. Pande & D.K. Jain.
9. An Introduction to Embryology of Angiosperms - P. Maheswari.
10. Plant Anatomy- B.P. Pandey.
11. A. Text Book of Plant Anatomy -P.C. Vasistha.
12. Applications of Biotechnology- B.D. Singh.
13. Economic Botany- B.P. Pandey
14. Economic Botany in Tropics- S.L. Kochhar, Macmillan & Company, New Delhi India.
15. Plant Physiology- H.N. Srivastava.
16. Plant Physiology- V. Verma.
17. Plant Physiology- K.N. Bhatia and A.N. Parasher.

**PRACTICAL  
(PAPER-II)**

Time : 3 hours

Full Mark -30 Marks

1. Study of flowering plants belonging to the dicot families in the syllabus.
  2. Study of flowering plants belonging to the monocot families in the syllabus.
  3. Study of embryological slides related to the syllabus.
  4. Study of anomalous secondary growth of different plant species included in the syllabus (*Bignonia*, *Bougainvillea*, *Amaranthus* and *Boerrhaavia*).
  5. Study of economically important plants included in the syllabus.
  6. Determination of osmotic pressure by plasmolytic method.
  7. Determination of diffusion pressure deficit (DPD) of storage tissue.
  8. To measure the ratio between transpiration and absorption by T / A apparatus.
  9. Measurement of rate of photosynthesis by using Willmott's Bubbler under different light qualities and CO<sub>2</sub> concentration.
  10. Microscopic observation of opening and closing of stomata.
-



**+3 SECOND YEAR THIRD SEMESTER  
CORE COURSE - V (C-5) - BOTANY  
ANATOMY OF ANGIOSPERMS**

**Time: 3 Hours**

**End Semester Theory : 50 Marks**

**Credit: 6**

**Mid Semester : 20 Marks**

**UNIT-I**

**Introduction and scope of anatomy, Tissue:** Application of plant anatomy in systematics, forensics and pharamacognosy. Tissues: Meristem and meristematic tissue (Classification, distribution, structure and function), Permanent Tissues: Simple tissue (Structure, function and distribution of parenchyma, collenchymas, sclerenchyma) complex tissue (xylem and phloem), Secretory tissue (Laticiferous, glandular, Hydathodes and Nectaries).

**UNIT-II**

**Structural organization of Root, Stem and Leaf:** Organization of root apex (Apical cell theory, Histogen theory, korpor-kappe theory) Quiescent centre, Root cap, anatomy of dicot and monocot root. Organization of shoot apex (Apical cell theory, Histogen theory, Tunica corpus theory), Cytohistological zonation, Root-stem transitions, Origin of lateral roots. Anatomy of dicot and monocot stem. Anatomy of dicot and monocot leaf, Kranz anatomy.

**UNIT-III**

**Protective and ground tissue system :** Introduction to tissue system: Epidermal tissue system (Cuticle, epidermis), structure, classification, distribution and function of stomata, unicellular and multicellular trichomes, glandular and non-glandular hairs. Ground or fundamental tissue system: Structure and functions of cortex, endodermis, pericycle, pith and pith rays.

**UNIT-IV**

**Mechanical and Vascular tissue system:** Principle, organization, distribution and function of mechanical tissues in angiosperms. Structure and functions of primary vascular tissue: procambium, fascicular and inter fascicular cambium, origin and duration of cambium, cambium in monocots. Types of vascular bundles and their arrangement in roots and stem. Structure, organization and function of periderm in root and stem Rhytidome, lenticels.

**UNIT-V**

**Secondary growth and ecological anatomy:** Normal secondary growth in stem and root: Dendrochronology, annual ring, tyloses, sapwood and heart wood. Anomalous secondary growths (adaptive and non adaptive) abnormal secondary growth in dicot stem (*Bignonia, Aristolochia, Amaranthus, Bougainvillea, Boerhaavia, Achyranthus Chenopodium*), Monocot stem (*Dracaena*). Ecological anatomy: Anatomy of Hydrophytes, Xerophytes epiphytes & Halophytes .

**PRACTICAL**

**C - 5**

Time : 3 hours

Full Mark -30 Marks

1. Study of anatomical details through permanent slides/temporary stain mounts/macerations/museum specimens with the help of suitable examples.
2. Apical meristem of root, shoot and vascular cambium.
3. Distribution and types of parenchyma, collenchymas and sclerenchyma.
4. Xylem: Tracheary elements-tracheids, vessel elements; thickenings; perforation plates; xylem fibres.
5. Wood: Ring porous; diffuse porous; tyloses; heart- and sapwood.
6. Phloem: Sieve tubes-sieve plates; companion cells; phloem fibres.
7. Epidermal tissue system : cell types, stomata types; trichomes: non-glandular and glandular.
8. Root: Monocot, dicot, secondary growth.

9. Stem: Monocot, dicot- Primary and secondary growth; periderm; lenticels.
10. Leaf : isobilateral, dorsiventral, C4 leaves (Kranz anatomy)
11. Adaptive Anatomy : xerophytes, hydrophytes.
12. Secretory tissues: cavities, lithocysts and laticifers.
13. Study of anomalous secondary growth of different plant included in the syllabus.

#### Suggested Books:

1. Dickison, W.C. (2002), Integrative Plant Anatomy. Harcourt Academic press, USA.
2. Fahn. A. (1974). Plant Anatomy. Pergmon Press, USA.
3. Mauseth, J.D (1988), Plant Anatomy. The Benjamin/Cummings Publisher, USA.
4. Esau, K. (1977). Anatomy of seed plants. John Wiley & Sons, Inc, Delhi.
5. Pandey B.P. Plant Anatomy, S. Chand Publication.
6. Haberlandt- Anatomy
7. A Text Book of Botany, S.N. Pandey & Chadha, Vikas Publishing house Pvt. Ltd.

## +3 SECOND YEAR THIRD SEMESTER CORE COURSE - VI (C-6) - BOTANY ECONOMIC BOTANY

Time: 3 Hours

Credit: 6

End Semester Theory : 50 Marks

Mid Semester : 20 Marks

#### UNIT-I

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

#### UNIT-II

**Cereals, legumes, Sugar and Starches:** Wheat and Rice (Origin, morphology, processing & uses).  
Legumes: General account, importance to man and ecosystem.  
Sugar & Starches: Morphology and processing of sugarcane, Potato (Morphology, propagation & uses).

#### UNIT-III

**Spices, Beverages, Durg-yielding plants :** Listing of important spices, their family and part used, economic importance with special reference to Saffron, clove and Black pepper.  
Beverages: Tea, Coffee (Morphology, processing & uses)  
Drug-yielding plants: Therapeutic and habit-forming drugs with special reference to *Cinchona*, *Digitalis*, *Papaver* and *Cannabis*. Tobacco: Tobacco (Morphology, processing, uses and health hazards).

#### UNIT-IV

**Oils, Fats & Medicinal plants:** General description, extraction, their uses and health implications of groundnut, coconut, sunflower, and mustard (Botanical name, family & Uses)  
Medicinal plants: General accounts botanical name and uses of Tulsi, Aloe, Turmeric, Neem, Roubolfia.

#### UNIT-V

**Natural Rubber, Fibres and timber plants:** Rubber plant, morphology tapping, processing and uses.  
Timber plants: General account with special reference to Teak and Sal.  
Fibres: Cotton and jute (Morphology, processing and uses)

### PRACTICAL

C - 6

Time : 3 hours

Full Mark -30 Marks

1. Cereals: Rice (habit sketch, study of paddy and grain, starch grains, micro-chemical tests).
2. Legumes: Green Gram & Black Gram: Habit, fruit, seed structure.



3. Sugar & Starches: Sugarcane (Habit, sketch, cane juice-micro-chemical tests), Potato (habit sketch, tuber morphology, T.S. tuber to show localization of starch grains, w.m. starch grains, micro-chemical tests).
4. Spices: Black pepper, Clove (Specimen).
5. Beverages: Tea (specimen, tea leaves), Coffee (specimen).
6. Oils & Fats: Coconut, Mustard-plant specimen, seeds, tests for fats in crushed seeds.
7. Rubber: Specimen, photograph/model of tapping, samples of rubber products.
8. Drug-yielding plants: Specimens of *Digitalis*, *Papaver* and *Cannabis*, *Cinchona*.
9. Tobacco: Specimen and products of Tobacco.
10. Medicinal plants : Tulsi, Aloe, Turmeric, Neem, *Rouvolfia* (Specimen)
11. Woods: Tectona, Sal: (Specimen).
12. Fibre-yielding plants: Cotton (Specimen and test for cellulose), Jute (Specimen test for lignin).

#### Suggested Books:

1. Kochhar, S.L. (2012), Economic Botany in Topics, Macmillan & Co. New Delhi, India.
2. Wickens, G.E. (2001) Economic Botany: Principals & Practices. Kluwer Academic publishers, The Netherland.
3. Chrispeels, M.J, and Sadava, D.E. (2003), Plants Genes and Agriculture. Jones & Bartlett publishers.
4. Pandey, B. P. (2012). Economic Botany, S. Chand & Company Ltd. New Delhi.
5. Singh, V., Pandey, P.C. and Jain, D.K. (2005). Economic Botany. Rastogi publications, Meerut, India.

## +3 SECOND YEAR THIRD SEMESTER CORE COURSE - VII (C-7) - BOTANY GENETICS

Time: 3 Hours

Credit: 6

End Semester Theory : 50 Marks

Mid Semester : 20 Marks

#### UNIT-I

**Mendelian genetics and its extension:** Mendel's experiments and principles of inheritance, Chromosomal theory of inheritance, other paterrens of inheritance: incomplete dominance, co-dominance multiple alleles, Lethal alleles, Gene interaction: Complementary, supplementary, inhibitory, and Epistasis gene action, Pleiotropy, Penetrance and Expressivity.

#### UNIT-II

**Cytoplasmic Inheritance:** Characteristics of cytoplasmic inheritance. Plastid inheritance in *Mirabilis Jalapa* Mitochondrial inheritance in yeast. Cytoplasmic male sterility, Maternal effects of shell coiling in snail, Infective heredity: Kappa Particles in paramecium.

#### UNIT-III

**Linkage and Crossing over:** Linkage: coupling and repulsion, complete and incomplete linkage, linkage maps, sex linkage: Characteristics of sex-linkage, Inheritance of white eye in *Drosophila*. Crossing over: Molecular Mechanism, Cytological basis of crossing over, Recombination frequency, two point and three point cross, interference and coincidence.

#### UNIT-IV

**Variation in Chromosome number:** Euploidy: Haploidy: polyploidy: Origin types and effect of autopolyploids and allopolyploids, Aneuploidy: Origin cytology genetic effects of monosomics, nullisomics, trisomics. Applications of polyploids.

**Variation in chromosome structure:** Chromosomal aberrations: Origin, Types: cytology and genetic effects of Deletion, Duplication, Inversion and Translocation.

#### UNIT-V

**Fine Structure of gene:** Concept of gene, cis-trans complementation, test for functional allelism, Fine structure of rII locus in T4 phage.

**Mutation** : Types; Spontaneous and induced mutation, Molecular basis of gene mutation, Mutagens: Physical and chemical (Base analogues, deamination agent, alkylating agents), Detection of mutation: detection of sex linked lethal by CIB method and attached X method of Drosophila.

**Population and Evolutionary Genetics:** Gene and genotypic frequency, Hardy Weinberg's law, Genetic drift, Speciation, Genetic variation.

## PRACTICAL

### C - 7

Time : 3 hours

Full Mark -30 Marks

1. Mendel's laws through seed ratios. Laboratory exercise in probability and chi-square analysis.
2. Chromosome mapping using test cross data.
3. Pedigree analysis.
4. Incomplete dominance and gene interaction through seed ratios (9:7,9:6:1,13:3,15:1, 12:3:1,9:3:4)
5. Study of aneuploidy: Down's Klinefelter's and Turner's syndromes.
6. Photographs/permanent slides showing translocation Ring, Laggards and Inversion Bridge.
7. Determination of allelic frequency and genotypic frequency.

#### **Suggested Books:**

1. Gardner, E.J, Simmons, M.J, Snustad, D.P (1991), Principles of Genetics, John Wiley & Sons, India, 8th edition.
2. Snustad, D.P and Simmos, M.J. (2010), Principles of Genetics, John Wiley & sons inc. India, 5th edition.
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, Freeman and Co. U.S.A. 10th Edition.
5. Verma, P. S., and Agarwal (2009), Genetics, S Chand and Company Ltd 1st multi colour edition, New Delhi.
6. Singh, B. D., (2009) Genetics, Kalyani Publishers, 2nd edition, New Delhi.
7. Gupta, P. K. (1998), Genetics, Rastogi Publication, Meerut.

## +3 SECOND YEAR FOURTH SEMESTER CORE COURSE - VIII (C-8) - BOTANY MOLECULAR BIOLOGY

Time: 3 Hours

Credit: 6

End Semester Theory : 50 Marks

Mid Semester : 20 Marks

### UNIT-I

**Nucleic Acids:** Properties of genetic materials, The search for genetic material : Evidences of DNA as genetic material (Experiments of Griffith, Avery, Macleod and Mc Carty and Harshey and Chase), RNA as genetic material (Fraenkel- Conrat's Experiment) Constituents of nucleic acids (Phosphoric acids, Pentose sugar, Nitrogenous bases), nucleosides and nucleotides. Structure of DNA (Double helix model), alternative forms of DNA double helix (A,B and Z form), Organelle DNA (Mitochondrial, chloroplast). Structure of RNA.

### UNIT-II

**Replication of DNA:** DNA replication: Experimental evidence for semi conservative DNA replication in E.Coli: (Meselson and Stahl's experiment) Enzymes & proteins involved in DNA replication (DNA

polymerase, primase, ligase, Helicase, SS Binding Protein) Mechanism of DNA replication.

**DNA Sequencing:** Maxam and Gilbert's method, Sanger's method.

#### UNIT-III

**Chromosomes :** Chromosome number, size, shape morphology euchromatin, heterochromatin and ideogram chemical composition. C-value paradox, histones and non histones protein, nucleosome concept, polytenes chromosome and Lampbrush chromosome.

Genetic Code: Properties of genetic code, wobble hypothesis.

#### UNIT-IV

Expression of gene: Central dogma, Mechanism of transcription in prokaryotes, post-transcriptional processing of m-RNA. Translation: Process of translation in prokaryotes and difference between prokaryotes and eukaryotes, post translational modifications.

#### UNIT-V

**Regulation of gene expression:** Introduction and levels of regulations of gene expression. Regulations of gene action in prokaryotes: Transcriptional control mechanisms: negative control (inducible and repressible operon) positive control (Inducible and repressible), regulation of gene action in eukaryotes, hormonal control of gene expression, gene silencing.

### PRACTICAL

#### C - 8

Time : 3 hours

Full Mark -30 Marks

1. Preparation of LB medium and raising E.coli.
2. Isolation of genomic DNA from E. coli.
3. DNA isolation and RNA estimation by orcinol method.
4. DNA estimation by diphenylamine reagent/UV spectrophotometry
5. Study of DNA replication mechanisms through photographs (Rolling circle, Theta replication and semi-discontinuous replication).
6. Study of structures of prokaryotic RNA polymerase and eukaryotic RNA polymerase II through photographs.
7. Photographs establishing nucleic acid as genetic material (Messelson and Stahl's, Averyetal, Griffith's Hershey & Chase's and Fraenkel & Contrat's experiments),
8. Study of the following through photographs: Assembly of Spliceosome machinery: Splicing mechanism in group I & Group II introns; Ribozyme and Alternative splicing.

#### Suggested Books

1. Watson. J.D. Baker, T.A. Bell, S.P. Gann, A. Leine, 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 sons Inc. 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. Russell, P. J. (2010). IGenetics- A Molecular Approach. Benjamin Cummings, U.S.A., 3rd edition.
5. Griffiths, A.J.F., Wessler, S.R. Carroll, S.B. Doebley, J. (2010), introduction to Genetic Analysis W. H. Freeman and Co, U.S.A 10th edition.
6. Pal, Jayanta, K. Ghaskdbi (2009) Fundamental of molecular biology Oxford University press New Delhi.

**+3 SECOND YEAR FOURTH SEMESTER  
CORE COURSE - IX (C-9) - BOTANY  
PLANT ECOLOGY AND PHYTOGEOGRAPHY**

**Time: 3 Hours**

**End Semester Theory : 50 Marks**

**Credit: 6**

**Mid Semester : 20 Marks**

**UNIT-I**

**Introduction and components of Environment :** Concept and scope of ecology, autoecology, Synecology, system ecology, levels of organization. Inter-relationship between living world and environment. Components of environment (Hydrosphere, lithosphere, biosphere). Concept of biological stress and strain, dynamism, homeostasis, concept of habitat and niche, ecological equivalents.

**UNIT-II**

**Ecological Factors:** Climatic factors (Light and temperature, their variations, precipitation, humidity of air, atmospheric gases and wind-their variations, and adaptations of plants. Edaphic factor : Importance of soil, formation and composition, soil profile, physical properties of soil, soil erosion and conservation. Biotic factor-Relationship among organisms, positive interactions (Mutualism, Commensalism, Proto-Co-operation), Negative interactions (Exploitation, Antibiosis, Competition).

**UNIT-III**

**Population and Community ecology:** Basic concept, characteristics (Size and density, dispersion, age structure, natality and mortality) Biotic Potential, population dynamics. Community characteristics: Analytical and Synthetic characters-Methods of study of plant community (Raunkiaer's method and phytosociological method), species diversity. Community dynamics: General causes and process of succession (Hydrosere and xerosere), concept of climax.

**UNIT-IV**

**Ecosystems and pollution ecology:** kinds of ecosystem; structure and components of ecosystem (food chain, food web, ecological pyramids). Functional aspects of ecosystem: Principle and models of energy flow (Single channel and Y shaped channel), productivity, ecological efficiency, biogeochemical cycles of nitrogen, carbon and phosphorus. Pollution of air, water and thermal (causes, effects and control measures).

**UNIT-V**

**Conservation and Phytogeography:** Concept and classification of resources (Renewable, non renewable, their conservation and management). Concept of biodiversity, their depletion and conservation, Social forestry and Agro forestry. Phytogeography: Continental drift, endemism, major terrestrial biomes of the world (Tropical, rain forest, Grassland, Mangrove and Tundra). Phytogeographical division (Vegetation) regions of India. Vegetation of Odisha.

**PRACTICAL**

**C - 9**

Time : 3 hours

Full Mark -30 Marks

1. Determination of pH of various soil and water samples (pH meter, universal indicator and pH paper)
2. Analysis for carbonates, chlorides, nitrates, sulphates, organic matter from two soil samples.
3. To estimate dissolve oxygen content by Winkler's method.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes.  
(b) Study of biotic interactions of the following: Lichens, Stem parasite (Cuscuta), Root parasite (Orabanche), Epiphytes-predation (Insectivorous plants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus, by species area curve method.
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison

with (Raunkiaer's frequency distribution law), density abundance in the college campus.

7. Quantitative analysis of herbaceous vegetation for density and abundance in the college campus
8. Field visit to familiarize students with ecology of different sites.
9. Study of water holding capacity, porosity and moisture content of two different classes of soil.
10. To estimate the salinity of water samples.

#### Suggested Books:

1. Odum, E.P (2005) Fundamentals of ecology, Cengage Learning India Pvt. Ltd., New Delhi 5th edition.
2. Singh, J.S. Singh S.P Gupta, S (2006). Ecology Environment and Research Conservation, Anamaya publication, New Delhi, India.
3. Sharma, P.D. (2010), Ecology and Environment. Rastogi publications, Meerut, India, 8th edition.
4. Wilkinson, D.M. (2007) Fundamental processes in Ecology: An earthy systems Approach. Oxford University press, U.S.A.
5. Kormondy, E.J. (1996), Concepts of ecology. PHI Learning Pvt. Ltd. Delhi, India, 4th Edition.
6. Ms. S. Arora - Fundamental of Environmental Biology
7. Odum. E.P (1993), Basic Ecology, Sanders college publishing, Japan.
8. Dash M.C. (1995). Fundamentals of Ecology. Tata. Mc. Graw-Hill Publishing Company, Ltd. New Delhi.
9. Sukia, R.S & Chandel P.S. (2005), A. Text Book of Plant Ecology, S. Chand and Company Ltd. New Delhi.

## +3 SECOND YEAR FOURTH SEMESTER CORE COURSE - X (C-10) - BOTANY PLANT TAXONOMY & SYSTEMATICS

Time: 3 Hours

Credit: 6

End Semester Theory : 50 Marks

Mid Semester : 20 Marks

### UNIT-I

**Taxonomic and systematics:** Basic concept of Taxonomy and systematics, Goals and aims of plant systematic: Hierarchical categories of taxonomy, Herbarium techniques: Plant collection, pressing, drying, poisoning, mounting, labeling, storage and fumigation. Important botanical gardens of world and India. Plant identification: Character consider for identification, identification with Keys, Unconventional identification methods.

### UNIT-II

**Botanical nomenclature :** Concept of taxa (Family, genus, species). Concept of species (Taxonomic, biological, genetic, evolutionary). Plant nomenclature: Principle and rule of ICN (Typification, author citation, principle of priority and its limitations, valid publication, rejection of names and synonyms, names of hybrids).

### UNIT-III

**Systems of classification:** Major contributions of Theophrastus, Bauhin, Linnaeus, A.P. de Candolle, Artificial system of Classification by Linnaeus, Natural systems of classification by Bentham and Hooker, Phylogenetic system of classifications by Hutchinson and Engler and Prantl.

### UNIT-IV

**Modern trends in plant taxonomy:** Taxonomy in relation to anatomy, embryology, palynology. Cytotaxonomy, Chemo Taxonomy, Numerical taxonomy, Origin and evolution of Angiosperms.

### UNIT-V

**General Accounts and floral structure:** Dicot families : Magnoliaceae, Rosaceae, Rutaceae, Cucurbitaceae, Rubiaceae, Apocynaceae, Asclepiadaceae, Convolvulaceae, Lamiaceae, Acanthaceae and Asteraceae Monocot families: Orchidaceae, Musaceae, Zingiberaceae, Cyperaceae, Poaceae & Amaryllidaceae.



**PRACTICAL****C - 10**

Time : 3 hours

Full Mark -30 Marks

1. Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s floral formula/e and systematic position according to Bentham & Hooker's of classification).  
Dicot families : Magnoliaceae, Rosaceae, Rutaceae, Cucurbitaceae, Rubiaceae, Apocynaceae, Asclepiadaceae, Convolvulaceae, Lamiaceae, Acanthaceae and Asteraceae  
Monocot families: Orchidaceae, Musaceae, Zingiberaceae, Cyperaceae, Poaceae Amaryllidaceae.
2. Filed Visit for collection and identification of plants
3. Collection, identification and preparation of herbarium of plant species.

**Suggested Books:**

1. Singh G. (2012) plant systematic: Theory and practice. Oxford & IBH Pvt. Ltd, New Delhi. 3rd edition.
2. Jeffry, 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-A Phylogenetic Approach Sinauer Associates Inc. U.S.A. 2nd edition.
4. Maheshwari, J.K. (1963), Flora of Delhi. CSIR, New Delhi.
5. Radford, A.E. (1986). Fundamentals of plant Systematics. Harper and Row, New York.
6. Sharma O.P (1993) Plant Taxonomy. Tata Mc. Graw- Hill Publishing company limited, New Delhi.
7. Pandey, H.P (2009). Plant Taxonomy (Principle and practice). Silverline publications, New Delhi.
8. Sambamurty, A.V.S.S., Taxonomy of Angiosperms
9. Singh. V. & Jain D.K. Taxonomy of Angiosperms by Rastogi publication, Meerut.
10. Saxena, N.B and Saxena Samindra -Plant Taxonomy Pragati prakashan, Meerut (8th edition -2012)

**+3 FINAL YEAR FIFTH SEMESTER  
CORE COURSE - XI (C-11) - BOTANY  
REPRODUCTIVE BIOLOGY OF ANGIOSPERMS**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**UNIT-I**

**Introduction, Microsporogenesis and Male gametophyte:** Scope, Contributions of S.G Nawaschin and P. Maheswari to Embryology. Microsporogenesis: Microsporangium, Anther wall (Structure and functions) sporogenous tissue, microsporetetrads. Male gametophyte: Structure of pollen grain, Development of Male gametophyte, pollen sterility, NPC system, scope of palynology.

**UNIT-II**

**Megasporogenesis, Female gametophyte :** Megasporogenesis: Types of ovules, integuments, micropyle, nucellus, special structures (endothelium, Obturator, aril, caruncle) Hypostase, epistase, megasporogenesis.

**Female gametophyte:** Mono, bi and tetrasporic embryo sacs, Detailed structure of mature polygonum type of embryo sac( Synergids, egg, antipodals, central cell). Haustorial behaviour of embryo sac. Nutrition to embryo sac.

**UNIT-III**

**Fertilization and Endosperm:** Path of pollen tube, Entry of pollen tube into the ovule and embryo sac, pollen tube discharge, syngamy, double fertilization and triple fusion.

**Endosperm and Embryo:** Endosperm: Development of endosperm Types (Nuclear, Cellular, Helobial & Mosaic), endosperm haustoria, Xenia & Metaxenia.

**UNIT-IV**

**Embryo and self incompatibility:** Embryo development in dicots and monocots: Details of development of typical dicot and monocot embryo, suspensor, nutrition to embryo, embryo development in Paeonia.

**Self incompatibility:** Basic concepts (interspecific, intraspecific, homomorphic, Heteromorphic, GSI and SSI); Methods to overcome self-incompatibility.

**UNIT-V**

**Polyembryony and development of seeds:** Polyembryony: Origin, classification, causes and practical applications of Polyembryony. Apomixis: Types and significance. Seed: Development of Seed

**PRACTICAL****C -11**

Time : 3 hours

Full Mark -30 Marks

1. Anther: Wall and its ontogeny; Tapetum (Amoeboid and glandular); MMC, spore tetrads, uninucleae, bicelled and dehisced anther stages through slides/micrographs, male germ unit (MGU) through photographs and schematic representation.
2. Pollen grains: Fresh and acetolyzed showing ornamentation and aperture, pseudomonads, polyads, pollinia (Slides/Photographs, fresh material), ultra structure of pollen wall (micrograph); Pollen viability; Tetrazolium test. Germination: calculation of percentage germination in different media using hanging drop method.
3. Various types of Ovule: Types-anatropous, orthotropous, amphitropous/ campylotropous, circinotropous, unitegmie, bitegmie, Tenuinucellate and crassinucellate: special structures: Endothelium, obturator, hypostase, caruncle and aril (Permanent slide/ specimens/photographs).
4. Female gametophyte through permanent slides/photographs: Types, ultra structure of mature egg apparatus.
5. Intra-ovarian pollination: Test tube pollination through photographs.
6. Endosperm: Dissections of developing seeds for endosperm (*Cucurbita pepo*) seed.
7. Embryogenesis: Study of development of dicot embryo through permanent slides; dissection of developing seeds for embryos at various development stages; study of suspensor through electron micrographs.
8. To trace the path of pollen tube

**Suggested Books:**

1. Bojwani, S.S., Bhatnagar, S.P And Dant, P.K.,(2015). The Embryology of Angiosperm, Vikas Publishing House. Delhi, 5th edition.
  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. Singh. V. Pandey P.C. and Jain D.K. Embryology.
  6. Singh, Pandey and Jain (2011), Rastogi Publication, Meerut.
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**+ 3 FINAL YEAR FIFTH SEMESTER  
CORE COURSE - XII (C-12) - BOTANY  
PLANT PHYSIOLOGY**

**Time: 3 Hours**

**End Semester Theory : 50 Marks**

**Credit: 6**

**Mid Semester : 20 Marks**

**UNIT-I**

**Plant water relations:** Diffusion, osmosis, plasmolysis, imbibition, water potential and its components, Mechanism of absorption of water, path of water across the root, Transpiration: Types, mechanism of stomatal movement, factors affecting transpiration, significance of transpiration, Antitranspirants.

**UNIT-II**

**Mineral nutrition and Mineral salt absorption :** Criteria of essentiality, Essential elements: Macro and micro elements: their functions and deficiency symptoms, methods of determination of the mineral requirements of plants (Plant analysis. Hydroponics, solid medium culture). Mineral salt absorption: mechanisms of ion uptake Passive uptake (Diffusion, Ion exchange, Donnan equilibrium, mass flow) and active uptake.

**UNIT-III**

**Translocation in plants:** Ascent of sap: Path of water, mechanism of ascent of sap, Phloem transport: Movement in phloem, Direction of movement, source-Sink relationship, phloem loading and phloem unloading, mechanism of phloem transport.

**UNIT-IV**

**Plant growth regulators:** Discovery, Basic structure. Bio-assay, Biosynthesis and Physiological roles of Auxins, Gibberellins, Cytokinins. Abscisic acid, Ethylene.

**UNIT-V**

**Plant Development :** Physiology of flowering: Photoperiodism: Critical day length and photoperiodic induction. Role of phytochrome in the flower initiation, vernalization. Seed dormancy and germination: Factors causing dormancy of seeds and methods of breaking seed dormancy, factors essential for seed germination. Biochemical changes during seed germination Senescence: Types, causes, Physiology.

**PRACTICAL**

**C - 12**

Time : 3 hours

Full Mark -30 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 relation between transpiration and transpiring surface.
4. Calculation of stomatal index and stomatal frequency from both the surfaces of leaves.
5. Cuticular resistance of a xerophytes to transpiration.
6. Microscopic observation of opening and closing of stomata.
7. Measurement of rate of imbibitions in seeds.

**Suggested 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, 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. Verma, V. (2009), Text Book of Plant physiology, Ane Books Pvt. Ltd (New Delhi)
5. Salisbury F.B. & Ross C. W. (2005). Plant physiology C.B.S. publishers and distribution Pvt. New Delhi.



6. Srivastava H.N. (2013) Plant physiology. Pradeep publication Jalandhar.
7. Pandey, S.N. and Sinha, B.K. (2015) plant physiology Vikas publishing house Pvt. Ltd. Noida.
8. Jain, V.K. (2014) Fundamental of plant physiology S.Chand & company Pvt. Ltd.

**+ 3 FINAL YEAR SIXTH SEMESTER  
CORE COURSE - XIII (C-13) - BOTANY  
PLANT METABOLISM**

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

**UNIT-I**

**Concept of metabolism and Bioenergetics:** Introduction, anabolism and catabolism, Bioenergetics: Laws of thermodynamic with relation to biological system, enthalpy, entropy, Gibbs free energy, Redox potential.

**UNIT-II**

**Photosynthesis :** Historical back ground, photosynthetic pigments, light absorption the red drop and Emerson enhancement effect, photosystems, photosynthetic electron transport and photo phosphorylation. CO<sub>2</sub> reduction: Calvin cycle, C<sub>4</sub>-cycle, Crassulacean Acid Metabolism, photorespiration, factors affecting photosynthesis, synthesis.

**UNIT-III**

**Carbon of Oxidation starch and sucrose:** Respiration: Aerobic & anaerobic Respiratory substrate, RQ Glycolysis, regulation of glycolysis, metabolic fate of pyruvate, TCA cycle, Electron transport and oxidative phosphorylation, Mechanism of ATP synthesis, pentose phosphate pathway.

**UNIT-IV**

**Lipid metabolism:** Biosynthesis and oxidation of triglyceride: Biosynthesis: Synthesis of fatty acids, glycerol and condensation of fatty acid and glycerol. Oxidation: Hydrolysis of fat, metabolism of glycerol, oxidation of fatty acids: ( $\alpha$ -oxidation.  $\beta$ -oxidation). Conversion of fats into carbohydrates (Glyoxylate cycle)

**UNIT-V**

**Nitrogen and sulfur metabolism :** Physical and Biological nitrogen fixation: (symbiotic and non-symbiotic); Physiology and biochemistry of nitrogen fixation; Nitrate reduction in plants, Nitrogen assimilation: (Reductive amination and transamination), source and role of sulphur in higher plants, sulphate assimilation in plant.

**PRACTICAL**

**C - 13**

Time : 3 hours

Full Mark -30 Marks

1. Extraction and estimation 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 to carbon dioxide on the rate of photosynthesis.
5. Separation of photosynthetic pigments by paper chromatography.
6. To demonstration activity of Nitrate Reductase/Catalase.
7. To study of seed viability.
8. Demonstration of absorption spectrum of photosynthetic pigments.
9. To study the induction of amylase activity in germinating seeds.
10. Test for viability of seeds.
11. Photo reduction of dyes by isolated chloroplast.

**Suggested 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. CONN, Eric. E. Sampf P.K. Bruening G. Doi, R.H. (2007) out line of biochemistry Jhon Wiley and sons Singapur.
5. Pandey, S.N. and Sinha, B.K. (2015) plant physiology Vikas publishing house Pvt. Ltd. Noida.
6. Jain, V.K. (2014) Fundamental of plant physiology S.Chand & company Pvt. Ltd.
7. Srivastava H.N. (2013) Plant physiology. Pradeep publication Jalandhar

### + 3 FINAL YEAR SIXTH SEMESTER CORE COURSE - XIV (C-14) - BOTANY PLANT BIOTECHNOLOGY

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

#### UNIT-I

**Plant Tissue Culture** : Historical perspective, concept of totipotency: basic techniques of plant tissue culture, composition of culture media (MS, B5 and white's media). Types of culture: Cell culture, suspension culture, single cell isolation and culture. Organogenesis, embryogenesis, Application of tissue culture in agriculture, horticulture and forestry, micropropagation, Secondary metabolites in plant tissue culture.

#### UNIT-II

**Protoplast culture and somatic hybridisation** : Isolation and culture of protoplast. Somatic hybridization method and application, cybrids. Somaclonal variations. Production of haploid plants: Androgenesis, Gynogenesis. Germplasm conservation and cryopreservation.

#### UNIT-III

**Recombinant DNA technology-I**: Restriction Endonucleases: types of RE, Nomenclature, recognition sequences, cleavage patterns. Cloning vectors: Plasmids (PBR 322, PUC 18/19), Bacteriophage Vector (Lambda phage, phage M-13) cosmids, shuttle vectors. Gene cloning: generation of desired DNA fragments, insertion of DNA in to cloning vector, introduction of vector recognition.

#### UNIT-IV

**Recombinant DNA technology -II**: Gene construct: construction of genomic and cDNA libraries, screening DNA libraries to obtain desired gene by genetic selection, complementation, colony hybridization, probes-oligonucleotide, PCR. Agrobacterium- mediated gene transfer method, direct gene transfer by Electroporation, Microinjection, Microprojectile bombardment. Selection of transgenics - selectable marker and reporter genes. DNA finger printing.

#### UNIT-V

**Applications of Biotechnology** : Pest resistant (Bt-cotton); herbicide resistant plant (Round up Ready soybean); Transgenic crops with improved quality traits (Flar Savr Tomato, Golden rice); Role of transgenics in bioremediation (Superbug); edible vaccines; Industrial enzymes (Aspergillase, Protease, Lipase).

### PRACTICAL

#### C - 14

Time : 3 hours

Full Mark -30 Marks

1. (a) Preparation of MS medium.  
(b) Demonstration of in vitro sterilization and inoculation methods using leaf and nodal explants of,

**Datura, Brassica etc.**

2. Study of anther, embryo and endosperm culture, micropropagation, somatic embryogenesis & artificial seeds through photographs.
3. Isolation of protoplasts.
4. Construction of restriction map of circular and linear DNA from the data provided.
5. Study of methods of gene transfer through photographs: Agrobacterium-mediated, direct gene transfer by electroporation, microinjection, microprojectile bombardment.
6. Study of steps of genetic engineering for production of Bt cotton, Golden rice, Flavr Savr tomato through photographs.
7. Restriction digestion and gel electrophoresis of plasmid DNA.
8. Preparation of artificial seeds (by taking root or shoot apex).

**Suggested 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. Paternak, J.J. (2003). Molecular Biotechnology-Principles and Applications of recombinant DNA, ASM Press, Washington.
3. Bhojwani, S.S. and Bhatnagar, S.P (2011). The Embryology of Angiosperms. Vikas Publication house Pvt. Ltd. New Delhi. 5th edition.
4. Snustad, D.P. and Simmons, MJ. (2010), Principles of Genetics, John Wiley and Sons, U.K. 5th edition.
5. Stewart, C.N Jr. (2008) Plant Biotechnology & Genetics: Principles, Techniques and Applications. John Wiley & Sons Inc. U.S.A.
6. Chawla, H.S (2010). Introduction to plant Biotechnology. Oxford & IBH Publishing Co.Pvt. Ltd., New Delhi.
7. Singhy, B.D. (2010) Biotechnology: Expanding Horizon, Kalyani Publishers New Delhi.
8. Satyanarayan U (2012). Biotechnology. Books and allied (P), Kolkata.
9. De, Kalyan Kumar and introduction to plant tissue culture New Central Book Agency (P) Ltd. Kolkatta.

## + 3 THIRD YEAR FIFTH SEMESTER DSE- I - BOTANY BIostatISTICS

**Time: 3 Hours****Credit: 6****End Semester Theory : 50 Marks****Mid Semester : 20 Marks****UNIT-I**

**Biostatistics:** Definition, Characteristics, limitation and uses of biostatistics statistical terms, collection and classification of data, sampling and statistical error, methods of presentation of statistical data.

**UNIT-II**

**Frequency Distribution:** Introduction, types and terms associated with frequency distribution (class, class interval, class limit, class width, class frequency, total frequency, percentage frequency, frequency density, cumulative frequency. Graphical representation of data. Types and modes of graphical representation of ungrouped and grouped data. (Line diagram, Bar diagram, pie chart, Histogram, Frequency, Polygon, Ogives)..

**UNIT-III**

**Central Tendency :** Measures of central tendency, arithmetic mean, median, mode, its merits and demerits, others measures of central tendency, quartiles, deciles and percentiles, measures of variation-Dispersion, Range, Mean deviation, standard deviation (merits and demerits), Co-efficient of variation, standard error of mean.

**UNIT-IV**

**Normal Distribution:** Definition and properties of normal distribution, uses of normal distribution. Correlation and Regression: Types and methods studying correlation, types and methods of studying regression. Difference between correlation and regression.

**UNIT-V**

**Statistical inference:** Comparison of means of two small sample (Student's t'-test comparison of means of two large sample chi-square test, Null hypothesis, degrees of freedom, level of significance, Test for goodness of fit (pearsonian-  $x^2$ )

**PRACTICAL**  
**DSE - I**

Time : 3 hours

Full Mark -30 Marks

1. Calculation of mean, standard deviation and standard error.
2. Calculation of correlation coefficient values
3. Student's t'-test
4. Chi square test
5. Calculation of different measures of central tendency, dispersion skewness and kurtosis.
6. Calculation of simple correlation and regression lines, rank correlation.
7. Construction of frequency distribution table, histogram & frequency polygon.
8. Calculation of multiple and partial correlation coefficients.
9. Tests of significance based on Normal t and  $x^2$  distribution.

**Suggested Books:**

1. Biostatistics, Dannel, W.W. 1987, New York, John Wiley Sons.
2. An introduction to Biostatistics, 3rd edition, Sundarrao, P.S.S. and Richards, J. Christian Medical College, Vellore.
3. Statistical Analysis of epidemiological data, Selvin, S. 1991, New York University press.
4. Statistics for biology, Boston, Bishop, O.N. Houghton, Mifflin.
5. The Principles of Scientific research, freedman, P. New York, Pergamon Press.
6. Statistics for Biologists, Campbell, R.C. 1998, Cambridge University press.

**+ 3 THIRD YEAR FIFTH SEMESTER**  
**DSE- II - BOTANY**  
**PLANT BREEDING**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**UNIT-I**

**Plant breeding:** Introduction and objectives. Methods of reproduction in relation to plant breeding. Natural mating systems: Features and genetic consequences (Natural self Pollination, Natural cross-pollination often-cross pollination)

**UNIT-II**

**Method of crop improvement:** Plant introduction and acclimatization, Selection: Natural selection, artificial selection : Mass selection, pure line selection clonal selection for self and cross pollinated plants.

**UNIT-III**

**Hybridization :** Hybridization procedure: Selection of parents, selfing of parents, Hybridization technique (Emasculation, Bagging, crossing, labeling) Harvesting the hybrid seeds and raising F1 generation, Hybridization method of self pollinated crops (Pedigree method, Bulk method, Back cross method) and cross pollinated crops (single cross, three way cross, double cross, Top cross) Advantage and limitations of hybridization.

**UNIT-IV**

**Inbreeding and heterosis (Hybrid vigour):** Phenotypic consequences of inbreeding: Inbreeding depression, Genetic basis of inbreeding, inbreeding for crop improvement. Heterosis: Types, Effects, causes, applications and Genetic basis of heterosis.

**UNIT-V**

**Crop improvement :** Mutation breeding Role of polyploidy in plant breeding. Importance of plant breeding on modern agriculture, Role of Biotechnology in crop improvementf.

**PRACTICAL****DSE - II**

Time : 3 hours

Full Mark -30 Marks

1. Study of plant breeders Kit and its component.
2. General procedure of selfing and crossing techniques in plant.
3. Study of reproductive morphology and floral biology and crop plant.
4. Reproduction morphology, floral biding, and cross techniques in cereals (Rice), pulse (Green gram), oil seeds (groundnuts and sun flower).

**Suggested Books:**

1. Singh, B.D. (2005) plant breeding: Principles and methods. Kalyani Publishers, 7th edition, New Delhi.
2. Choudhari, H.K. (1984 Elementary Principles of plant breeding, Oxford and IBH publishing co, New Delhi.
3. Sharma, J.R. (1994) principles and practice of plant breeding. Tata Mc Graw Hill publishing company Ltd. New Delhi.

**+ 3 THIRD YEAR SIXTH SEMESTER****DSE- III - BOTANY****INDUSTRIAL AND ENVIRONMENTAL MICROBIOLOGY**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**UNIT-I**

**Industrial fermentation and Bioreactors :** Introduction and scope of industrial microbiology. Isolation and screening of industrial important microorganisms. Fermentation, Types and process of fermentation. Bioreactor: Design operation and principles of a typical bioreactor, types of bioreactors. Downstream processing.

**UNIT-II**

**Microbial production of Aminoacids, Enzymes and Alcoholic Beverages :** Production of amino acids: Lysin, Glutamic acid. Production of enzymes: commercial amylase, pectinase, cellulase and glucose isomerase. Industrial production of Beer, Toddy, and Rum. Microbial production of single cell protein.

**UNIT-III**

**Microbial production of Antibiotics, Biofertilizers, Biofuels and dairy products:** Antibiotic production: Penicillin, Streptomycin. Vaccines: Types of vaccines, production of Hepatitis, Polio, Myelieties Rabies: Mass production of Rhizobium biofertiliser and Azolla. General account of Biopesticides and Bio-herbicides. Production of biogas. Processing of milk. Dairy products: Cheese, Yogurt.

**UNIT-IV**

**Microbes in Air and Water:** Distribution of microbes in air. Isolation and control of indoor air borne micro organisms. Microbial components of water. Microbial indicator of water pollution. Role of microbes in sewage and domestic waste-water treatment. Determination BOD and COD of water samples. .

**UNIT-V**

**Microbes in Soil and Agriculture :** Soil microflora. Mycorrhizae. Bioremediation. Bioleaching. Composting technology. Role of microbes in biogeochemical cycles of nitrogen and carbon.

**PRACTICAL****DSE - III**

Time : 3 hours

Full Mark -30 Marks

1. Principle and functioning of instrument in microbiology laboratory.
2. Isolation of microbes from water, air, soil and sewage
3. Isolation of Rhizobia from Root Nodules.
4. Qualitative and quantitative estimation of microbial enzymes.
5. Study of fermentation process.
6. Determination of BOD and COD.
7. Study of mycorrhizal colonization in plant roots.

**Suggested Books:**

1. Pelzar, M.Jr. Chen. E.C.S. Krieg. N.R. (2010) Microbiology: An application based approach. Tata Mcgraw Hill Education Pvt. Ltd. Delhi.
2. Tortora, G.J. Funke, B.R. Case. C.L. (2007). Microbiology. Person Benjamin Cummings, San Francisco, U.S.A. 9th edition.
3. Sivakumar, P.K. Joe, M.M. and Sukesh, K., (2010) An introduction to industrial Microbiology. S. Chan & Company Ltd., New Delhi.
4. Sharma, K. (2011), Text Book of Microbiology. Ane Books Pvt. Ltd., New Delhi.
5. Sharma, P,D ( 2010). Microbiology. Rastogi publication, Meerut.
6. Dubey R.C. and Maheshwari, D.K,. (2013). A Text Book of Microbiology. S. Chand & Company Ltd., New Delhi.
7. Agrawal, A.K. and Parihar Pradeep, (2008) Industrial Microbiology Agrobios India,, Jodhur.

**+ 3 THIRD YEAR SIXTH SEMESTER  
DSE- IV - BOTANY  
(PROJECT)**

Credit : 6

Marks : 100





# CHEMISTRY

## +3 FIRST YEAR FIRST SEMESTER

### CORE COURSE - I (C - 1)

### INORGANIC CHEMISTRY - I

Time: 3 Hours  
Credit: 6

End Semester Theory : 50 Marks  
Mid Semester : 20 Marks

#### Unit-1

**ATOMIC STRUCTURE** : Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrodinger's wave equation, significance of  $\Psi^1$  and  $\Psi^2$ . Quantum numbers and their significance. Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for Hydrogen atom. Radial and angular distribution curves. Shapes of s,p,d and f orbitals Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

#### Unit-2

**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-block. (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/Mulliken's/ Allred Rachow's/ and Mulliken-Jaffe's electronegativity scales. Variation of electronegativity with bond order, partial charge and hybridization. Group electronegativity, Senderson's electron density ratio.

#### Unit-3

##### CHEMICAL BONDING-1 :

- Ionic bond: General characteristics, type of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals. Born-Landé equation with derivation and importance of (Kapustinskii expression for of Madelung constant lattice energy). Born-Haber cycle and its application, solubility of ionic solids, solvation energy.
- 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 of ionic character from dipole moment and electronegativity difference.

#### Unit -4

- Covalent bond : Lewis structure, Valence Bond theory (Heitler-London approach). Energetic of hybridization, equivalent and non-equivalent hybrid orbitals. Bent's rule, Resonance and Resonance energy.
- M.O.T : Molecular orbital theory, Molecular orbital diagrams of diatomic and simple and simple polyatomic molecules  $N_2$ ,  $O_2$ ,  $C_2$ ,  $B_2$ ,  $F_2$ , CO, NO, and their ions; HCl,  $BeF_2$ ,  $CO_2$ , (Idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond pairs of electrons, multiple bonding (sigma) and (pi) bond approach and bond length.

#### Unit -5

##### CHEMICAL BONDING-II :

- Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.

- (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 Hydrogen bonding on melting and boiling points of compounds Solubility. Energetics of dissolution process.

**OXIDATION-REDUCTION:**

- (iii) Redox equations, Standard Electrode Potential and its application to inorganic reactions. Principles involved in volumetric analysis like permanganometry, dischromatometry and Iodometry.

**Reference Books:**

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and McDaniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

**PRACTICAL  
CHEMISTRY LAB : C-I-LAB**

Time - 3hrs

Full Marks : 30 Marks

(Expt. - 15, Viva Voce - 10 & Lab. Record - 5)

**(A) Titrimetric Analysis**

- (i) Calibration and use of apparatus  
(ii) Preparation of solutions of different Molarity/Normality of titrants

**(B) 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

**(C) Oxidation-Reduction Titrimetry**

- (i) Estimation of Fe(II) and oxalic acid using standardized  $\text{KMnO}_4$  solution and standard oxalic acid. Estimation of Fe(II) with  $\text{K}_2\text{Cr}_2\text{O}_7$  using internal (diphenylamine, N-phenyl-anthranilic acid) and external indicator.

**Reference text :**

Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

**+3 FIRST YEAR FIRST SEMESTER  
CORE COURSE - II (C - 2) - CHEMISTRY  
PHYSICAL CHEMISTRY - I**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**Unit-1**

**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  $\sigma$  from  $\eta$  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.



**Unit-2****GASEOUS STATE - II**

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, vander Waals equation of state, its derivation and application in explaining real gas behaviour, mention of other equations of state (Berthelot, Dietrici); virial equation of state; van der Waals equation expressed in virial form and calculation of Boyle temperature. Isotherms of real gases and their comparison with van der Waals isotherms, continuity of states, critical state, relation between critical constants and van der Waals constants, law of corresponding states. '

**Unit-2****LIQUID STATE**

(i) Qualitative treatment of the structure of the liquid state; Radial distribution function; 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-I**

(ii) 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 and their dissociation constant, Ostwald's dilution law pH Scales, common ion effect; Dissociation constants of mono, di and triprotic acids.

**Unit-4****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, qualitative idea of point and space groups, 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. Glasses and liquid crystals.

**Unit-5****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 Hydrolysis and hydrolysis constants.

**Reference Books:**

- Atkins, P. W. & Paula, J. de Atkin's Physical Chemistry Ed., Oxford University Press 13 (2006).
- Ball, D. W. Physical Chemistry Thomson Press, India (2007).
- Castellan, G. W. Physical Chemistry 4th Ed. Narosa (2004). • Mortimer, R. G. Physical Chemistry 3rd Ed. Elsevier: NOIDA, UP (2009).

**PRACTICAL  
LAB : C-II - LAB-2**

Time - 3hrs

Full Marks : 30 Marks

(Expt. - 15, Viva Voce - 10 &amp; Lab. Record - 5)

**1. 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.
2. **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.
3. **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.

#### Reference Books

- Khosla, B. D.; Garg; V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co. :New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman. & Co.: New York (2003).

## +3 FIRST YEAR FIRST SEMESTER GE - I - CHEMISTRY

### ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY & ALIPHATIC HYDROCARBONS

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

#### Section A: Inorganic Chemistry

##### Unit-1 : Atomic Structure

- (a) Review of: Bohr's theory and its limitations, dual behaviour of matter and radiation, de-Broglie's relation, Heisenberg Uncertainty principle. Hydrogen atom spectra. Need of a new approach to Atomic structure.
- (b) What is Quantum mechanics? Schrodinger equation and meaning of various terms in it. Significance of  $\psi$  and  $\psi^2$ , Schrodinger equation for hydrogen atom. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers  $m_l$  and  $m_s$ . Shape of s, p and d and f atomic orbitals, nodal planes. Spin quantum number ( $s$ ) and magnetic spin quantum number ( $m_s$ ).
- (c) 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-2: Chemical Bonding and Molecular Structure

- (a) Ionic Bonding: General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage of ionic character.
- (b) 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 of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and NO<sup>+</sup>. Comparison of VB and MO approaches.

## Section B: Organic Chemistry

### Unit-3: 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: Benzenoids and Hückel's rule.

### Unit-4 : Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge ' Formula, Newman, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms).

Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

### Unit-5 : Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Alkanes:** (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction, Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

**Alkenes:** (Upto 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<sub>4</sub>) and trans-addition (bromine), Addition of HX (Markownikoff's and anti-Markownikoff's addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

**Alkynes:** (Upto 5 Carbons) Preparation: Acetylene from CaC<sub>2</sub>; and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline KMnO<sub>4</sub>, ozonolysis and oxidation with hot alk. KMnO<sub>4</sub>.

### Reference Books:

- J. D. Lee: A new Concise Inorganic Chemistry, E. L. B. S.
- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- Douglas, McDaniel and Alexander: Concepts and Models in Inorganic Chemistry, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
- T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry. Orient Longman.
- E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill. \* f. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

**PRACTICAL  
GE - 1**

Time - 3hrs

Full Marks : 30 Marks

(Expt. - 15, Viva Voce - 10 &amp; Lab. Record - 5)

**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  $\text{KMnO}_4$ .
3. Estimation of water of crystallization in Mohr's salt by titrating with  $\text{K}_2\text{MnO}_4$ .
4. Estimation of Fe (II) ions by titrating it with  $\text{K}_2\text{Cr}_2\text{O}_7$  using internal indicator.
5. Estimation of Cu (II) ions iodometrically using  $\text{Na}_2\text{S}_2\text{O}_3$ .

**Section B: Organic Chemistry**

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the  $R_f$  value in each case (combination of two compounds to be given)
  - (a) 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
  - (b) Identify and separate the sugars present in the given mixture by paper chromatography.

**Reference Books:**

- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
- Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

**+3 FIRST YEAR SECOND SEMESTER  
CHEMISTRY  
ORGANIC CHEMISTRY - I**

Time: 3 Hours  
Credit: 6

End Semester Theory : 50 Marks  
Mid Semester : 20 Marks

**Unit-1 : BASICS OF ORGANIC CHEMISTRY:**

Organic Compounds: Classification, and Nomenclature. Hybridization, Shapes of molecules, Influence of hybridization on bond properties.

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, formal charges; Electrophiles and Nucleophiles; Nucleophilicity and basicity; Types, shape and their 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 - 2 : STEREOCHEMISTRY**

Fischer Projection, Newmann and Sawhorse Projection formulae 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 two or more chiral-centres, Diastereoisomers, meso structures, Racemic mixture and resolution. Relative and absolute configuration: D/L and R/S designations.

### Unit - 3 : CHEMISTRY OF ALIPHATIC HYDROCARBONS

#### Carbon-Carbon pi bonds:

Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions. Saytzeff and Hofmann eliminations.

Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylic bromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene. 15 Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

### Unit - 4 : Cycloalkanes and Conformational Analysis

Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformational analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat . forms; Relative stability with energy diagrams.

### Unit - 5 : AROMATIC HYDROCARBONS

Aromaticity: Huckel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

#### Reference Books:

- Morrison, R.N. & Boyd, R.N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. & Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

### PRACTICAL

#### LAB : C - III - LAB-3

Time - 3hrs

Full Marks : 30 Marks

(Expt. - 15, Viva Voce - 10 & Lab. Record - 5)

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:
  - a. Water
  - b. Alcohol
  - c. Alcohol-Water
3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point - mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds, (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography
  - a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
  - b. Separation of a mixture of two sugars by ascending paper chromatography
  - c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

**Reference Books**

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- 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 COURSE - IV (C - 4) - CHEMISTRY  
PHYSICAL CHEMISTRY - II**

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

**End Semester Theory : 50 Marks**  
**Mid Semester : 20 Marks**

**Unit-1 : CHEMICAL THERMODYNAMICS - I**

- (i) 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.

- (ii) 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 (Kirchhoffs equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

**Unit-2 : CHEMICAL THERMODYNAMICS - II**

- (i) Second Law: statement of the second law of thermodynamics; Carnot cycles, efficiency of Carnot engine, Carnot's theorem. Thermodynamic scale of temperature, Concept of entropy; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes. Entropy of mixing of gases.
- (ii) Third Law : Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

**Unit-3 : CHEMICAL THERMODYNAMICS - III**

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; inversion temperature; Gibbs-Helmholtz equation; Maxwell 17 relations; thermodynamic equation of state.

Partial molar quantities, dependence of thermodynamic parameters on composition; GibbsDuhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

**Unit-4 : 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. Coupling of exoergic and endoergic reactions. 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); equilibrium between ideal gases and a pure condensed phase.

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**Unit-4 : SOLUTIONS AND COLLIGATIVE PROPERTIES:**

Dilute solutions; lowering of vapour pressure. Raoult's and Henry's Laws and their applications. Excess thermodynamic functions. 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.

**Reference Books**

- Peter, A. & Paula, J. de. Physical Chemistry 9th Ed., Oxford University Press (2011).
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. Molecular Thermodynamics Viva Books Pvt. Ltd.: New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Levine, I. N. Physical Chemistry 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C.R. 2000 solved problems in chemistry, Schaum Series (2006)

**PRACTICAL  
LAB : C-IV-LAB-4**

Time - 3hrs

Full Marks : 30 Marks

(Expt. - 15, Viva Voce - 10 &amp; Lab. Record - 5)

**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 (endothermic and exothermic) solution of salts.
- (e) Determination of basicity/acidity 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) Study of the solubility of benzoic acid in water and determination of  $\Delta H$ .

**Reference Books**

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry. R. Chand & Co.: New Delhi (2011).
- Athawale, V. D. & Mathur, P. Experimental Physical Chemistry New Age International: New Delhi (2001).

**+3 FIRST YEAR SECOND SEMESTER**  
**GE - II - CHEMISTRY**  
**CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL**  
**ORGANIC CHEMISTRY-I**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**SECTION A: PHYSICAL CHEMISTRY**

**Unit-1 : Chemical Energetics**

- (a) Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature - Kirchhoffs equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

**Chemical Equilibrium:**

- (b) Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal 'gases'.

**Unit-2 : 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**

**Unit-3**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**i) Aromatic hydrocarbons**

Preparation (Case 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) (upto 4 carbons on benzene). Side chainoxidation of alkyl benzenes (upto 4 carbons on benzene).

**ii) Alkyl Halides**

**Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution ( $S_N1$ ,  $S_N2$  and  $S_Ni$ ) reactions.

Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrite & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.

**Unit- 4**

- (i) **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  $NaNH_2/NH_3$ ).

Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.

- (ii) **Alcohols** (Upto 5 Carbons)



**Alcohols:** Preparation: Preparation of 1° , 2° and 3° alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.

Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk.  $\text{KMnO}_4$ , acidic dichromate, cone.  $\text{HNO}_3$ ). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

### Unii-5

- (i) **Phenols:** (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts. Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. ReimerTiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten - Baumann Reaction.
- (ii) **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.
- (iii) **Aldehydes and ketones (aliphatic and aromatic):** (Formaldehyde, acetaldehyde, acetone and benzaldehyde)  
Preparation: from acid chlorides and from nitriles.  
Reactions - Reaction with HCN, ROH,  $\text{NaHSO}_3$ ,  $\text{NH}_2$ -G derivatives, [odoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Pondorff Verley reduction.

### Reference Books:

- T. VV. Graham Solomons: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
- G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
- G. VV. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Lening India Pvt. Ltd., New Delhi (2009).
- B. H. Mahan. University Chemistry 3rd Ed. Narosa (1998)
- R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co. : New York (1985).

## PRACTICAL GE - 2

Time - 3hrs

(Expt. - 15, Viva Voce - 10 & Lab. Record - 5)

Full Marks : 30 Marks

### Section A: Physical Chemistry

#### Thermochemistry

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 ( $\text{KNO}_3$ ,  $\text{NH}_4\text{Cl}$ ).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of DH.

#### Ionic equilibria

7. 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:
  - (i) Sodium acetate-acetic acid
  - (ii) 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 alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
  - (a) Bromination of Phenol/Aniline
  - (b) Benzoylation of amines/phenols
  - (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

### Reference Books

- A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

## +3 SECOND YEAR THIRD SEMESTER CORE COURSE - V (C- 5) - CHEMISTRY INORGANIC CHEMISTRY - II

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

### 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 with reference to cyanide process for silver and gold. Methods of purification of metals: Electrolytic process, van Arkel-de Boer process and Mond's process, Zone refining.

### Unit - II : Chemistry of s Block Elements:

- (i) General characteristics: melting point, flame colour, reducing nature, diagonal relationships and anomalous behavior of first member of each group.
- (ii) Reactions of alkali and alkaline earth metals with oxygen, hydrogen, nitrogen and water.
- (iii) Common features such as ease of formation, thermal stability and solubility of the following alkali and alkaline earth metal compounds: hydrides, oxides, peroxides, superoxides, carbonates, nitrates, sulphates.
- (iv) Complex formation tendency of s-block elements; structure of the following complexes: crown ethers and cryptates of Group I; basic beryllium acetate, beryllium nitrate, EDTA complexes of calcium and magnesium.
- (v) Solutions of alkali metals in liquid ammonia and their properties.

**Unit - III : Chemistry of p Block Elements:**

Electronic configuration, atomic and ionic size, metallic/non-metallic character, melting point, ionization enthalpy, electron gain enthalpy, electronegativity, Allotropy of C, P, S; inert pair effect, diagonal relationship between Band Si and anomalous behaviour of first member of each group.

**Unit - IV : Structure, bonding and properties: acidic/basic nature, stability, ionic/covalent nature, oxidation/red uction, hydrolysis, action of heat of the following:**

- Hydrides: hydrides of Group 13 (only diborane), Group 14, Group 15 ( $\text{EH}_3$  where E = N, P, As, Sb, Bi), Group 16 and Group 17.
- Oxides: oxides of phosphorus, sulphur and chlorine
- Oxoacids: oxoacids of phosphorus and chlorine; peroxyacids of sulphur
- Halides: halides of silicon and phosphorus

**Unit - V : Preparation, properties, structure and uses of the following compounds:**

- Borazine
- Silicates, silicones,
- Phosphonitrilic halides  $\{(\text{PNCl}_2)_n$  where  $n = 3$  and  $4$  }
- Interhalogen and pseudo halogen compounds
- Clathrate compounds of noble gases, xenon fluorides.

**Reference Books:**

- Lee, J.D. Concise Inorganic Chemistry, Pearson Education 2010
- Douglas, B.E; Mc Daniel, D.H. & Alexander, J.J. *Concepts & Models of Inorganic Chemistry 3rd Ed.*, John Wiley Sons, N.Y. 1994.
- Greenwood, N.N. & Earnshaw. *Chemistry of the Elements*, Butterworth- Heinemann. 1997.
- Cotton, F.A. & Wilkinson, G. *Advanced Inorganic Chemistry*, Wiley, YCH, 1999.
- Miessler, G. L. & Donald, A. *Tarr. Inorganic Chemistry 3rd Ed. (adapted)*, Pearson, 2009
- Shriver, D.F., Atkins P.W and Langford, C.H., *Inorganic Chemistry 2nd Ed.*, Oxford University Press, 1994

**PRACTICAL****C - 5****Time : 3 Hrs****Full Mark : 30 Marks****(A) Iodo / Iodimetric Titrations**

- Estimation of Cu(II) and  $\text{K}_2\text{Cr}_2\text{O}_7$  using sodium thiosulphate solution (Iodometrically).
- Estimation of available chlorine in bleaching powder iodometrically.

**(B) Complexometric titrations using disodium salt of EDTA**

- Estimation of  $\text{Mg}^{2+}$ ,  $\text{Zn}^{2+}$
- Estimation of  $\text{Ca}^{2+}$  by substitution method

**(C) Inorganic preparations**

- Cuprous Chloride,  $\text{Cu}_2\text{Cl}_2$
- Manganese(III) phosphate,  $\text{MnPO}_4 \cdot \text{H}_2\text{O}$  /"
- Aluminium potassium sulphate  $\text{KAl}(\text{SO}_4)_2 \cdot 12\text{H}_2\text{O}$  (Potash alum) or Chrome alum.

**Reference Books:**

- Vogel, A.I. *A Textbook of Quantitative Inorganic Analysis*, ELBS. 1978
- Marr, G. and Rockett, R.W. *Practical Inorganic Chemistry*, Van Nostrand Reinhold. 1972

**+3 SECOND YEAR THIRD SEMESTER  
CORE COURSE - VI (C- 6) - CHEMISTRY  
ORGANIC CHEMISTRY - II**

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

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

**Unit - I : Chemistry of Halogenated Hydrocarbons:**

*Alkyl halides:* Methods of preparation and properties, nucleophilic substitution reactions - SN1, SN2 and SNi mechanisms with stereochemical aspects and effect of solvent etc.; nucleophilic substitution vs. elimination.

*Aryl halides:* Preparation (including preparation from diazonium salts) and properties, nucleophilic aromatic substitution; S<sub>N</sub>Ar, Benzyne mechanism. Relative reactivity of alkyl, allyl, benzyl, vinyl and aryl halides towards nucleophilic substitution reactions.

**Unit - II : Alcohols, Phenols, Ethers and Epoxides:**

*Alcohols:* preparation, properties and relative reactivity of 1°, 2°, 3° alcohols, Bouvaelt- Blanc Reduction; Oxidation of diols by periodic acid and lead tetraacetate, Pinacol- Pinacolone rearrangement;

*Phenols:* Preparation and properties; Acidity and factors effecting 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 with alcohols, ammonia derivatives and LiAlH<sub>4</sub>.

**Unit - III : Carbonyl Compounds:**

Structure, reactivity, preparation and properties; Nucleophilic additions, Nucleophilic addition-elimination reactions with ammonia derivatives with mechanism; Mechanisms of Aldol and Benzoin condensation, Knoevenagel condensation, Claisen-Schmidt, Perkin, Cannizzaro and Wittig reaction, Beckmann and Benzil- Benzilic acid rearrangements, haloform reaction and Baeyer Villiger oxidation, α - substitution reactions, oxidations and reductions (Clemmensen, Wolff-Kishner, LiAlH<sub>4</sub>, NaBH<sub>4</sub>, MPV, PDC)

Addition reactions of α, β- unsaturated carbonyl compounds: Michael addition.

**Unit-IV : Active methylene compounds:**

Keto-enol tautomerism. Preparation and synthetic applications of diethyl malonate, and ethyl acetoacetate.

**Organic Metallic Compounds :** Grignards Reagent :Structure, formation and reactivity, application of Grignards reagents in Organic Synthesis, Organozinc compounds formation and chemical reaction Organolithium compounds : Organosulphur compounds - Preparation and properties, reactions of Thiols.

**Unit - V : Carboxylic Acids and their Derivatives:** General methods of preparation, physical properties and reactions of monocarboxylic acids, effect of substituents on acidic strength. Typical reactions of dicarboxylic acids, hydroxy acids and unsaturated acids.

Preparation and reactions of acid chlorides, anhydrides, esters and amides; Comparative study of nucleophilic substitution at acyl group -Mechanism of acidic and alkaline hydrolysis of esters, Claisen condensation, Dieckmann and Reformatsky reactions, Hofmann- bromamide degradation and Curtius rearrangement.

**Reference Books:**

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

## PRACTICAL C - 6

**Time : 3 Hrs****Full Mark : 30 Marks**

1. Functional group tests for alcohols, phenols, carbonyl and carboxylic acid group.
2. Organic preparations:
  - i. Acetylation of one of the following compounds: amines (aniline, o-, m-, p- toluidines and O-, m, p- anisidine) and phenols (b -naphthol, vanillin, salicylic acid) by anyone method:
    - a. Using conventional method.
    - b. Using green approach
  - ii. Benzoylation of one of the following amines (aniline; o-, m-, p- toluidines and o-, m-, p-anisidine) and one of the following phenols (b-naphthol, resorcinol, p- cresol) by Schotten-Baumann reaction.
  - iii. Oxidation of ethanol/ isopropanol (Iodoform reaction).
  - iv. Selective reduction of meta dinitrobenzene to m-nitroaniline.
  - v. Hydrolysis of amides and esters.
  - vi. Semicarbazone of anyone of the following compounds: acetone, ethyl methyl ketone; cyclohexanone, benzaldehyde.
  - vii. S-Benzylisothiuronium salt of one each of water soluble and water insoluble acids (benzoic acid, oxalic acid, phenyl acetic acid and phthalic acid).
  - viii. Aldol condensation using either conventional or green method.The above derivatives should be prepared using 0.5-1g of the organic compound. The solid samples must be collected and may be used for recrystallization and melting point.

**Reference Books:**

- Mann, F.o. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

## +3 SECOND YEAR THIRD SEMESTER CORE COURSE - VII (C- 7) - CHEMISTRY PHYSICAL CHEMISTRY - III

**Time: 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid Semester : 20 Marks****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 ( $H_2O$  and S), with applications. Phase diagrams for systems of solid-liquid equilibria involving eutectic, congruent and incongruent melting points.

Three component systems : triangular plots, water-chloroform-acetic acid system.

**Unit - II : Phase Equilibria - II :**

Binary solutions: Gibbs-Duhem- Margules equation, Its derivation and applications to fractional distillation

of binary miscible liquids (ideal and non ideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

### Unit - III : Electrochemical Cells-I:

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 (i) free energy, enthalpy and entropy of a cell reaction, (ii) equilibrium constants, and (iii) pH values using hydrogen, quinone-hydroquinone, glass and  $\text{SbO/Sb}_2\text{O}_3$  electrodes.

### Unit - IV : Electrochemical Cells - 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).

### Unit - V : Surface chemistry:

Physical adsorption, chemisorption, adsorption isotherms (Langmuir and Freundlich). nature of adsorbed state. Qualitative discussion of Gibb's and BET adsorption equation. Preliminary idea about Micelle Formation, Critical Micellar concentration (CMC).

### Reference Book:

- Peter Atkins & Julio De Paula, Physical Chemistry 9th Ed., Oxford University Press (2010).
- Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).
- McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi(2004)
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Zundhal, S.S. Chemistry concepts and applications Cengage India (2011) . • Ball, D. W. Physical Chemistry Cengage India (2012).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: NOIDA, UP (2009).
- Levine, I. N. Physical Chemistry 6th Ed., Tata McGraw-Hill (2011).
- Metz, C. R. Physical Chemistry 2nd Ed., Tata McGraw-Hill (2009).

## PRACTICAL

### C - 7

**Time : 3 Hrs**

**Full Mark : 30 Marks**

### Phase Equilibria :

- I. Determination of critical solution temperature and composition at CST of the phenol- water system and to study the effect of impurities of sodium chloride and succinic acid on it.
- II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method: a. simple eutectic and b. congruently melting systems.
- III. Distribution of acetic/ benzoic acid between water and chloroform or cyclohexane.
- IV. Study the equilibrium of at least one of the following reactions by the distribution method:
  - (i)  $\text{I}_2(\text{aq}) + \text{I}^-(\text{aq}) \rightleftharpoons \text{I}_3^-(\text{aq})$
  - (ii)  $\text{Cu}^{2+}(\text{aq}) + n\text{NH}_3 \rightleftharpoons \text{Cu}(\text{NH}_3)_n^{2+}$

### Potentiometry:

- V. Perform the following potentiometric titrations: (i) HCl Strong acid vs. NaOH strong base (ii)  $\text{CH}_3\text{COOH}$  Weak acid vs. NaOH strong base (iii) ..... Dibasic acid vs.  $\text{H}_2\text{SO}_4$  strong NaOH (iv) Potassium dichromate vs. Mohr's salt



**Reference Books:**

- Khosla, B. D.; Garg, V. C. & Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co. New Delhi (2011). 25
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

**+3 SECOND YEAR THIRD SEMESTER  
GE - III - CHEMISTRY  
ATOMIC STRUCTURE, BONDING, GENERAL ORGANIC CHEMISTRY &  
ALIPHATIC HYDROCARBONS**

**Time: 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid Semester : 20 Marks****Section A: Inorganic Chemistry****Unit-1 : 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. Need of a new approach to Atomic structure.
- What is Quantum mechanics? Schrodinger equation and meaning of various terms in it. Significance of  $\Psi$  and  $\Psi^2$ , Schrodinger equation for hydrogen atom. Radial distribution functions and the concept of the most probable distance with special reference to 1s and 2s atomic orbitals. Significance of quantum numbers, orbital angular momentum and quantum numbers  $m_l$  and  $m_s$ . Shape of s, p and d and f atomic orbitals, nodal planes. Spin quantum number ( $s$ ) and magnetic spin quantum number ( $m_s$ ).
- 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-2: Chemical Bonding and Molecular Structure**

- Ionic Bonding:** General characteristics of ionic bonding. Energy considerations in ionic bonding, lattice energy and solvation energy and their importance in the context of stability and solubility of ionic compounds. Statement of Born-Landé equation for calculation of lattice energy, Born-Haber cycle and its applications, polarizing power and polarizability. Fajan's rules, ionic character in covalent compounds, bond moment, dipole moment and percentage of ionic character.
- 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 of 1st and 2nd periods (including idea of s-p mixing) and heteronuclear diatomic molecules such as CO, NO and  $\text{NO}^+$ . Comparison of VB and MO approaches.

**Section B: Organic Chemistry****Unit-3: 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: Benzenoids and Hückel's rule.

#### Unit-4 : Stereochemistry

Conformations with respect to ethane, butane and cyclohexane. Interconversion of Wedge ' Formula, Newmann, Sawhorse and Fischer representations. Concept of chirality (upto two carbon atoms). Configuration: Geometrical and Optical isomerism; Enantiomerism, Diastereomerism and Meso compounds). Threo and erythro; D and L; cis - trans nomenclature; CIP Rules: R/ S (for upto 2 chiral carbon atoms) and E / Z Nomenclature (for upto two C=C systems).

#### Unit-5 : Aliphatic Hydrocarbons

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**Alkanes:** (Upto 5 Carbons). Preparation: Catalytic hydrogenation, Wurtz reaction. Kolbe's synthesis, from Grignard reagent. Reactions: Free radical Substitution: Halogenation.

**Alkenes:** (Upto 5 Carbons) Preparation: Elimination reactions: Dehydration of alkenes and dehydrohalogenation of alkyl halides (Saytzeffs rule); cis alkenes (Partial catalytic hydrogenation) and trans alkenes (Birch reduction). Reactions: cis-addition (alk.  $\text{KMnO}_4$ ) and trans-addition (bromine), Addition of HX (Markownikoff s and anti-Markownikoff s addition), Hydration, Ozonolysis, oxymercuration-demercuration, Hydroboration-oxidation.

**Alkynes:** (Upto 5 Carbons) Preparation: Acetylene from  $\text{CaC}_2$ : and conversion into higher alkynes; by dehalogenation of tetra halides and dehydrohalogenation of vicinal-dihalides. Reactions: formation of metal acetylides, addition of bromine and alkaline  $\text{KMnO}_4$ , ozonolysis and oxidation with hot alk.  $\text{KMnO}_4$ .

#### Reference Books:

- J. D. Lee: A new Concise Inorganic Chemistry, E L. B. S.
- F. A. Cotton & G. Wilkinson: Basic Inorganic Chemistry, John Wiley.
- Douglas, McDaniel and Alexander: Concepts and Models in Inorganic Chemistry, John Wiley.
- James E. Huheey, Ellen Keiter and Richard Keiter: Inorganic Chemistry: Principles of Structure and Reactivity, Pearson Publication.
- T. W. Graham Solomon: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry. Orient Longman.
- E. L. Eliel: Stereochemistry of Carbon Compounds, Tata McGraw Hill.\* f. L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand

#### PRACTICAL GE - 3

Time - 3hrs

(Expt. - 15, Viva Voce - 10 & Lab. Record - 5)

Full Marks : 30 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  $\text{KMnO}_4$ .
3. Estimation of water of crystallization in Mohr's salt by titrating with  $\text{KMnO}_4$ .
4. Estimation of Fe (II) ions by titrating it with  $\text{K}_2\text{Cr}_2\text{O}_7$  using internal indicator.
5. Estimation of Cu (II) ions iodometrically using  $\text{Na}_2\text{S}_2\text{O}_3$ .

**Section B: Organic Chemistry**

1. Detection of extra elements (N, S, Cl, Br, I) in organic compounds (containing upto two extra elements)
2. Separation of mixtures by Chromatography: Measure the R<sub>f</sub> value in each case (combination of two compounds to be given)
  - (a) 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
  - (b) Identify and separate the sugars present in the given mixture by paper chromatography.

**Reference Books:**

- Vogel's Qualitative Inorganic Analysis, A.I. Vogel, Prentice Hall, 7th Edition.
- Vogel's Quantitative Chemical Analysis, A.I. Vogel, Prentice Hall, 6th Edition.
- Textbook of Practical Organic Chemistry, A.I. Vogel, Prentice Hall, 5th edition.
- Practical Organic Chemistry, F. G. Mann. & B. C. Saunders, Orient Longman, 1960.

**+3 SECOND YEAR FOURTH SEMESTER  
CORE COURSE - VIII (C- 8) - CHEMISTRY  
INORGANIC CHEMISTRY - III**

**Time: 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid Semester : 20 Marks****Unit-I : Coordination Chemistry - I :**

- a) Werner's theory, valence bond theory (inner and outer orbital complexes), electroneutrality principle and back bonding. EAN rule.
- b) IUPAC nomenclature of coordination compounds, isomerism in coordination compounds stereochemistry of complexes with 4 and 6 coordination numbers. Chelate effect, polynuclear complexes of Fe, Co & Mn. Labile and inert complexes.

**Unit-II : Coordination Chemistry - II :**

Crystal field theory, measurement of  $10 Dq$  (**D<sub>o</sub>**), CFSE in weak and strong fields, pairing energies, factors affecting the magnitude of  $10 Dq$  (**D<sub>o</sub>**, **D<sub>t</sub>**). Octahedral vs. tetrahedral coordination, tetragonal distortions from octahedral geometry Jahn- Teller theorem, square planar geometry. Qualitative aspect of Ligand field and MO Theory.

**Unit-III :****a) Transition Elements:**

General group trends with special reference to electronic configuration, colour, variable valency, magnetic and catalytic properties, ability to form complexes. Stability of various oxidation states and e.m.f. (Latimer diagrams) Difference between the first, second and third transition series.

Chemistry of Cr, Mn, Fe and Co in various oxidation states with special reference to the following compounds: peroxo compounds of chromium, potassium dichromate, potassium permanganate ferrocyanide potassium, sodium nitroprusside and sodium cobaltinitrite

**b) Lanthanoids and Actinoids:**

Electronic configuration, oxidation states, colour, spectral and magnetic properties, lanthanide contraction, separation of lanthanides (ion-exchange method only).

**Unit-IV : Hard and Soft Acids and Bases (HSAB) :**

Classification of acids and bases as hard and soft, Pearson's HSAB concept, Acid-Base strength, hardness and softness symbiosis. Theoretical basis of hardness and softness. Electronegativity and hardness and softness. Application of HSAB Principle.

**Unit-V : Inorganic Reaction Mechanism :**

Introduction to inorganic reaction mechanisms. Substitution reactions in square planar complexes, Trans-effect, theories of trans effect. Thermodynamic and Kinetic stability, Reaction effecting stability.

**Reference Books:**

- Purcell, K.F & Kotz, J.C., *Inorganic Chemistry* W.B. Saunders Co, 1977.
- Huheey, J.E., *Inorganic Chemistry*, Prentice Hall, 1993.
- Cotton, F.A. & Wilkinson, G., *Advanced Inorganic Chemistry* Wiley-VCH, 1999
- Basolo, F, and Pearson, R.C., *Mechanisms of Inorganic Chemistry*, John Wiley & Sons, NY, 1967.
- Greenwood, N.N. & Earnshaw A., *Chemistry of the Elements*, Butterworth-Heinemann, 1997.
- Miessler, G. L. & Tarr, Donald A. *Inorganic Chemistry* 7<sup>th</sup> Ed. (adapted), Pearson, 2009

**PRACTICAL****C - 8****Time : 3 Hrs****Full Mark : 30 Marks****Gravimetric Analysis:**

- i. Estimation of nickel (II) using Dimethylglyoxime (DMG).
- ii. Estimation of copper as CuSCN
- iii. Estimation of iron as Fe<sub>2</sub>O<sub>3</sub> by precipitating iron as Fe(OH)<sub>3</sub>
- iv. Estimation of Al(III) by precipitating with oxine and weighing as Al (oxine), (aluminium oxinate).

**Inorganic Preparations:**

- i. Tetraamminecopper (II) sulphate, [Cu(NH<sub>3</sub>)<sub>4</sub>]SO<sub>4</sub>.H<sub>2</sub>O
- ii. Acetylacetonate complexes of Cu<sup>2+</sup>/Fe<sup>3+</sup>
- iii. Tetraamminecarbonatocobalt (III) nitrate
- iv. Potassium tri(oxalato)ferrate(III)

**Properties of Complexes**

- i. Measurement of 10 Dq by spectrophotometric method
- ii. Verification of spectrochemical series.
- iii. Synthesis of ammine complexes of Ni(II) and its ligand exchange reactions (e.g. bidentate ligands like acetylacetonate, DMG, glycine) by substitution method.

**Reference Book:**

- Vogel, A.I. A text book of Quantitative Analysis, ELBS 1986.
- G. Marr and B.W. Rockett, Practical Inorganic Chemistry, Van Nostrand Reinhold. 1972

**+3 SECOND YEAR FOURTH SEMESTER  
CORE COURSE - IX (C- 9) - CHEMISTRY  
ORGANIC CHEMISTRY - III**

**Time: 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid Semester : 20 Marks****Unit - I : Nitrogen Containing Functional Groups**

Preparation and important reactions of nitro compounds, nitriles and isonitriles. *Amines*: Preparation and properties: Effect of substituent and solvent on basicity; 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. Diazonium Salts: Preparation and their synthetic applications.

**Unit - II : Heterocyclic Compounds**

Classification and nomenclature, Structure, aromaticity in 5-membered 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). Thiophene, Pyridine (Hantzsch synthesis).

### Unit - III : Polynuclear Hydrocarbons and fused heterocycles

Aromaticity of polynuclear hydrocarbons, structure elucidation of naphthalene; Preparation and properties of naphthalene, phenanthrene and anthracene.

Indole (Fischer indole synthesis and Madelung synthesis), Quinoline and isoquinoline, (Skraup synthesis, Friedlander's synthesis, Knorr quinoline synthesis, Doebner Miller synthesis, Bischler-Napieralski reaction, Pictet-Spengler reaction, Pomeranz-Fritsch reaction)

### 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 Nicotine. Medicinal importance of Nicotine, Hygrine, Quinine, Morphine, Cocaine and Reserpine.

### Unit - V : Terpenes

Occurrence, classification, isoprene rule; Elucidation of structure and synthesis of Citral.

#### Reference Books:

- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Acheson, R.M. Introduction to the Chemistry of Heterocyclic compounds, John Wiley & Sons (1976).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.
- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Clayden, J.; Greeves, N.; Warren, S.; Wothers, P.; Organic Chemistry, Oxford University Press.
- Singh, J.; Ali, S.M. & Singh, J. Natural Product Chemistry, PrajatiParakashan (2010).

## PRACTICAL

### C - 9

Time : 3 Hrs

Full Mark : 30 Marks

1. Functional group test for nitro, amine and amide groups.
2. Qualitative analysis of unknown organic compounds containing simple functional groups (alcohols, carboxylic acids, phenols, carbonyl compounds and esters)

#### Reference Books:

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)
- Ahluwalia, V.K. & Aggarwal, R. Comprehensive Practical Organic Chemistry: Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V.K. & Dhingra, S. Comprehensive Practical Organic Chemistry: Qualitative Analysis, University Press (2000).

## +3 SECOND YEAR FOURTH SEMESTER CORE COURSE - X (C- 10) - CHEMISTRY PHYSICAL CHEMISTRY - IV

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**Unit - I : Conductance:** Quantitative aspects of Faraday's laws of electrolysis 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 : 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 : 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 rate laws, kinetics of complex reactions (integrated rate expressions up to first order only) : (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

**Unit - IV : Temperature dependence of reaction rates**; Arrhenius, equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rate.

**Catalysis**: Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces. Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

**Unit - V : Photochemistry**: Characteristics of electromagnetic radiation, Lambert-Beer's law and its limitations, 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, photosensitized reactions, quenching. Role of photochemical reactions in biochemical processes, photostationary states, chemiluminescence.

**Reference Books:**

- Atkins, P.W & Paula, J.D. Physical Chemistry, 9th Ed., Oxford University Press (2011) .
- Castellan, G. W. Physical Chemistry 4th Ed., Narosa (2004).
- Mortimer, R. G. Physical Chemistry 3rd Ed., Elsevier: Narosa, UP (2009).
- Barrow, G. M., Physical Chemistry 5th Ed., Tata McGraw Hill: New Delhi (2006) .
- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Rogers, D. W. Concise Physical Chemistry Wiley (2010).
- Silbey, R.J.; Alberty, R.A. & Bawendi, M.G. Physical Chemistry 4th Ed., John Wiley & Sons, Inc. (2005).

## PRACTICAL C - 10

**Time : 3 Hrs**

**Full Mark : 30 Marks**

**Conductometry:**

- I. Determination of cell constant
- II. Determination of conductivity, molar conductivity, 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. Mixture of strong acid and weak acid vs. strong base iv. Strong acid vs. weak base

Unit - IV : Study the kinetics of the following reactions.

1. Iodide-persulphate reaction (i) Initial rate method; (ii) Integrated rate method
2. Acid hydrolysis of methyl acetate with hydrochloric acid.
3. Saponification of ethyl acetate.
4. Comparison of the strengths of HCl and H<sub>2</sub>SO<sub>4</sub> by studying kinetics of hydrolysis of methyl acetate.

**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 Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- n Halpern, A.M. & Mcbane, G.C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.; New York (2003).

**+3 SECOND YEAR FOURTH SEMESTER  
GE - IV - CHEMISTRY  
CHEMICAL ENERGETICS, EQUILIBRIA & FUNCTIONAL  
ORGANIC CHEMISTRY-I**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**Section A: Physical Chemistry****Unit-1 : Chemical Energetics**

- (a) Review of thermodynamics and the Laws of Thermodynamics. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature - Kirchhoffs equation. Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

**Chemical Equilibrium:**

- (b) Free energy change in a chemical reaction. Thermodynamic derivation of the law of chemical equilibrium. Distinction between  $\Delta G$  and  $\Delta G^\circ$ , Le Chatelier's principle. Relationships between  $K_p$ ,  $K_c$  and  $K_x$  for reactions involving ideal gases.

**Unit-2 : 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****Unit-3**

Functional group approach for the following reactions (preparations & reactions) to be studied in context to their structure.

**i) Aromatic hydrocarbons**

Preparation (Case 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) (upto 4 carbons on benzene). Side chain oxidation of alkyl benzenes (upto 4 carbons on benzene).

**ii) Alkyl Halides**

**Alkyl Halides** (Upto 5 Carbons) Types of Nucleophilic Substitution ( $S_N1$ ,  $S_N2$  and  $S_Ni$ ) reactions. Preparation: from alkenes and alcohols.

Reactions: hydrolysis, nitrite & nitro formation, nitrite & isonitrile formation. Williamson's ether synthesis: Elimination vs substitution.



**Unit- 4**

- (i) **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:  $\text{KNH}_2/\text{NH}_3$  (or  $\text{NaNH}_2/\text{NH}_3$ ).  
Reactivity and Relative strength of C-Halogen bond in alkyl, allyl, benzyl, vinyl and aryl halides.
- (ii) **Alcohols (Upto 5 Carbons)**  
**Alcohols:** Preparation: Preparation of  $1^\circ$ ,  $2^\circ$  and  $3^\circ$  alcohols: using Grignard reagent, Ester hydrolysis, Reduction of aldehydes, ketones, carboxylic acid and esters.  
Reactions: With sodium, HX (Lucas test), esterification, oxidation (with PCC, alk.  $\text{KMnO}_4$ , acidic dichromate, cone.  $\text{HNO}_3$ ). Oppeneauer oxidation Diols: (Upto 6 Carbons) oxidation of diols. Pinacol-Pinacolone rearrangement.

**Unii-5**

- (i) **Phenols:** (Phenol case) Preparation: Cumene hydroperoxide method, from diazonium salts.  
Reactions: Electrophilic substitution: Nitration, halogenation and sulphonation. Reimer-Tiemann Reaction, Gattermann-Koch Reaction, Houben-Hoesch Condensation, Schotten - Baumann Reaction.
- (ii) **Ethers (aliphatic and aromatic):** Cleavage of ethers with HI.
- (iii) **Aldehydes and ketones (aliphatic and aromatic):** (Formaldehyde, acetaldehyde, acetone and benzaldehyde)  
Preparation: from acid chlorides and from nitriles.  
Reactions - Reaction with HCN, ROH,  $\text{NaHSO}_3$ ,  $\text{NH}_2\text{-G}$  derivatives, [odoform test. Aldol Condensation, Cannizzaro's reaction, Wittig reaction, Benzoin condensation. Clemensen reduction and Wolff Kishner reduction. Meerwein-Ponndorf Verley reduction.

**Reference Books:**

- T. VV. Graham Solomons: Organic Chemistry, John Wiley and Sons.
- Peter Sykes: A Guide Book to Mechanism in Organic Chemistry, Orient Longman.
- I.L. Finar: Organic Chemistry (Vol. I & II), E. L. B. S.
- R. T. Morrison & R. N. Boyd: Organic Chemistry, Prentice Hall.
- Arun Bahl and B. S. Bahl: Advanced Organic Chemistry, S. Chand.
- G. M. Barrow: Physical Chemistry Tata McGraw-Hill (2007).
- G. VV. Castellan: Physical Chemistry 4th Edn. Narosa (2004).
- J. C. Kotz, P. M. Treichel & J. R. Townsend: General Chemistry Cengage Learning India Pvt. Ltd., New Delhi (2009).
- B. H. Mahan. University Chemistry 3rd Ed. Narosa (1998)
- R. H. Petrucci: General Chemistry 5th Ed. Macmillan Publishing Co. : New York (1985).

**PRACTICAL****GE - 4**

Time - 3hrs

Full Marks : 30 Marks

(Expt. - 15, Viva Voce - 10 &amp; Lab. Record - 5)

**Section A: Physical Chemistry****Thermochemistry**

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 ( $\text{KNO}_3$ ,  $\text{NH}_4\text{Cl}$ ).
5. Determination of enthalpy of hydration of copper sulphate.
6. Study of the solubility of benzoic acid in water and determination of DH.



**Ionic equilibria**

7. 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:
      - (i) Sodium acetate-acetic acid
      - (ii) 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 alcohol) and distillation.
2. Criteria of Purity: Determination of melting and boiling points.
3. Preparations: Mechanism of various reactions involved to be discussed. Recrystallisation, determination of melting point and calculation of quantitative yields to be done.
  - (a) Bromination of Phenol/Aniline
  - (b) Benzoylation of amines/phenols
  - (c) Oxime and 2,4 dinitrophenylhydrazone of aldehyde/ketone

**Reference Books**

- A.I. Vogel: Textbook of Practical Organic Chemistry, 5th edition, Prentice-Hall.
- F. G. Mann & B. C. Saunders, Practical Organic Chemistry, Orient Longman (1960).
- B.D. Khosla, Senior Practical Physical Chemistry, R. Chand & Co.

**+3 THIRD YEAR FIFTH SEMESTER  
CORE COURSE - XI (C- 11) - CHEMISTRY  
ORGANIC CHEMISTRY - IV**

**Time: 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid Semester : 20 Marks****Unit - I : Nucleic Acids**

Components of nucleic acids, Nucleosides and nucleotides;  
Structure, synthesis and reactions of Adenine, Guanine, Cytosine, Uracil and Thymine; Structure of polynucleotides (DNA and RNA).

**Unit - II : Amino Acids, Peptides and Proteins**

Amino acids, Peptides and their classification.

$\alpha$ -Amino Acids - Synthesis, ionic properties and reactions. Zwitterious,  $pK_a$  values, isoelectric point and electrophoresis;

Study of peptides : 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; primary, secondary and tertiary structures of proteins, Denaturation.

**Unit - III : 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, specificity of enzyme action (including stereospecificity), enzyme inhibitors and their importance.

**Lipids :**

Introduction to oils and fats; common fatty acids present in oils and fats, Hydrogenation of fats and oils, Saponification value, acid value, iodine number. Reversion and rancidity.

**Unit - IV : Concept of Energy in Biosystems :**

Cells obtain energy by the oxidation of foodstuff (organic molecules). Introduction to metabolism (catabolism, anabolism).

ATP : The universal currency of cellular energy, ATP hydrolysis and free energy change. Agents for transfer of electrons in biological redox systems : NAD<sup>+</sup>, FAD.

Conversion of food to energy : Outline of catabolic pathways of carbohydrate-glycolysis, fermentation, Krebs cycle.

Caloric value of food, standard caloric content of food types.

**Unit - V : 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).

**Reference Books :**

- n Berg, J.M., Tymoczko, J.L. and Stryer, L. (2006) Biochemistry. VIth Edition. W.H. Freeman and Co.
- n Nelson, D.L., Cox, M.M. and Lehninger, A.L. (2009) Principles of Biochemistry. IV Edition.
- n Murray, R. K., Granner, D. K., Mayes, P.A. and Rodwell, V.W. (2009) Harper's Illustrated Biochemistry. XXVIII edition. Lange Medical Books/McGraw-Hill.

### PRACTICAL C - 11

**Time : 3 Hrs****Full Mark : 30 Marks**

1. Estimation of glycine by Sorenson's formalin method.
2. Study of the titration curve of glycine.
3. Estimation of proteins by Lowry's method.
4. Study of the action of salivary amylase on starch at optimum conditions.
5. Effect of temperature on the action of salivary amylase.
6. Saponification value of an oil or a fat.
7. Determination of Iodine number of an oil/ fat.
8. Isolation and characterization of DNA from onion! cauliflower/peas.

**Reference Books:**

- Manual of Biochemistry Workshop, 2012, Department of Chemistry, University of Delhi.
- Arthur, I. V. Quantitative Organic Analysis, Pearson.

## +3 THIRD YEAR FIFTH SEMESTER CORE COURSE - XII (C- 12) - CHEMISTRY PHYSICAL CHEMISTRY - V

**Time: 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid Semester : 20 Marks**

**Unit - I : Quantum Chemistry:** Postulates of quantum mechanics, quantum mechanical operators and commutation rules, Schrodinger equation and its application to free particle and "particle-in-a- box" (rigorous treatment), quantization of energy levels, zero-point energy and Heisenberg Uncertainty principle; wave functions, 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.

Angular momentum. Rigid rotator model of rotation of diatomic molecule. Schrodinger equation in

Cartesian and spherical polar (Derivation not required). Separation of variables. Spherical harmonics. Discussion of solution (Qualitative).

**Unit - II : 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. Setting up of Schrodinger equation for many-electron atoms (He; Li). Need for approximation methods. Statement of variation theorem and application to simple systems (particle-in-a-box, harmonic oscillator, hydrogen atom).

**Unit - III : Chemical bonding:** Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of  $H_2^+$ . 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. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH).

**Unit - IV : Molecular Spectroscopy:** Interaction of electromagnetic radiation with molecules and various types of spectra; Born Oppenheimer approximation.

Rotation spectroscopy: 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, concept of group frequencies.

**Vibration-rotation spectroscopy:** diatomic vibrating rotator, P, Q, R branches.

**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, calculation of electronic transitions of polyenes using free electron model.

**Unit - V : Nuclear Magnetic Resonance (NMR) spectroscopy:** Principles of NMR spectroscopy, Larmor precession, chemical shift and low resolution spectra, different scales (d and i), spin-spin coupling and high resolution spectra, interpretation of PMR spectra of organic molecules .

Electron Spin Resonance (ESR) spectroscopy: Its principle, hyperfine structure, ESR of simple radicals.

**Reference Books:**

- Banwell, C. N. & McCash, E. M. Fundamentals of Molecular Spectroscopy 4th Ed. Tata McGraw-Hill: New Delhi (2006) .
- Chandra, A. K. Introductory Quantum Chemistry Tata McGraw-Hill (2001) . • House, J. E. Fundamentals of Quantum Chemistry 2nd Ed. Elsevier: USA (2004) .
- Lowe, J. P. & Peterson, K. Quantum Chemistry, Academic Press (2005).
- Kakkar, R. Atomic & Molecular Spectroscopy, Cambridge University Press (2015).

## PRACTICAL C - 12

**Time : 3 Hrs**

**Full Mark : 30 Marks**

**Colorimetry :**

- I. Verify Lambert-Beer's law and determine the concentration of  $CuSO_4/KMnO_4/K_2Cr_2O_7$  in a solution of unknown concentration
- II. Determine the concentrations of  $KMnO_4$  and  $K_2Cr_2O_7$  in a mixture.

- III. Study the kinetics of iodination of propanone in acidic medium.
- IV. Determine the amount of iron present in a sample using 1, 10-phenanthroline.
- V. Determine the dissociation constant of an indicator (phenolphthalein).
- VI. Study the kinetics of interaction of crystal violet! phenolphthalein with sodium hydroxide.
- VII. Analysis of the given vibration-rotation spectrum of HCl(g)

#### Adsorption

- VIII. Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

#### UV/Visible spectroscopy:

- I. Study the 200-500 nm absorbance spectra of  $\text{KMnO}_4$  and  $\text{K}_2\text{Cr}_2\text{O}_7$  (in 0.1 M  $\text{H}_2\text{SO}_4$ ) and determine the  $I_{\text{max}}$  values. Calculate the energies of the two transitions in different units ( $\text{J molecule}^{-1}$ ,  $\text{kJ mol}^{-1}$ ,  $\text{cm}^{-1}$ , eV).
- II. Study the pH-dependence of the UV-Vis spectrum (200-500 nm) of  $\text{K}_2\text{Cr}_2\text{O}_7$ .
- III. Record the 200-350 nm UV spectra of the given compounds (acetone, acetaldehyde, 2-propanol, acetic acid) in water. Comment on the effect of structure on the UV spectra of organic compounds.

#### Reference Books:

- Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, I. W. & Shoemaker, D. P. Experiments in Physical Chemistry 8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. & McBane, G. C. Experimental Physical Chemistry 3rd Ed.; W.H. Freeman & Co.: New York (2003).

## +3 THIRD YEAR FIFTH SEMESTER DSE - I - CHEMISTRY POLYMER CHEMISTRY

Time: 3 Hours

Credit: 6

End Semester Theory : 50 Marks

Mid Semester : 20 Marks

#### UNIT-I 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 Kinetics of Polymerization

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.

#### Nature and structure of polymers

Structure Property relationships.

#### Determination of molecular weight of polymers

( $M_n$ ,  $M_w$ , etc) by end group analysis, viscometry, light scattering and osmotic pressure methods. Molecular weight distribution and its significance. Polydispersity index.

**UNIT-III Glass transition temperature (T<sub>g</sub>) and determination of T<sub>g</sub>,**

Free volume theory, WLF equation, Factors affecting glass transition temperature (T<sub>g</sub>).

**Polymer Solution**

Criteria for polymer solubility, Solubility parameter, Thermodynamics of polymer solutions, entropy, enthalpy, and free energy change of mixing of polymers solutions, Flory- Huggins theory, Lower and Upper critical solution temperatures.

**UNIT-IV Properties of Polymers** (Physical, thermal, Flow & Mechanical Properties).

Brief introduction to preparation, structure, properties and application of the following polymers: polyolefins, polystyrene and styrene copolymers, poly(vinyl chloride) and related polymers, poly(vinyl acetate) and related polymers, acrylic polymers, fluoro polymers, polyamides and related polymers. Phenol formaldehyde resins (Bakelite, Novalac), polyurethanes, silicone polymers, polydienes, Polycarbonates, Conducting Polymers, [polyacetylene, polyamide, poly(p-phenylene sulphide polypyrrole, polythiophene)].

**Reference Books:**

- *Seymour's Polymer Chemistry*, Marcel Dekker, Inc.
- G. Odian: *Principles of Polymerization*, John Wiley.
- F.W. Billmeyer: *Text Book of Polymer Science*, John Wiley.
- P. Ghosh: *Polymer Science & Technology*, Tata Mcgraw-Hill.
- R.W. Lenz *Organic Chemistry of Synthetic High Polymers*.

## PRACTICAL - DSE - 1 POLYMER CHEMISTRY

Time : 3hrs

Full Mark : 30 Marks

**Polymer synthesis**

1. 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-isobutyronitrile (AIBN)
2. Preparation of nylon 66/6
  1. Interfacial polymerization, preparation of polyester from isophthaloyl chloride (iPC) and phenolphthalein
    - a. Preparation of IPC
    - b. Purification of IPC
    - c. Interfacial polymerization
  3. Redox-polymerization of acrylamide
  4. Precipitation polymerization of acrylonitrile
  5. Preparation of urea-formaldehyde resin
  6. Preparations of novalac resin/resold resin.
  7. Microscale Emulsion Polymerization of Poly(methylacrylate).

**Polymer characterization**

1. Determination of molecular weight by viscometry:
  - (b) Polyacrylamide-aq. NaNO<sub>2</sub> solution (Poly vinyl propylidene (PVP) in water
2. Determination of the viscosity-average molecular weight of poly(vinyl alcohol) (PVOH) and the fraction of "head-to-head" monomer linkages in the polymer.
3. Determination of molecular weight by end group analysis: Polyethylene glycol (PEG) (OH group).
4. Testing of mechanical properties of polymers.
5. Determination of hydroxyl number of a polymer using colorimetric method.

**Polymer analysis**

1. Estimation of the amount of HCHO in the given solution by sodium sulphite method
2. Instrumental Techniques
3. IR studies of polymers
4. DSC analysis of polymers
5. Preparation of polyacrylamide and its electrophoresis  
\*at least 7 experiments to be carried out.

**Reference Books:**

- n Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3<sup>rd</sup> Ed.
- n Harry R. Allcock, Frederick W. Lampe and James E. Mark. Contemporary Polymer Chemistry, 3<sup>rd</sup> ed. Prentice-Hall (2003)
- n Fred W. Billmeyer, Textbook of Polymer Science, 3<sup>rd</sup> ed. Wiley-Interscience (1984)
- n Joel R. Fried, Polymer Science and Technology, 2<sup>nd</sup> ed. Prentice-Hall (2003)
- n Petr Munk and Teirai M. Aminabhavi, Introduction to Macromolecular Science, 2<sup>nd</sup> ed. John Wiley & Sons (2002)
- n L. H. Sperling, Introduction to Physical Polymer Science, 4<sup>th</sup> ed. John Wiley & Sons (2005)
- n Malcolm P. Stevens, Polymer Chemistry: An Introduction, 3<sup>rd</sup> ed. Oxford University Press (2005)
- n Seymour/Carraher's Polymer Chemistry. 9<sup>th</sup> ed by Charles E. Carraher, Jr. (2013)

**+3 THIRD YEAR FIFTH SEMESTER  
DSE - II - CHEMISTRY  
GREEN CHEMISTRY**

Time: 3 Hours

Credit: 6

End Semester Theory : 50 Marks

Mid Semester : 20 Marks

**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**

Twelve principles of Green Chemistry with their explanations and examples; Designing a Green Synthesis using these principles; Prevention of Waste/byproducts; maximum incorporation of the materials used in the process into the final products (Atom Economy); prevention/minimization of hazardous/toxic products; designing safer chemicals - different basic approaches to do so; selection of appropriate auxiliary substances (solvents, separation agents), green solvents, solventless processes, immobilized solvents and ionic liquids; energy requirements for reactions - use of microwaves, ultrasonic energy; selection of starting materials; avoidance of unnecessary derivatization - careful use of blocking/protecting groups; use of catalytic reagents (wherever possible) in preference to stoichiometric reagents; designing of biodegradable products; prevention of chemical accidents; strengthening/development of analytical techniques to prevent and minimize the generation of hazardous substances in chemical processes.

**UNIT-II Examples of Green Synthesis/ Reactions-I**

1. Green Synthesis of the following compounds: adipic acid, catechol, BHT, methyl methacrylate, urethane, aromatic amines (4-aminodiphenylamine), benzyl bromide, acetaldehyde, disodium iminodiacetate (alternative to Strecker synthesis), citral, ibuprofen, paracetamol, furfural.
2. Microwave assisted reactions in water: Hofmann Elimination, Hydrolysis (of benzyl chloride, benzamide, n-phenyl benzamide, methylbenzoate to benzoic acid), Oxidation (of toluene, alcohols).  
Microwave assisted reactions in organic solvents: Esterification, Fries rearrangement, Orthoester Claisen Rearrangement, Diels-Alder Reaction, Decarboxylation



Microwave assisted solid state reactions: Deacetylation, Deprotection. Saponification of esters, Alkylation of reactive methylene compounds, reductions, synthesis of nitriles from aldehydes; anhydrides from dicarboxylic acid; pyrimidine and pyridine derivatives; 1,2-dihydrotriazine derivatives; benzimidazoles,

3. Ultrasound assisted reactions: Esterification, saponification, substitution reactions, Alkylations, oxidation, reduction, coupling reaction, Cannizzaro reaction, Strecker synthesis, Reformatsky reaction.

### UNIT-III Examples of Green Synthesis/Reactions-!!

Selective methylation of active methylene group using dimethylcarbonate: Solid-state polymerization of amorphous polymers using diphenylcarbonate; Use of "Clayan", a nonmetallic oxidative reagent for various reactions; Free Radical Bromination; Role of Tellurium in organic syntheses; Biocatalysis in organic syntheses.

#### Future Trends in Green Chemistry

Oxidation reagents and catalysts; Biomimetic, multifunctional reagents; Combinatorial green chemistry; Proliferation of solventless reactions; oncovalent derivatization; Green chemistry in sustainable development.

#### Reference Books:

- V.K. Ahluwalia & MR. Kidwai: New Trends in Green Chemistry, Anamalaya Publishers (2005).
- P.T. Anastas & J.K. Warner: Oxford Green Chemistry- Theory and Practical, University Press (1998).
- A.S. Matlack: Introduction to Green Chemistry, Marcel Dekker (2001).
- M.C. Cann & M.E. Connely: Real-World cases 'in Green Chemistry, American Chemical Society, Washington (2000).
- M.A. Ryan & M. Tinnesand, Introduction to Green Chemistry, American Chemical Society, Washington (2002).

## PRACTICAL DSE - 2 GREEN CHEMISTRY

Time - 3hrs

Full Mark : 30 Marks

### 1. Safer starting materials

The Vitamin C clock reaction using Vitamin C tablets, tincture of iodine, hydrogen peroxide and liquid laundry starch.

Effect of concentration on clock reaction

Effect of temperature on clock reaction, (if possible)

### 2. Using renewable resources

Preparation of biodiesel from vegetable oil.

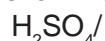
### 3. Avoiding waste

Principle of atom economy.

Use of molecular model kit to stimulate the reaction to investigate how the atom economy can illustrate Green Chemistry.

Preparation of propene by two methods can be studied

- (I) Triethylamine ion + OH<sup>⊖</sup> propene + trimethylpropene + water





(II) i-propanol  $\xrightarrow{\text{R}}$  propene + water

The other types of reactions, like addition, elimination, substitution and rearrangement should also be studied for the calculation of atom economy.

**4. Use of enzymes as catalysts**

Benzoin condensation using Thiamine Hydrochloride as a catalyst instead of cyanide Alternative Green solvents

**5. Diels Alder reaction in water**

Reaction between furan and maleic acid in water and at room temperature rather than in benzene and reflux.

6. Extraction of D-limonene from orange peel using liquid  $\text{CCl}_2$  prepared from dry ice.

7. Mechanochemical solvent free synthesis of azomethines

8. Co-crystal controlled solid state synthesis ( $\text{C}^2\text{S}^1$ ) of N-organophthalimide using phthalic anhydride and 3-aminobenzoic acid.

**Alternative sources of energy**

9. Solvent free, microwave assisted one pot synthesis of phthalocyanine complex of copper (II).

10. Photoreduction of benzophenone to benzopinacol in the presence of sunlight.

**Reference Books:**

- Anastas, P.T & Warner, J.C. Green Chemistry: Theory and Practice, Oxford University Press (1998).
- Kirchoff, M. & Ryan, M.A. Greener approaches to undergraduate chemistry experiment. American Chemical Society, Washington DC (2002).
- Ryan, M.A. Introduction to Green Chemistry, Tinnensand: (Fd). American Chemical Society, Washington DC (2002).
- Sharma, R.K.; Sidhwani, IT. & Chaudhari, M.K. I.K. Green Chemistry Experiment: A monograph International Publishing House Pvt Ltd. New Delhi. Bangalore ISBN 978-93-81141-55-7(2013).
- Cann, M.C. & Connelly, M. E. Real world cases in Green Chemistry, American Chemical Society (2008).
- Cann, M. C. & Thomas, P. Real world cases in Green Chemistry, American Chemical Society (2008).
- Pavia, D. L. Lamponan, G. H. & Kriz, G.S. *WB Introduction to organic laboratory*.

**+3 THIRD YEAR SIXTH SEMESTER  
CORE COURSE - XIII (C- 13) - CHEMISTRY  
INORGANIC CHEMISTRY - IV**

**Time: 3 Hours**

**Credit: 6**

**End Semester Theory : 50 Marks**

**Mid Semester : 20 Marks**

**Unit - I : Theoretical Principles in Qualitative Analysis ( $\text{H}_2\text{S}$  Scheme)**

Basic principles involved in analysis of cations and anions. Solubility products, common ion effect. Principles involved in separation of cations into groups and choice of group reagents. Interfering anions (fluoride, borate, oxalate and phosphate) and need to remove them after Group II.

**Unit - II : Organometallic Compounds**

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. Structures of mononuclear and binuclear carbonyls of Cr, Mn, Fe, Co and Ni using VBT.  $\pi$ -acceptor behaviour of CO

(MO diagram of CO to be discussed), synergic effect and use of IR data to explain extent of back bonding.

**Unit - II : Zeise's salt :** Preparation and structure, evidences of synergic effect and comparison of synergic effect with that to carbonyls.

Metal Alkyls : Important structural features of methyl lithium (tetramer) and trialkyl aluminium (dimer), concept of multicentre bonding in these compounds.

Ferrocene : Preparation and reactions (acetylation, alkylation, metallation, Mannich Condensation). Structure and aromaticity. Comparison of aromaticity and reactivity with that of benzene.

**Unit - IV : Bioinorganic Chemistry:**

Metal ions present in biological systems, classification of elements according to their action in biological system. Geochemical effect on the distribution of metals. Sodium / 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, Cisplatin as an anti-cancer drug. Iron and its application in bio-systems, Haemoglobin, Myoglobin; Storage and transfer of iron.

**Unit - V : Catalysis by Organometallic Compounds**

Study of the following industrial processes and their mechanism:

1. Alkene hydrogenation (Wilkinson's Catalyst)
2. Synthetic gasoline (Fischer Tropsch reaction)
3. Polymerisation of ethene using Ziegler-Natta catalyst

**Reference Books :**

- Vogel, A.I. *Qualitative Inorganic Analysis*, Longman, 1972
- Svehla, G. *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall, 1996-03-07.
- Lippard, S.J. & Berg, J.M., *Principles of Bioinorganic Chemistry* Panima Publishing Company 1994.
- Cotton, F.A., Wilkinson, G., & Gaus, P.L. *Basic Inorganic Chemistry Jrd Ed.*; Wiley India,
- Huheey, J. E.; Keiter, E.A. & Keiter, R.L. *Inorganic Chemistry, Principles of Structure and Reactivity 1h Ed.*, Harper Collins 1993, Pearson, 2006.
- Sharpe, A.G. *Inorganic Chemistry*, 4th Indian Reprint (Pearson Education) 2005
- Douglas, B. E.; McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry J<sup>rd</sup> Ed.*, John Wiley and Sons, NY, 1994.
- Greenwood, N.N. & Earnshaw, A. *Chemistry of the Elements 2<sup>nd</sup> Ed*, Elsevier, 1997 (Ziegler Natta Catalyst and Equilibria in Grignard Solution).
- Lee, J.D. *Concise Inorganic Chemistry 5<sup>th</sup> Ed.*, John Wiley and sons 2008.
- Powell, P. *Principles of Organometallic Chemistry*, Chapman and Hall, 1988.
- Shriver, D.D., Atkins, P. and Langford, C.H., *Inorganic Chemistry 2<sup>nd</sup> Ed.*, Oxford University Press, 1994.
- Purcell, K.F. & Kotz, J.C., *Inorganic Chemistry*, W.B. Saunders Co. 1977
- Miessler, G. L. & Tarr, Donald A., *Inorganic Chemistry 1h Ed.*, Pearson, 2010.
- Collman, James P. et al. *Principles and Applications of Organotransition Metal Chemistry*. Mill Valley, CA: University Science Books, 1987.
- Crabtree, Robert H. *The Organometallic Chemistry of the Transition Metals*. John Wiley New York, NY, 2000.
- Spessard, Gary O., & Miessler, Gary L., *Organometallic Chemistry*. Upper Saddle River, NJ: Prentice-Hall, 1996.

## PRACTICAL C - 13

Time : 3 Hrs

Full Mark : 30 Marks

**Colorimetry :**

Qualitative semimicro analysis of mixtures containing 3 anions and 3 cations. Emphasis should be given to the understanding of the chemistry of different reactions. The following radicals are suggested:  $\text{CO}_3^{2-}$ ,  $\text{NO}_2^-$ ,  $\text{S}^{2-}$ ,  $\text{SO}_3^{2-}$ ,  $\text{S}_2\text{O}_3^{2-}$ ,  $\text{CH}_3\text{COO}^-$ ,  $\text{F}^-$ ,  $\text{Cl}^-$ ,  $\text{Br}^-$ ,  $\text{I}^-$ ,  $\text{NO}_3^-$ ,  $\text{BO}_3^{3-}$ ,  $\text{C}_2\text{O}_4^{2-}$ ,  $\text{PO}_4^{3-}$ ,  $\text{NH}_4^+$ ,  $\text{K}^+$ ,  $\text{Pb}^{2+}$ ,  $\text{Cu}^{2+}$ ,  $\text{Cd}^{2+}$ ,  $\text{Bi}^{3+}$ ,  $\text{Sn}^{2+}$ ,  $\text{Sb}^{3+}$ ,  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$ ,  $\text{Zn}^{2+}$ ,  $\text{Mn}^{2+}$ ,  $\text{CO}^{2+}$ ,  $\text{Ni}^{2+}$ ,  $\text{Ba}^{2+}$ ,  $\text{Sr}^{2+}$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ .

Mixtures should preferably contain one interfering anion, or insoluble component ( $\text{BaSO}_4$ ,  $\text{SrSO}_4$ ,  $\text{PbSO}_4$ ,  $\text{CaF}_2$  or  $\text{Al}_2\text{O}_3$ ) or combination of anions e.g.  $\text{CO}_3^{2-}$  and  $\text{SO}_3^{2-}$ ,  $\text{NO}_2^-$  and  $\text{NO}_3^-$ ,  $\text{Cl}^-$  and  $\text{Br}^-$ ,  $\text{Cl}^-$  and  $\text{I}^-$ ,  $\text{Br}^-$  and  $\text{I}^-$ ,  $\text{NO}_3^-$  and  $\text{Br}^-$ ,  $\text{NO}_3^-$  and  $\text{I}^-$ .

Spot tests should be done whenever possible.

Principles involved in chromatographic separations. Paper chromatographic separation of following metal ions:

- i. Ni (II) and Co (II)                      ii. Cu(II) and Cd (II)

**Reference Books:**

- Vogel's Qualitative Inorganic Analysis, Revised by G. Svehla.
- Vogel, A.I. A Textbook of Quantitative Analysis, ELBS. 1986

## +3 THIRD YEAR SIXTH SEMESTER CORE COURSE - XIV (C- 14) - CHEMISTRY ORGANIC CHEMISTRY - V

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**Unit - I : Organic Spectroscopy**

General principles Introduction to absorption and emission spectroscopy.

**UV Spectroscopy:** Types of electronic transitions,  $\lambda_{\text{max}}$ , Chromophores and Auxochromes, Bathochromic and Hypsochromic shifts, Intensity of absorption; Application of Woodward Rules for calculation of  $\lambda_{\text{max}}$  for the following systems: a,b-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 .

**IR Spectroscopy:** Fundamental and non-fundamental molecular vibrations; IR absorption positions of O, N and S containing functional groups; Effect of H-bonding, conjugation, resonance and ring size on IR absorptions; Fingerprint region and its significance; application in functional group analysis.

**Unit - II : 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.

Applications of IR, UV and NMR for identification of simple organic molecules.

**Mass Spectroscopy:** Basic principle simple ideas about instruments (Block diagram) Determination of molecular formula, parent and base peaks, metastable peaks, McLafferty rearrangement Nitrogen rule, ring rule mass spectra of simple hydrocarbons.

**Unit - III : Carbohydrates**

Occurrence, classification and their biological importance.

Monosaccharides: Constitution and absolute configuration of glucose and fructose, epimers and anomers, mutarotation, 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 maltose, lactose and sucrose.

Polysaccharides - Elementary treatment of starch, cellulose and glycogen.

#### Unit - IV : Dyes and Synthetic drugs :

- a) Classification, Colour and constitution; Mordant and Vat Dyes; Chemistry of dyeing; Synthesis and applications of: Azo dyes - Methyl orange; Triphenyl methane dyes-Malachite green and Rosaniline; Phthalein Dyes - Phenolphthalein; Natural dyes-structure elucidation and synthesis of Alizarin and Indigotin; Edible Dyes with examples.
- b) Synthetic drugs : Antibiotics & Analgesics (Synthesis of few patented compounds-penicilline, Streptomycine, Aspirin, phenacetin, Paracetamol Sulphonamide, Sulphadiazine.)

#### Unit - V : Polymers :

Introduction and classification including di-block, tri-block and amphiphilic polymers; Polymerisation reactions -Addition and condensation -Mechanism of cationic, anionic and free radical addition polymerization; Metallocene-based Ziegler-Natta polymerisation of alkenes; Preparation and applications of plastics - thermosetting (phenol-formaldehyde, Polyurethanes) and thermosoftening (PVC, polythene); Introduction to biodegradable and conducting polymers with examples.

#### Reference Books:

- Kalsi, P. S. Textbook of Organic Chemistry 1st Ed., New Age International (P) Ltd. Pub.
- Morrison, R. T. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Billmeyer, P. W. Textbook of Polymer Science, John Wiley & Sons, Inc.
- Gowariker, V. R.; Viswanathan, N. V. & Sreedhar, J. Polymer Science, New Age International (P) Ltd. Pub.
- Finar, L L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Graham Solomons, T.W. Organic Chemistry, John Wiley & Sons, Inc.

## PRACTICAL C - 14

Time : 3 Hrs

Full Mark : 30 Marks

(Expt-15, Viva Voce - 10 + Lab Record-5)

1. Extracteon of caffeine from tea leaves.
2. Preparation of sodium polyacrylate.
3. Preparation of urea formaldehyde.
4. Analysis of Carbohydrate : aldases and ketoses, reducing and non-reducing sugars.
5. Qualitative analysis of unknown organic compounds contasing monofunctional groups (Carbohydrates, asyl halides, aromatic hydrocarbons, nitro compounds, amines and amides) and simple bifunctional groups, for e.g. sa..... and cinnemic and nitrophenols etc.

#### Reference Books :

- Vogel, A. I. Quantitative Organic Analysis, Part-3, Pearson (2012)
- Mann, F.G. & Sounders, B. C. Practical organic chemistry, persons Educations (2009)
- Furniss, B. S; Hannaford, A. J. ; Smith, P.W.G; Tatchell, A.R. Practical Organise chemistry, 5th ed. pearson (2012).
- Ahluwalia, V. K. & Aggarwal, R. Comprehensive Practical Organic Chemistry; Preparation and Quantitative Analysis, University Press (2000).
- Ahluwalia, V. K. & Aggarwal, R. Comprehensive Prectical Organic Chemisty; Qualitative Analysis, University Press (2000)

**+3 THIRD YEAR SIXTH SEMESTER**  
**DSE - III**  
**INDUSTRIAL CHEMICALS AND ENVIRONMENT**

Time: 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid Semester : 20 Marks

**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, neon, helium, hydrogen, acetylene, carbon monoxide, chlorine, fluorine, sulphur dioxide and phosgene.

*Inorganic Chemicals:* Manufacture, application, analysis and hazards in handling the following chemicals: hydrochloric acid, nitric acid, sulphuric acid, caustic soda, common salt, borax, bleaching powder, sodium thiosulphate, hydrogen peroxide, potash alum, chrome 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  $\text{SO}_2$ ,  $\text{CO}_2$ , CO,  $\text{NO}_x$ ,  $\text{H}_2\text{S}$  and other foul smelling gases. Methods of estimation of CO,  $\text{NO}_x$ ,  $\text{SO}_x$  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. Control of particulates.

**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, agro, fertilizer, etc. Sludge disposal.

Industrial waste management, incineration of waste. Water treatment and purification (reverse osmosis, electro dialysis, ion exchange). Water quality parameters for waste water, industrial water and domestic water.

**UNIT-IV Energy & Environment:**

Sources of energy: Coal, petrol and natural gas. Nuclear Fusion / Fission, Solar energy, Hydrogen, geothermal, Tidal and Hydel, etc.

Nuclear Pollution: Disposal of nuclear waste, nuclear disaster and its management.

**Biocatalysis**

Introduction to biocatalysis: Importance in "Green Chemistry" and Chemical Industry.

**Reference Books:**

- E. Stocchi: *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK.
- R.M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry*; CBS Publishers, New Delhi.

- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt, Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*: Wiley Eastern Ltd, New Delhi.
- S. E. Manahan, *Environmental Chemistry*, CRC Press (2005).
- G. T. Miller, *Environmental Science* 11th edition. Brooks/ Cole (2006).
- A. Mishra, *Environmental Studies*. Selective and Scientific Books, New Delhi (2005).

**PRACTICAL  
DSE - III  
INDUSTRIAL CHEMICALS & ENVIRONMENT**

**Time - 3hrs**

**Full Mark : 30 Marks**

1. Determination of dissolved oxygen 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<sub>3</sub> and potassium chromate).
6. Estimation of total alkalinity of water samples (CO<sub>3</sub><sup>2-</sup>, HCO<sub>3</sub><sup>-</sup>;) using double titration method.
7. Measurement of dissolved CO<sub>2</sub>.
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:**

- E. Stocchi: *Industrial Chemistry*, V'oi-L Hi I is Norwood Ltd. UK.
- R. M. Felder, R.W. Rousseau: *Elementary Principles of Chemical Processes*, Wiley Publishers, New Delhi.
- J. A. Kent: *Riegel's Handbook of Industrial Chemistry*, CBS Publishers, New Delhi.
- S. S. Dara: *A Textbook of Engineering Chemistry*, S. Chand & Company Ltd. New Delhi.
- K. De, *Environmental Chemistry*: New Age International Pvt., Ltd, New Delhi.
- S. M. Khopkar, *Environmental Pollution Analysis*; Wiley Eastern Ltd., New Delhi

**+3 THIRD YEAR SIXTH SEMESTER  
DSE - IV - CHEMISTRY**

**PROJECT / DISSERTATION**

**Credit : 6**

**Marks : 100**

To be announced by concern H.O.D.





# COMPUTER SCIENCE

## +3 FIRST YEAR FIRST SEMESTER

### CORE COURSE - I (C-1)

### PROGRAMMING USING C

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

#### UNIT-I

Introduction to Programming Language, Introduction to C Programming, Character Set, C Tokens, Keywords & Identifiers, Constants, Variables, Data Types, Variables, Storage Classes, Operators (Arithmetic, Relational, Logical, Assignment, Increment & Decrement, Conditional, Bitwise), Expressions, Input and Output Operations.

#### UNIT-II

Decision Making and Branching: Simple IF Statement, IF ..... ELSE Statement, Nesting IF .... ELSE Statement, ELSE IF Ladder, Switch Statement : Operator, GOTO Statement. Decision Making and Looping: The WHILE Statement, The DO while Statement, The FOR Statement, Jumps in LOOPS. Arrays, Character Arrays and Strings.

#### UNIT - III

User-defined Functions: Need, Elements & Definition, Function Calls, Function Definition, Category of Functions, Recursion. Structures and Unions: Defining, Declaring, Accessing, Initialization Structure, Arrays of Structures, Arrays within Structures, Structures and Functions, Unions.

#### UNIT-IV

Pointers: Accessing the Address of a Variable, Declaring Pointer Variables, Initializations of Pointer Variable, Accessing a Variable through its Pointer, Chain of Pointers, Pointer Expressions, Pointer Increments and Scale Factor, Pointers and Arrays" Pointers and Character Strings, Array of Pointers, Pointers as Function Arguments, Functions Returning Pointers, Pointers to Functions, Pointers to Structures, Troubles with Pointers.

#### UNIT- V

File Management in C: Defining and Opening a File, Closing a File, Input/ Output Operations on Files, Error Handling During 1/0 Operations, Random Access to Files, Command Line Arguments, Dynamic Memory Allocation.

#### Recommended Books:

1. E. Balaguruswamy, "Programming in ANSI C", 4/e, (TMH)
2. Paul Deitel, Harvey Deitel, "C: How to Program", 8/e, Prentice Hall.
3. J. R. Hanly, "Problem Solving & Program Design in C", 7/e, Pearson
4. B. Kernighan & D.M. Ritchie, "The C Programming Language", 2/e PHI

#### PRACTICAL

#### C-1 LAB - 1

Time : 2 hours

End Sem. : 30 Marks

Exercises to study various features of C language, writing of well structured modular programs, Case studies of use of various data structures, stack, Queues, linked list, binary trees, using arrays and pointers, and their applications in sorting, searching, string manipulation and linked list manipulation.



**+3 FIRST YEAR FIRST SEMESTER  
CORE COURSE - II (C-2) - COMPUTER SCIENCE  
COMPUTER ORGANIZATION**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

**UNIT - I**

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.

**UNIT-II**

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, Timing Diagrams, The Finite State Machine Model, Synthesis of Finite State Machines.

**UNIT-III**

Basic Structure of Computers: Computer Types, Functional Units, Input Unit, Memory Unit, Arithmetic and Logic Unit, Output Unit, Control Unit, Basic Operational Concepts, Bus Structures, Software. Machine Instructions and Programs: Numbers, Arithmetic Operations, and Characters: Number Representation, Addition of Positive Numbers, Addition and Subtraction of Signed Numbers, Overflow of Integer Arithmetic, Characters, Memory Locations and Addresses, Byte Addressability, Word Alignment, Accessing Numbers, Characters, and Character Strings, Memory Operations, Instructions and Instruction Sequencing, Register Transfer Notation, Basic Instruction Types, Instruction Execution and Straight-Line Sequencing, Branching, Condition Codes, Generating Memory Addresses, Addressing Modes, Implementation of Variables and Constants, Indirection and Pointers, Indexing and Arrays, Relative Addressing.

**UNIT-IV**

THE ARM EXAMPLE: Registers, Memory Access, and Data Transfer, Register Structure, Memory Access Instructions and Addressing Modes, Register Move Instructions, Arithmetic and Logic Instructions: Arithmetic Instructions, Logic Instructions, Branch Instructions, Setting Condition Codes, Assembly Language, Pseudo-Instructions, I/O Operations, Subroutines, Vector Dot Product Program, Byte-Sorting Program, Linked-List Insertion and Deletion Subroutines. Basic Input-Output Operations, Stacks and Queues, Subroutines. PowerPC Example: Basic PowerPC Processor Organization, Load and Store Instructions, Arithmetic and Logic Instructions, Flow Control Instructions, Compare Instructions, Logic Instructions, Subroutines.

**UNIT-V**

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.

**Recommended Books:**

1. Carl Hamacher, Z. Vranesic, S. Zaky: Computer Organization, 5/e (TMH)
  2. William Stallings: Computer Organization and Architecture (Design for Performance), 9/e
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3. S. Brown, & Z. Vranesic, "Fundamentals of Digital Logic Design with VHDL", 2/e, McGraw-Hill
4. J. P. Uyemura, "A First Course in Digital System Design, An Integrated Approach", Cengage Learning.

## PRACTICAL

### C-2 LAB - 2

Time : 2 hours

End Sem. : 30 Marks

Study of truth tables of logic Gates, verification of Boolean expressions, De-morgan's theorem, construction of half adder and full adder, Flipflops, counters, (ripple), convertors (decimal to binary), decoder (BCD to decimal), multiplexer/demultiplexer, multivibrators, Familiarity with intel 8086 microprocessor, assembly language and machine language programming, writing a simplex program such as addition of integers in arithmetic progression, finding largest number among a given set of numbers, interfacing 8086 with keyboard and segment display units. Familiarity with PC system; architecture, functions of CPU, memory input output devices, Bus structure introduction to nomenclatures such as COM1, COM2, Power equipments, MS Office : MS Word, MS Excel, Web page design (development of webpages & website hosting), MS DOS (internal commands, external commands, filters, batch files).

## +3 FIRST YEAR SECOND SEMESTER CORE COURSE - III (C-3) - COMPUTER SCIENCE PROGRAMMING USING C++

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

### UNIT-I

Principles of Object-Oriented Programming: Object-Oriented Programming (OOP) Paradigm, Basic Concepts of OOP, Benefits of OOP, Object Oriented Languages, Applications of OOP. Beginning with C++: Applications of C++, C++ statements, Example with Class, Structure of C++ Program, Creating the Source File, Compiling and Linking. Tokens, Expressions and Control Structures: Tokens, Keywords, Identifiers & Constants, Basic Data Types, User-Defined Data Types, Derived Data Types, Symbolic Constants, Type Compatibility, Declaration of Variables, Dynamic Initialization of Variables, Reference Variables, Operators in C++, Scope Resolution Operator, Member Dereferencing Operators, Memory Management Operators, Manipulators, Type Cast Operators, Expressions and their Types, Special Assignment Expressions, Implicit Conversions, Operator Overloading, Operator Precedence, Control Structures.

### UNIT-II

Functions in C++: The Main Function, Function Prototyping, Call By Reference, Return by Reference, Inline Functions, Default Arguments, Const. Arguments, Function Overloading, Friend & Virtual Functions, Math. Library Functions. Classes and Objects: Specifying a Class, Defining Member Functions, Making an outside Function Inline, Nested Member Functions, Private Member Functions, Arrays within a Class, Memory Allocation for Objects, Static Data Members, Static Member Functions, Arrays of Objects, Objects as Function Arguments, Friendly Functions, Returning Objects, Const. Member Functions, Pointer to Members, Local Classes.

### UNIT- III

Constructors & Destructors: Constructors, Parameterized Constructors, Multiple Constructors in a Class, Constructors with Default Arguments, Dynamic Initialization of Objects, Copy Constructor, Dynamic Constructors, Constructing Two-Dimensional Arrays, Const. Objects, Destructors. Operator Overloading and Type Conversions: Defining Operator Overloading, Overloading Unary Operators, Overloading

Binary Operators, Overloading Binary Operators using Friends, Manipulation of Strings using Operators, Rules for Overloading Operators, Type Conversions.

#### UNIT-IV

Inheritance: Defining Derived Classes, Single Inheritance, Making a Private Member Inheritance, Multilevel Inheritance, Multiple Inheritance, Hierarchical Inheritance, Hybrid Inheritance, Virtual Base Classes, Abstract Classes, Constructors in Derived Classes, Member Classes, Nesting of Classes. Pointers, Virtual Functions and Polymorphism: Pointers, Pointers to Objects, this Pointer, Pointers to Derived Classes, Virtual Functions, Pure Virtual Functions.

#### UNIT- V

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.

#### Recommended Books;

1. E. Balgurusamy, Object Oriented Programming with C++:, 4/e (TMH).
2. Paul Deitel, Harvey Deitel, "C++: How to Program",9/e. Prentice Hall.
3. J. Farrell, "Object-Oriented Programming, Cengage Learning
4. BjarneStroustrup, "Programming — Principles and Practice using C++", 2/e, Addison-Wesley 2014

### PRACTICAL

#### C-3 LAB - 3

Time : 2 hours

End Sem. : 30 Marks

Simple C++ Program : Streambased I/O, use of scope resolution operator, variable aliases reference variable, parameter passing by reference, inline function, default argument in function.

Class and Object : Class specification, class object definition, accessing class members, defining class member function inside class body and outside class body, pointers within class, friend function and friend classes. Constant parameters and member function, static data and member function. Constructor, parameterised constructor, constructor overloading, destructor, order of construction & destruction, dynamic constructor, copy constructor, constructor for two dimension array, nested classes, Empty classes, Nameless objects, pointers to object, dynamic object, use of this pointer

Operator Overloading : Binary operator overloading, unary operator overloading, data conversion, operator overloading with friend function.

inheritance & Polymorphism : Base class and derive class specification, different types of inheritance, constructors and destructors in inheritance.

Constructor invocation and data member initialisation on. Virtual base class, object composition and delegation.

Virtual function definition, pointer to derived class objects. Pure virtual function abstract classes, dynamic binding (dynamic polymorphism) virtual destructor.

Stream computation and file handling : Unformatted I/O operation, formatted console I/O operation, manipulators, file opening and closing, File I/O with stream classes, ASCII and binary files operation, random access file.

**+3 FIRST YEAR SECOND SEMESTER  
CORE COURSE - IV (C-4) - COMPUTER SCIENCE  
DATA STRUCTURE**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

**UNIT-I**

Introduction and Overview: Definitions, Concept of Data Structures, Overview of Data Structures, Implementation of Data Structures. Arrays: Terminology, One- Dimensional Array, Multi-Dimensional Arrays, Pointer Arrays.

**UNIT-II**

Linked Lists: Single Linked List, Circular Linked List, Double Linked List, Circular Double Linked List, Application of Linked Lists, Memory Representation, Boundary Tag System, De-allocation Strategy, Buddy System, Compaction.

**UNIT -III**

Stacks: Definition, Representation of Stack (Array, Linked List), Operations on Stacks, Applications of Stack (Evaluation of Arithmetic Expressions, Code Generation, Implementation of Recursion, Factorial Calculation, Quick Sort, Tower of Hanoi, Activation Record Management).

**UNIT -IV**

Queues: Definition, Representation of Queues (Array, Linked List), Circular Queue, Deque, Priority Queue, Application of Queues (Simulation, CPU Scheduling in Multiprogramming Environment, Round Robin Algorithm).

**UNIT -V**

Tree: Binary Trees, Properties of Binary Tree, Linear Representation of Binary a Binary Tree, Linked Representation of a Binary Tree, Physical Implementation of Binary Tree in Memory, Operations on Binary Tree (Insertion, Deletion, Traversal, Merging of two Binary Trees), Types of Binary Trees (Expression Tree, Binary Search Tree, Heap Tree, Threaded Binary Trees, Height Balanced Binary Tree, Weighted Binary Tree, Decision Trees).

**Recommended Books:**

1. D. Samanta, "Classic Data Structures":, 2/e (PHI).
2. D.S Malik, "Data Structure using C++", 2/e, Cengage Learning, 2010
3. Adam Drozdek, "Data Structures and algorithm in C++", 3/e, Cengage Learning, 2012.
4. Robert L. Kruse, "Data Structures and Program Design in C++", Pearson.

**PRACTICAL**

**C-4 LAB - 4**

Time : 2 hours

End Sem. : 30 Marks

Case studies of use of various data structures, stack, queues, linked list, binary trees using array and linked list and their application in sorting searching string manipulation and linked list manipulation.

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**+3 SECOND YEAR THIRD SEMESTER  
CORE COURSE - V (C - 5) - COMPUTER SCIENCE  
OPERATING SYSTEMS**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

**UNIT-I**

Operating System, Computer-System Organization, Computer-System Architecture, Operating-System Structure, Operating-System Operations, Process Management, Memory Management, Storage, Management, Protection and Security, Distributed Systems, Special Purpose Systems, Computing Environments, Open-Source Operating Systems. Operating System Services, User Operating System Interface, System Calls, Types of System Calls, System Programs, Operating-System Design and Implementation, Operating System Structure, Virtual Machines, Operating System Debugging, Operating System Generations. System Boot.

**UNIT - II**

Process: Process Concept, Process Scheduling, Operations on Processes, Inter-Process Communication, Examples of IPC Systems, Communication in Client-Server Systems. Multithreaded Programming: Multithreading Models, Thread Libraries, Threading Issues, Operating-System Examples.

**UNIT - III**

Process Scheduling: Basic Concepts, Scheduling Criteria, Scheduling Algorithms, Thread Scheduling. Multiple-Process Scheduling. Synchronization: The Critical Section Problem, Peterson's Solution, Synchronization Hardware, Semaphores, Classical Problems of Synchronization, Monitors, Synchronization Examples, Atomic Transactions.

**UNIT-IV**

Deadlocks: System Model, Deadlock Characterization, Methods of Handling Deadlocks, Deadlock Prevention, Deadlock avoidance, Deadlock Detection, Recovery from Deadlock. Memory Management Strategies: Swapping, Contiguous Memory Allocation, Paging, Structure of the Page Table, Segmentation, Example: The Intel Pentium.

**UNIT- V**

Virtual-Memory Management: Demand Paging, Copy-on-Write, Page Replacement, Allocation of Frames, Thrashing, Memory-Mapped Files, Allocating Kernel Memory. File System: File Concept, Access Methods, Directory and Disk Structure, File-System Mounting, File Sharing, Protection.

**Recommended Books:**

1. A Silberschatz, P.B. Galvin, G. Gagne, Operating Systems Concepts, 8/e, John Wiley Publications 2008.
  2. A.S. Tanenbaum, Modern Operating Systems, 3/e, Pearson Education 2007
  3. W. Stallings, "Operating Systems, Internals & Design Principles", 5/e, Prentice Hall of India. 2008
  4. G. Nutt, "Operating Systems: A Modern Perspective", 2/e, Pearson Education 1997.
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**PRACTICAL : C - 5**

Time : 3 Hrs

Full Mark : 30 Marks

Unix/Linux O.S.  
**+3 SECOND YEAR THIRD SEMESTER**  
**CORE COURSE - VI (C - 6) - COMPUTER SCIENCE**  
**DATABASE MANAGEMENT SYSTEM**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**UNIT-I**

Databases and Database Users, Database System Concepts and Architecture, Data Modelling using the Entity-Relationship(ER) Model, The Enhanced Entity-Relationship (EER) Model.

**UNIT-II**

Relational Model: The Relational Data Model and Relational Database Constraints, The Relational Algebra and Relational Calculus.

**UNIT-III**

Relational Database Design by ER- and EER-to-Relational Mapping, SQL-99: Schema Definition, Constraints, Queries, and Views, Introduction to SQL Programming Techniques.

**UNIT-IV**

Functional Dependencies and Normalization for Relational Databases, Relational Database Algorithms and Further Dependencies, Practical Database Design Methodology and use of UML Diagrams.

**UNIT-V**

Disk Storage, Basic File Structures, and Hashing, Indexing Structures for Files, Algorithms for Query Processing and Optimization, Physical Database Design and Tuning.

**Recommended Books:**

1. R. Elmasri, S.B. Navathe, "Fundamentals of Database Systems", 6/e, Pearson Education, 2010
2. A. Silberschatz, H.F. Korth, S. Sudarshan, "Database System Concepts" 6/e, McGraw Hill, 2010
3. R. Ramakrishnan, J. Gehrke, "Database Management Systems", McGraw-Hill
4. C. Coronel, S. Morris, & P. Rob, "Database Principles (Fundamentals of Design, Implementation, and Management)", 9/e, Cengage Learning.

**PRACTICAL : C-6**

Time : 3 Hrs

Full Mark : 30 Marks

**DBMS (ORACLE)**  
**+3 SECOND YEAR THIRD SEMESTER**  
**CORE COURSE - VII (C - 7) - COMPUTER SCIENCE**  
**DISCRETE STRUCTURES**

Time : 3 Hours

End Semester Theory : 80 Marks

Credit : 6

Mid-Semester : 20 Marks

**UNIT-I**

Logic and Proofs: Propositional Logic, Propositional Equivalences, Predicates and Quantifiers, Nested Quantifiers, Rules of Inference, Introduction to Proofs, Normal Forms, Proof Methods and Strategy, Mathematical Induction, Strong Induction and Well-Ordering, Recursive Definitions and Structural Induction, Recursive Algorithms.

**UNIT-II**

Basic Structures: Sets, Set Operations, Functions, Recursive Functions, Sequences and Summations.



Relations: Relations and their Properties, n-ary Relations and their Applications, Representing Relations, Closures of Relations, Equivalence Relations, Partial Ordering. Boolean.

#### UNIT-III

Algebra: Boolean Functions, Representing Boolean Functions, Logic Gates, Minimization of Circuits. Algebraic Structures & Coding Theory: The Structure of Algebras, Semi-groups, Monoids and Groups, Homomorphism, Normal Subgroups, and Congruence Relations, Rings, Integral Domains and Fields, Quotient and Product Algebras, Coding Theory. Polynomial Rings and Polynomial Codes.

#### UNIT-IV

Counting: Basics of Counting, The Pigeonhole Principle, Permutations and Combinations, Binomial Coefficients, Generalized Permutations and Combinations, Generating Permutations and Combinations. Advanced Counting Techniques, Applications of Inclusion-Exclusion, Discrete probability, Conditional probability, Bayes' Theorem.

#### UNIT-V

Graphs: Graphs and Graph Models, Graph Terminology and Special Types of Graphs, Havel-Hakimi Theorem, Representing Graphs and Graph Isomorphism, Connectivity, Cut-Sets, Euler and Hamiltonian Paths, Shortest-Path Problem, Planar Graphs, Graph Coloring, Network Flows.

#### Recommended Books:

1. Kenneth H Rosen, Discrete Mathematics & Its Applications, McGraw-Hill. 7/e.
2. J. L. Hein, Discrete Structures, Logic, and Computability, 3rd Edition, Jones and Bartlett Publishers, 2009
3. C.L. Liu , D.P. Mahopatra, Elements of Discrete mathematics, 2nd Edition, Tata McGraw Hill, 1985
4. M. O. Albertson and J. P. Hutchinson, Discrete Mathematics with Algorithms, John wiley Publication, 1988

## +3 SECOND YEAR FOURTH SEMESTER CORE COURSE - VIII (C - 8) - COMPUTER SCIENCE JAVA PROGRAMMING

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**UNIT-I : Introduction to Java:** Java Architecture and Features, Understanding the semantic and syntax differences between C++ and Java, Compiling and Executing a Java Program, Variables, Constants, Keywords Data Types, 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).

**UNIT-II : Arrays, Strings and I/O:** Creating & Using Arrays (One Dimension and Multidimensional), Referencing Arrays Dynamically, Java Strings: The Java String class, Creating & Using String Objects, Manipulating Strings, String Immutability & Equality, Passing Strings To & From Methods, String Buffer Classes. Simple I/O using System.out and the Scanner class, Byte and Character streams, Reading/Writing from console and files. Object-Oriented Programming Overview: Principles of Object-Oriented Programming, Defining & Using Classes, Controlling Access to Class Members, Class Constructors, Method Overloading, Class Variables & Methods, Objects as parameters, final classes, Object class, Garbage Collection.



**UNIT-III**

**Inheritance, Interfaces, Packages, Enumerations, Autoboxing and Metadata:** Inheritance: (Single Level and Multilevel, Method Overriding, Dynamic Method Dispatch, Abstract Classes), Interfaces and Packages, Extending interfaces and packages, Package and Class Visibility, Using Standard Java Packages (util, lang, io, net), Wrapper Classes, Autoboxing/Unboxing, Enumerations and Metadata.

**UNIT-IV**

**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. Using java.net package, Overview of TCP/IP and Datagram programming. Accessing and manipulating databases using JDBC.

**UNIT-V**

**Applets and Event Handling:** Java Applets: Introduction to Applets, Writing Java Applets, Working with Graphics, Incorporating Images & Sounds. Event Handling Mechanisms, Listener Interfaces, Adapter and Inner Classes. The design and Implementation of GUIs using the AWT controls, Swing components of Java Foundation Classes such as labels, buttons, text fields, layout managers, menus, events and listeners; Graphic objects for drawing figures such as lines, rectangles, ovals, using different fonts. Overview of servlets.

**Recommended Books:**

1. E. Balagurusamy, "Programming with Java", 4/e, TMH
2. Bruce Eckel, "Thinking Java", 8/e, Pearson India, 2010.
3. John R. Hubbard, "Programming with JAVA", Schaum's Series, 2/e, 2004.
4. Cay S. Horstmann, Gary Cornell, "Core Java 2 Volume 1", 9/e, Prentice Hall, 2012.

**PRACTICAL : C-8**

Time : 3 Hrs

Full Mark : 30 Marks

**Java Programming Practical**

**+3 SECOND YEAR FOURTH SEMESTER  
CORE COURSE - IX (C - 9) - COMPUTER SCIENCE  
COMPUTER NETWORK**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**UNIT-I**

**Introduction:** Data Communications, Networks, The Internet, Protocols and Standards. Network Models: Layered Tasks, The OSI Model, Layers in the OSI Model, TCP/ IP Protocol Suite, Addressing.

**UNIT-II**

**Data and Signals:** Analog and Digital, Periodic Analog Signals, Digital Signals, Transmission Impairment, Data Rate Limits, Performance. Digital Transmission: Digital- To-Digital Conversion, Analog- To-Digital Conversion, Transmission Modes. Analog Transmission: Digital-To-Analog Conversion, Analog-To-Analog Conversion.

**UNIT-III**

**Multiplexing and Spreading:** Multiplexing, Spread Spectrum. Transmission Media: Guided Media, Unguided Media (Wireless). Switching: Circuit Switched, Datagrams, Virtual Circuit Networks, Structure of a Switch. Telephone Network, Dial-Up MODEMS, Digital Subscriber Line (DSL), Cable TV Networks, Cable TV for Data Transfer.

**UNIT-IV**

Error Detection and Correction: Introduction, Block Coding, Linear Block Codes, Cyclic Codes, Checksum. Data Link Control: Framing, Flow and Error Control, Protocols, Noiseless Channels, Noisy Channels, HDLC, Point-To-Point Protocol.

Multiple Access: Random Access, Controlled Access, Channelization. Wired LANs: IEEE Standards, Standard Ethernet, Changes in the Standard, Fast Ethernet, Gigabit Ethernet: Wireless LANs: IEEE 802.11, Bluetooth.

**UNIT-V**

Connecting LANs: Connecting Devices, Backbone Networks, Virtual LANs. Wireless LANs: Cellular Telephony, Satellite Networks. SONET: Architecture, SONET Layers, SONET Frames, STS Multiplexing, SONET Networks, Virtual Tributaries. Virtual-Circuit Networks. Frame Relay, ATM, ATM LANs,

**Recommended Books:**

1. B. A. Forouzan, "Data Communications and Networking", 4/e, THM ,2007
2. A. S. Tanenbaum, & David J. Wetherall, "Computer Networks", 5/e, Pearson

**PRACTICAL : C-9****Time : 3 Hrs****Full Mark : 30 Marks****Computer Network Practical.****+3 SECOND YEAR FOURTH SEMESTER  
CORE COURSE - X (C - 10) - COMPUTER SCIENCE  
COMPUTER GRAPHICS****Time : 3 Hours****End Semester Theory : 50 Marks****Credit : 6****Mid-Semester : 20 Marks****UNIT-I**

**Computer Graphics:** A Survey of Computer graphics, Overview of Graphics System: Video Display Devices, Raster-Scan Systems, Input Devices, Hard- Copy Devices, Graphics Software, Introduction to OpenGL. 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, Antialiasing.

**UNIT-II**

**Geometric Transformations (both 2-D & 3-D):** Basic Geometric Transformations, Matrix Representation and Homogeneous Coordinates, Composite Transformations, Inverse Transformations, Other Transformations (Reflection, shear), Transformation between coordinate systems, Affine Transformations. Two Dimensional Viewing: Viewing pipeline, Clipping Window, Normalization & Viewport coordinate Transformations, Clipping Algorithms: Point clipping, Line clipping and Polygon clipping. Three Dimensional Viewing: 3-dimensional Viewing' Concepts, Viewing pipeline, Projection Transformations (Orthogonal, Oblique parallel, Perspective), Clipping Algorithms.

**UNIT -III**

**Three Dimensional Object Representations:** Curved Surfaces, Quadratic . Surfaces, Spline Representations, Bezier Spline Curves and Surfaces, B-Spline Curves and Surfaces, Octrees, BSP Trees, Fractal Geometry Methods, Gamma correction.

**UNIT-IV**

**Visible Surface Detection Methods:** Classification of Visible-Surface Detection Algorithms, Back-Face Detection, Depth-Buffer method, A-Buffer Method, Scan line and Depth Sorting, Area subdivision Method, Ray Casting Method.

**UNIT-V**

**Illumination Models:** Basic Illumination Models, Displaying light Intensities, Halftone Patterns and Dithering techniques, Polygon-Rendering Methods (Gouroud Shading, Phong Shading), Ray-Tracing Methods (Basic Ray-Tracing Algorithm, Ray-Surface Intersection Calculations). Computer Animation, Hierarchical Modeling (introductory idea only).

**Recommended Books:**

1. Donald Hearn & M. Pauline Baker, "Computer Graphics with Open GL", Pearson Education.
2. A.v. Dan, F.H. Jones, J.D. Foley, S.K. Feiner, "Computer Graphics Principles & Practices in C", 2/e, Pearson.
3. D. F. Rogers, "Procedural Elements for Computer Graphics", McGraw Hill
4. D. F. Rogers, & J. A. Adams, "Mathematical Elements for Computer Graphics", 2/e, McGraw Hill

**PRACTICAL : C-10**

Time : 3 Hrs

Full Mark : 30 Marks

**Computer Graphics Practical**

**+3 THIRD YEAR FIFTH SEMESTER  
CORE COURSE - XI (C - 11) - COMPUTER SCIENCE  
INTERNET TECHNOLOGY**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**UNIT-I**

**Java:** Use of Objects, Array and ArrayList class

**UNIT-II**

**JavaScript:** Data types, operators, functions, control structures, events and event handling.

**UNIT-III**

**JDBC:** JDBC Fundamentals, Establishing Connectivity and working with connection interface, Working with statements, Creating and Executing SQL Statements, Working with Result Set Objects.

**UNIT-IV**

**JSP:** Introduction to Java Server Pages, HTTP and Servlet Basics, The Problem with Servlets, The Anatomy of a JSP Page, JSP Processing, JSP Application Design with MVC, Setting Up the JSP Environment, Implicit JSP Objects, Conditional Processing, Displaying Values, Using an expression to Set an Attribute, Declaring Variables and Methods, Error Handling and Debugging, Sharing Data Between JSP Pages, Requests, and Users, Database Access.

**UNIT-V**

**Java Beans:** Java Beans Fundamentals, JAR files, Introspection, Developing a simple Bean, Connecting to DB

**Recommended Books:**

1. Ivan Bayross, Web Enabled Commercial Application Development Using HTML, DHTML, Javascript, Perl CGI , BPB Publications, 2009.
2. Cay Horstmann, BIG Java, Wiley Publication, 3/e, 2009
3. Herbert Schildt, Java 7, The Complete Reference, , 8/e, 2009.
4. Jim Keogh , The Complete Reference ~2EE, TMH, , 2002

**PRACTICAL : C-11**

Time : 3 Hrs

Full Mark : 30 Marks

HTML, DHTML, PHP, Java Script Practical and Basic ideas on internet accessing.

**+3 THIRD YEAR FIFTH SEMESTER  
CORE COURSE - XII (C - 12) - COMPUTER SCIENCE  
SOFTWARE ENGINEERING**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

**UNIT-I**

Professional Software Development, Software Engineering Ethics, Software Processes, Software Process Models, Process Activities, Coping with Change, The Rational Unified Process, Agile Software Development, Agile Methods, Plan- Driven and Agile Development, Extreme Programming, Agile Project Management, Scaling Agile Methods.

**UNIT -II**

Requirements Engineering, Functional and Non-Functional Requirements, The Software Requirements Document, Requirements Specification, Requirements Engineering Processes, Requirements Elicitation and Analysis, Requirements Validation, Requirements Management, System Modelling, Context Models, Interaction Models, Structural Models, Behavioural Models, Model-Driven, Engineering, Architectural Design, Architectural Design Decisions, Architectural Views, Architectural Patterns, Application Architectures.

**UNIT-III**

Design and Implementation: Object-Oriented Design using the UML, Design Patterns, Implementation Issues, Open Source Development, Software Testing: Development Testing, Test-Driven Development, Release Testing, User Testing, Software Evolution: Evolution Processes, Program Evolution Dynamics, Software Maintenance, Legacy System Management, Dependability and Security.

**UNIT-IV**

Socio-technical Systems: Complex Systems, Systems Engineering, System Procurement, System Development, System Operation. Dependability and Security: Dependability Properties, Availability and Reliability, Safety, Security. Dependability and Security Specification: Risk-Driven Requirements, Specification, Safety Specification, Reliability Specification, Security, Specification, Formal Specification.

**UNIT-V**

Dependability Engineering: Redundancy and Diversity, Dependable Processes, Dependable Systems Architectures, Dependable Programming. Security Engineering: Security Risk Management, Design for Security, System Survivability. Dependability and Security Assurance: Static Analysis, Reliability Testing, Security Testing, Process Assurance, Safety and Dependability Cases.

**Recommended Books:**

1. I. Sommerville, "Software Engineering", 9/e, Addison Wesley.
2. R. Mall, "Fundamentals of Software Engineering", 3/e, PHI
3. R.S. Pressman, "Software Engineering", A Practitioner's Approach, 7/e, McGraw-Hill, 2009
4. K.K. Aggarwal and Y. Singh, "Software Engineering", 2/e, New Age International Publishers, 2008

**PRACTICAL : C-12**

Time : **3 Hrs**

Full Mark : **30 Marks**

Software Engineering Practical

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**+3 THIRD YEAR SIXTH SEMESTER  
CORE COURSE - XIII (C - 13) - COMPUTER SCIENCE  
ARTIFICIAL INTELLIGENCE**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

**UNIT-I**

Intelligent Agents, Solving problems by searching, Uninformed search strategies(BFS, DFS, DLS, IDS, BD and Uniform cost search), Informed search and exploration (Greedy Best first, A \* and its variations) Constraint satisfaction Problems, Adversarial search(Alpha-beta pruning).

**UNIT-II**

Knowledge and reasoning, logical agent (Wumpus world), Propositional logic, First order logic, Inference in first order logic(Forward chaining, backward chaining, Resolution) , Knowledge representation.

**UNIT-III**

Planning, Partial-Order planning, Planning Graphs, Planning and acting in the real world, Uncertain knowledge and reasoning.

**UNIT-IV**

Learning from Observations, Decision trees, Neural network (Multilayer), Reinforcement Learning.

**UNIT-V**

NLP, Communication, A formal grammar for a fragment of English, Syntactic analysis (chat parsing), semantic Interpretation, Ambiguity of grammar, Machine Translation.

**Recommended Books:**

1. Stuart Russell and Peter Norvig, "ARTIFICIAL INTELLIGENCE A MODERN APPROACH", 2/e, PHI.
2. D.W. Patterson, "Introduction to A.I and Expert Systems", PHI, 2007.
3. Rich & Knight, "Artificial Intelligence", 2/e, Tata McGraw Hill, 1991.
4. W.F. Clocksin and Mellish, "Programming in PROLOG", Narosa Publishing House, 3/e

**PRACTICAL : C-13**

Time : **3 Hrs**

Full Mark : **30 Marks**

Artificial intelligence Practical

**+3 THIRD YEAR SIXTH SEMESTER  
CORE COURSE - XIV (C - 14) - COMPUTER SCIENCE  
DESIGN AND ANALYSIS OF ALGORITHMS**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

**UNIT-I**

Analysis and Design of. Algorithm (Case study insertion sort and merge sort)Asymptotic Analysis, Divide and Conquer, Recurrence Relations, Strassen's Matrix Multiplication.

**UNIT-II**

Sorting: Quick sort, heap sort, Counting sort, lower bound for sorting, Randomized quicksort, Order Statistics.

**UNIT-III**

Amortized Analysis (Aggregate analysis, Accounting analysis, Potential analysis), 2-3-4 tree Advanced

Data structure: Fibonacci heap, Redblack tree, hashing, data structure on disjoint set, Sciccinet Data Structure.

**UNIT-IV**

Dynamic Programming : Matrix Chain multiplication, LCS, TSP, Branch and Bound. Greedy Algorithm: MST: Krushkal , Prims, Dijkstra Algorithm, Huffman Coding, Maxflow matching, Computational geometry: Convex Hall,0-1-knaplock, fractional knapsack, Back tracking (4-Queen Prob.)

**UNIT-V**

Complexity” Class: P. PSPACE, NP, NP-Hard, NP Complete, Satisfiability, Cheque, Vertex Cover, Independent set, Exact cover, Graph Coloring, Hamiltonian, Cycle Matching. Approximation Algorithm: Vertex Cove, TSP, Independent Set, Sum of subset.

**Recommended Books:**

1. T.H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein “Introduction to Algorithms”, PHI, 3/e, 2009.
2. Sarabasse & A.V. Gelder Computer Algorithm, “Introduction to Design and Analysis”, Pearson 3/e, 1999
3. E. Horowitz, S. Sahni, & S. Rajasekaran, “Fundamentals of Computer Algorithms”, 2/e, University Press.
4. A.V. Aho, J.E. Hopcroft, & J.D. Ullman, “The Design and Analysis of Computer Algorithm, Pearson.

**PRACTICAL : C-14****Time : 3 Hrs****Full Mark : 30 Marks**

Design and analysis practical

**+3 THIRD YEAR FIFTH SEMESTER  
DSE - 1 - COMPUTER SCIENCE  
INFORMATION SECURITY**

**Time : 3 Hours****End Semester Theory : 50 Marks****Credit : 6****Mid-Semester : 20 Marks****UNIT-I**

Introduction: Security, Attacks, Computer Criminals, Security Services, Security Mechanisms. Cryptography: Substitution ciphers, Transpositions Cipher, Confusion, diffusion, Symmetric, Asymmetric Encryption. DES Modes of DES, Uses of Encryption, Hash function, key exchange, Digital Signatures, Digital Certificates.

**UNIT-”**

Program Security: Secure programs, Non malicious Program errors, Malicious codes virus, Trap doors, Salami attacks, Covert channels, Control against program.

**UNIT-III**

Threats: Protection in OS: Memory and Address Protection, Access control, File Protection, User Authentication. Database Security: Requirements, Reliability, Integrity, Sensitive data, Inference, Multilevel Security.

**UNIT-IV**

Security in Networks: Threats in Networks, Security Controls, firewalls, Intrusion detection systems, Secure e-mails.

**UNIT-V**

Administrating Security: Security Planning, Risk Analysis, Organisational Security Policy, Physical Security. Ethical issues in Security: Protecting Programs and data. Information and law.



**Recommended Books:**

1. C. P. Pfleeger, S. L. Pfleeger; Security in Computing, PHI, 2006
2. W. Stallings; Network Security Essentials: Applications and Standards, 4/E, 2010

**PRACTICAL : DSE-1****Time : 3 Hrs****Full Mark : 30 Marks**

Information Security Practical.

**+3 THIRD YEAR FIFTH SEMESTER  
DSE - 2 - COMPUTER SCIENCE  
MICROPROCESSOR**

**Time : 3 Hours****End Semester Theory : 50 Marks****Credit : 6****Mid-Semester : 20 Marks****UNIT-I**

An Introduction to Processor Design: Processor architecture and organization, Abstraction in hardware design, MUO - a simple processor, Instruction set design, Processor design trade-offs, The Reduced Instruction Set Computer, Design for low power consumption. The ARM Architecture: The Acorn RISC Machine, Architectural inheritance, The ARM programmer's model, ARM development tools.

**UNIT -II**

ARM Assembly Language Programming: Data processing instructions, Data transfer instructions, Control flow instructions, Writing simple assembly language programs. ARM Organization and Implementation: Pipeline, Types, 3-stage pipeline ARM organization, 5-stage pipeline ARM organization, ARM instruction execution, ARM implementation, The ARM coprocessor interface.

**UNIT-III**

The ARM Instruction Set: Introduction, Exceptions, Conditional execution, Branch and Branch with Link (B, BL), Branch, Branch with Link and exchange (BX, BLX), Software Interrupt (SWI). Data, processing instructions, Multiply instructions, Single word and unsigned byte data transfer instructions, Half-word and signed byte data transfer instructions, Multiple register transfer instructions, Status register to general register transfer instructions, General register to status register transfer instructions, Coprocessor instructions. Coprocessor data operations, Coprocessor data transfers, Coprocessor register transfers, Breakpoint instruction (BRK - architecture v5T only), Unused instruction space, Memory faults, ARM architecture variants.

**UNIT-IV**

Architectural Support for High-Level Languages: Abstraction in software design, Data types, Floating-point data types, The ARM floating-point architecture, Expressions, Conditional statements, Loops, Functions and procedures, Use of memory, Run-time environment, Examples and exercises.

**UNIT-V**

Thumb Instruction Set: The Thumb bit in the CPSR, The Thumb programmer's model, Thumb branch instructions, Thumb software interrupt instruction, Thumb data processing instructions, Thumb single register data transfer instructions, Thumb multiple register data transfer instructions, Thumb breakpoint instruction, Thumb implementation, Thumb applications. Architectural Support for System Development: The ARM memory interface, The Advanced Microcontroller Bus Architecture (AMBA), The ARM reference peripheral specification, Hardware system prototyping tools, The ARMulator.

**Recommended Books:**

1. Steve Furber : "ARM System-On-Chip Architecture".

**PRACTICAL : DSE-2****Time : 3 Hrs****Full Mark : 30 Marks**

Microprocessor Practical



## **+3 THIRD YEAR SIXTH SEMESTER DSE - 3 - COMPUTER SCIENCE CLOUD COMPUTING**

Time : **3 Hours**

End Semester Theory : **80 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

### **UNIT-I**

Overview of Computing Paradigm: Recent trends in Computing : Grid Computing, Cluster Computing, Distributed Computing, Utility Computing, Cloud Computing. Introduction to Cloud Computing: Introduction to Cloud Computing, History of Cloud Computing, Cloud service providers, Benefits and limitations of Cloud Computing.

### **UNIT -II**

Cloud Computing Architecture: Comparison with traditional computing architecture (client/server), Services provided at various levels, Service Models-Infrastructure as a Service(IaaS), Platform as a Service(PaaS), Software as a Service(SaaS), How Cloud Computing Works, Deployment , Models- Public cloud, Private cloud, Hybrid cloud, Community cloud, Case study of NIST architecture.

### **UNIT-III**

Case Studies: Case Study of Service, Model using Google App Engine, Microsoft Azure, Amazon EC2, Eucalyptus.

### **UNIT-IV**

Service Management in Cloud Computing, Service Level Agreements (SLAs), Billing & Accounting, Comparing Scaling Hardware: Traditional vs. Cloud, Economics of Scaling.

### **UNIT-V**

Cloud Security: Infrastructure Security- Network level security, Host level security, Application level security, Data security and Storage- Data privacy and security Issues, Jurisdictional issues raised by Data location, Authentication in Cloud Computing.

### **Recommended Books:**

1. Barrie Sosinsky, "Cloud Computing Bible", Wiley-India, 2010
2. Rajkumar Buyya, James Broberg, Andrzej, M. Goscinski, "Cloud Computing Principles & Paradigms", Wiley-2011.
3. Nikos Antonopoulos, Lee Gillam, "Cloud Computing: Principles, Systems and Applications", Springer, 2012.
4. Ronald L. Krutz, Russell Dean Vines, "Cloud Security: A Comprehensive Guide to Secure Cloud Computing ", Wiley-India, 2010.
5. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing,. A Practical Approach" ,McGraw Hills, 2010.
6. Dimitris N. Chorafas, "Cloud Computing Strategies", CRC Press, 2010

## **+3 THIRD YEAR SIXTH SEMESTER DSE - 4 - COMPUTER SCIENCE PROJECT**

Time : **3 Hrs.**

Full Mark : **100**

Credit : **6**

# MATHEMATICS

## +3 FIRST YEAR FIRST SEMESTER CORE COURSE - I (C-1) CALCULUS - I

Time : 3 Hours  
Credits : 6

End Semester Theory : 50 Marks  
Mid-Semester : 20 Marks

### UNIT - I

Hyperbolic functions, higher order derivatives, Leibnitz's Rule and its applications to problems of the type  $e^{ax+b} \sin x$ ,  $e^{ax+b} \cos x$ ,  $(ax+b)^n \sin x$ ,  $(ax+b)^n \cos x$ . concavity and inflexion points. L-Hospital's rule, applications in business, economics and life sciences.

### UNIT - II

Curvature, Asymptotes, Curve tracing in Cartesian coordinates and polar coordinates of standard curves.

### UNIT - III

Reduction formulas - Derivation and use in  $\int \sin^n x dx$ ,  $\int \cos^n x dx$ ,  $\int \tan^n x dx$ ,  $\int \sec^n x dx$ ,  $\int \log^n x dx$ ,  $\int \sin^n x \cos^m x dx$ .

Volumes and areas of surface of revolution, arc length, arc length of parametric curves.

### UNIT - IV

Techniques of sketching conics. Reflection properties of properties of conics, rotation of axes and second degree equations, classification into conics using discriminant, polar equations of conics; sphere cone, Cylinder.

### UNIT - V

Triple product, introduction to vector functions, operations with vector valued functions, limit, continuity of vector functions, differentiation and integration of vector functions, tangent and normal components of acceleration.

## PRACTICAL CALCULUS - I

Mid-Semester : 30 Marks

List of Practicals (Using any software)

Practical/Lab work to be performed on a Computer.

1. Plotting the graphs of the functions  $e^{ax+b}$ ,  $\log(ax + b)$ ,  $1/(ax + b)$ ,  $\sin(ax + b)$ ,  $\cos(ax + b)$ ,  $|ax + b|$  and to illustrate the effect of a and b on the graph.
2. Plotting the graphs of the polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
3. Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, 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, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using cartesian coordinates.
7. Matrix operation (addition, multiplication, inverse, transpose).

**Books Recommended:**

1. Analytical Geometry of Quadratic Surfaces, B.P. Acharya and D.C. Sahu, Kalyani Publishers, New Delhi, Ludhiana. [Cone and Cylinder (Ch.1-2, 3)]
2. A Text Book of Calculus part II. Shantinayakan, S. Chand & Co. [Ch-7, 8 (24, 25), 10 (33-37)]
3. A T. B. of Calculus Part III, Shantinayakan, S. Chand & Co.[Ch-1 (1, 2), Ch-3 (7, 8, 9), 5 (Art-73), Ch-6 (Art-15)]
4. Vector Calculus, by Sharan & Prasad.

**Books for Reference:**

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. R. Courant and F. John, Introduction to Calculus and Analysis (Volumes I & II), Springer-Verlag, New York, Inc., 1989.
3. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.

**+3 FIRST YEAR FIRST SEMESTER  
CORE COURSE - II (C-2) - MATHEMATICS  
ALGEBRA - I**

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

**UNIT - I**

Polar representation of complex numbers,  $n$  th roots of unity. Demoivres theorem for rational indicies and its applications.

**UNIT - II**

Equivalence relations, Functions, Composition of Functions, Invertible Functions, One-to-one correspondence and cardinality of a set, 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**

System of Linear equations, row reduction and echelon forms, vector equations, the matrix equation  $Ax = b$ , Solution Sets of linear systems, Applications of linear systems, linear independence.

**UNIT - IV**

Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix, charecterization of invertible matrices, subspaces of  $R^n$ , dimension of subspaces of  $R^n$ .

**UNIT - V**

Rank of a matrix, Eigen values, Eigenvectors and characteristic Equations of matrix.

**Books Recommended :**

1. L. V. Ahlfors, Complex Analysis, McGraw-Hill (International Student Edn.)
2. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006, Chapter:2
3. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint 2005. Chapters:2 (2.4), 3,4 (4.1-4.1.6, 4.2-4.2.11, 4.4(4.1-4.4.8), 4.3-4.3.9, 5(5.1-5.1.4)
4. David C. Lay, Linear Algebra and its Applications, 3rd Ed., Person Education Asia, Indian Reprint, 2007. Chapters: 1(1.1-1.9), 2(2.1-2-2.3), 2.8, 2.9), 5(5.1, 5.2)

#### Books for Reference :

1. complex Analysis : S. Arumngam, Thangapandi & Soma Sundaram; SCITEC
2. An introduction to Linear Algebra, V. Krishnamurti & Others (Aff. East West Pub. )
3. Discrete mathematics and its applications - K. H. Rosen Tata - MG Atill Publication.

## +3 FIRST YEAR FIRST SEMESTER GENERIC ELECTIVE - I (GE-1) - MATHEMATICS CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

#### UNIT-I

Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quadrature, Volume and Surface area of solids of revolution.

#### UNIT-II

Sphere, Cones and Cylinders.

#### UNIT-III

Explicit and Implicit functions, 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 Maclaurins theorem for functions of two variables.

#### UNIT-IV

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogenous, exact and linear). Equations of 1st order but higher degree.

#### UNIT-V

Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters. Laplace transforms.

#### Books Recommended:

1. Shantinayakan-Text Book of Calculus, Part-II, S. Chand and Co., Chapter-8 (Art. 24,25,26)
2. Shantinayakan-Text Book of Calculus, Part-III, S. Chand and Co., Chapter-1 (Art 1,2), 3, 4(Art. 10 to 12 ommitting Simpsons Rule), 5(Art-13) and 6(Art-15).
3. B.P. Acharya and D.C. Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana.
4. Santosh K. Sengar-Advanced Calculus, Chapters: 2,4, 5, 6, 7, 11, 12, 13.

5. J. Sinharoy and S. Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Pub-lishers. Chapters: 2(2.1 to 2.7), 3, 4(4.1 to 4.4), 5, 9(9.1, 9.2, 9.3, 9.4, 9.5)
6. Mathematical Analysis, Mallik Arora, New Age Publication-Ch-15 (1-5, 8, 9).
7. A Text Book of Calculus - Panda Satpathy.

**Books for References:**

1. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
2. David V. Weider-Advanced Calculus, Dover Publications.
3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
4. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.
5. G. Dennis Zill-A First Course In Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.

**+3 FIRST YEAR SECOND SEMESTER  
CORE COURSE - III (C-3) - MATHEMATICS  
REAL ANALYSIS (ANALYSIS - I)**

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

**UNIT - I**

Review of Algebraic and order properties of  $\mathbb{R}$ , Neighborhood of a point in  $\mathbb{R}$ , Idea of countable sets, uncountable sets and uncountability of  $\mathbb{R}$ . Bounded above sets, Bounded below sets, Bounded sets, unbounded sets, suprema and infima.

**UNIT - II**

The completeness property of  $\mathbb{R}$ , The Archimedean property, Density of Rational (and irrational) numbers in  $\mathbb{R}$ , Intervals, limitpoint of a set, Isolated points, Illustrations of Bolzano-Weierstrass theorem for sets.

**UNIT - III**

Sequences, bounded sequences, convergent sequences, limit of a sequence, limit theorems, Monotone sequences, monotone convergence theorem subsequences, Divergence criteria, Monotone subsequence theorem (statement only).

**UNIT - IV**

Bolzano weierstrass Theorem for sequences. cauchy sequences, cauchys convergence criterion.

**UNIT - V**

Infinite series, convergence and divergence of Infinite series, Test for convergence : comparison test, limit comparison Test, Ratio Test, cauchy's nth root test, Integral Test.

**Books Recommended :**

1. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co., Chapters: 2(2.1 to 2.4, 2.5 to 2.7), 3(3.1-3.4), 4(4.1 to 4.7, 4.10, 4.11).
  2. S.C. Mallik & S. Arora - Mathematical Analysis, New AGE International Publication.
  3. W. Rudin - Mathematical Analysis - McGraw Hill Publication.
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**Books for Reference :**

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau, Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4. S. K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.
5. D. Samsundaram and B. Choudhury - A First Course in Mathematical Analysis, Narosa Publishing House.
6. S. L. Gupta and Nisha Rani-Real Analysis, Vikas Publishing House Pvt. Ltd., New Delhi.

**+3 FIRST YEAR SECOND SEMESTER  
CORE COURSE - IV (C-4) - MATHEMATICS  
DIFFERENTIAL EQUATIONS**

Time : 3 Hours

End Semester Theory : 50 Marks

Credits : 6

Mid-Semester : 20 Marks

**UNIT - I**

Differential equations and mathematical models. First order and first degree ordinary Differential equations - Variable separable, homogenous, exact and linear.

**UNIT - II**

Differential equations of first order but of higher degree. Applications of first order ordinary Differential equations to Growth, Decay, Heat flow, oxygen debt and Economics.

**UNIT - III**

Second order linear equations - (homogeneous and non-homogeneous) with constant coefficients, with variable coefficients, variation of parameters, method of undetermined coefficients. Equations reducible to linear equations with constant coefficients. Euler's equation, Applications of second order differential equations.

**UNIT - IV**

Power series solutions of regular and singular parts of second order differential equations, Legendre equations and Legendre polynomials.

**UNIT - V**

Laplace transforms, Differentiation and Integration of transforms, Application to solutions of Differential equations.

**PRACTICAL  
CALCULUS - II**

Mid-Semester : 30 Marks

**List of Practicals (Using any Software)**

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**Practical/Lab work to be performed on a Computer.**

1. Plotting of second order solution of family of differential equations.
2. Plotting of third order solution of family of differential equations.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Oxygen debt model.
6. Economic model.
7. Vibration problems.

**Books Recommended :**

1. J. Sinha Roy and S. Padhy, A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi, Chapters : 1,2(2.1 to 2.7), 3, 4(4.1 to 4.8), 5, 7(7.1-7.4), 9(9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.13).

**Books for Reference :**

1. Martin Braun, Differential Equations and their Applications, Springer International.
2. M. D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.
3. G. Dennis Zill-A First Course in Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.
4. S. L. Ross, Differential Equations, John Wiley & Sons, India, 2004

**+3 FIRST YEAR SECOND SEMESTER  
GENERIC ELECTIVE - II (GE-2) - MATHEMATICS  
LINEAR ALGEBRA AND ADVANCED ALGEBRA**

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

**UNIT-I**

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity, Inverse of a linear map, Rank-Nullity theorem.

**UNIT-II**

Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices. Elementary row operations, System of linear equations, Matrix inversion using row operations, Determinant and Rank of matrices, Eigen values, Eigen vectors.

**UNIT-III**

Group Theory: Definition and examples, Subgroups, Normal subgroups, Cyclic groups, Cosets, Quotient groups, Permutation groups, Homomorphism.

**UNIT-IV**

Ring Theory: Definition and examples, Some special classes of Rings, Ideals, Quotient rings, Ring homomorphism. Isomorphism theorems.

**UNIT-V**

Zero divisors, Integral domain, Finite fields, Finite field  $Z/pZ$ .



**Books Recommended:**

1. V. Krishnamurty, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 3, 4(4.1 to 4.4), 5(5.7 - 5.9), 6(6.5-6.8).
2. I. N. Herstein - Topics in Algebra, wiley Eastern Pvt. Ltd. [Ch-2 (2.1-2.6, 2.7 (ex application)) 3 -(3.1 to 3.4)]

**Books for References:**

1. S. Kumaresan-Linear Algebra: A Geometric Approach, Prentice Hall of India.
2. Rao and Bhimasankaran-Linear Algebra, Hindustan Publishing House.
3. S. Singh-Linear Algebra, Vikas Publishing House Pvt. Ltd., New Delhi.
4. Gilbert Strang-Linear Algebra & its Applications, (engage Learning India Pvt. Ltd.
5. Gallian-Contemporary Abstract Algebra, Narosa publishing House.
6. Artin-Algebra, Prentice Hall of India.
7. V.K. Khanna and S.K. Bhambri-A Course in Abstract Algebra, Vikas Publishing House Pvt. Ltd., New Delhi.

## +3 SECOND YEAR THIRD SEMESTER CORE COURSE - V (C-5) - MATHEMATICS

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

### THEORY OF REAL FUNCTIONS (ANALYSIS-II)

**Unit - I**

Limits of functions ( $\epsilon - \delta$  approach) sequential criterion for limits, cauchy's criterion for limits. Limit theorems, one sided limits, continuous functions, sequential criterion for continuity, Algebra of continuous functions, bounded functions and continuity, Dicontinuity, continuous on an interval.

**Unit - II**

Further Properties of continuity. Intermediate value theorem, monotonic functions and continuity, Infinite limits and limits at infinity. Limits of exponential and logarithmic functions.

**Unit-III**

Uniform continuity & nonuniform continuity criterion, uniform continuity theorem, Differentiability of a Function at a Point and in an interval, Left & Right derivatives, algebra of differentiable Functions.

**Unit - IV**

Rolle's Theorem, mean value theorem, Darbous theorem, Application of mean value theorem to inequality, Indeterminate forms, Extreme values.

**Unit - V**

Taylor's theorem (Schtomitch and ROche form of Remainder, cauchy's form of Remainder, Lagranges form of remainder) Second form of Taylor's theorem Maclaurin's Theorem. Deduction of Taylor's theorem From the mean value theorem, Taylor's infinite series & power series expansions, Maclaurin's infinite

series & expansions, exponential, Trigonometric and logarithmic series :  $\ln(1+x)$ ,  $\frac{1}{ax+b}$  and  $(1+x)^n$

**Book Recommended:**

1. G. Das and S. Pattanayak, Fundamentals of Mathematics Analysis, TMH Publishing Co., Chapters: Ch-6 (6.1-6.7, 6.9), 7(7.1-7.4).
2. S. C. Malik Ch 6 (Art 8), Ch 7 (Art 1,2)

**Books for References:**

1. R. Bartle and D.R. Sherbert, Introduction to Real Analysis, John Wiley and Sons, 2003.
2. K.A. Ross, Elementary Analysis: The Theory of Calculus, Springer, 2004.
3. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer. 2006.

### +3 SECOND YEAR THIRD SEMESTER CORE COURSE - VI (C-6) - MATHEMATICS

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

#### Group Theory(Algebra-II)

**Unit - I**

Definition and Examples of groups. Uniqueness of identity and inverse of elements in a group , subgroups.

**Unit - II**

Costs of a group. Definition of products of Subgroups counting principle. Cyclic groups. Properties of cosets. Lagrange Theorem. Normal subgroups and Quotient groups.

**Unit - III**

Homomorphism of groups, Kernel. Developing a homomorphism to isomorplism. Automorphism. Cayley's Theorem.

**Unit - IV**

Permutation groups and their properties. Another counting principle.

**Unit - V**

Sylow's Theorem. Direct product of groups finite abelian groups.

**Book Recommended:**

1. I N Herstein - Topics in Algebra (Wiley India)Ch. 2 (2.1 to 2.14)

**Books for References:**

1. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
2. J.A. Gallian - Contemporary Abstract Algebra (Pearson 2004)
3. J. J. Rotman - An Introduction to Theory of Groups (Springer - Verlay 1995)

### +3 SECOND YEAR THIRD SEMESTER CORE COURSE - VII (C-7) - MATHEMATICS

Time : 3 Hours

End Semester Theory : 50 Marks

Credits : 6

Mid-Semester : 20 Marks

#### C-3.3: Partial Differential Equations and Systems of Ordinary Differential Equations

**Unit - I**

Simultaneous linear first order equations in three variables, methods of solution, Pfaffian differential equations, methods of solutions of Pfaffian differential equations in three variables.

**Unit-II**

Formation of first order partial differential equations, Linear and non-linear partial differential equations of first order, special types of first-order equations, Solutions of partial differential equations of first order satisfying given conditions.

**Unit- III**

Linear partial differential equations with constant coefficients, Equations reducible to linear partial differential equations with constant coefficients, Partial differential equations with variable coefficients,

**Unit - IV**

Monges method of integrating  $Rr+Ss+Tt=V$ .

Laplace equation, Solution of Laplace equation by separation of variables,

**Unit - V**

One dimensional wave equation, Solution of the wave equation(method of separation of variables), Diffusion equation, Solution of one-dimensional diffusion equation, method of separation of variables.

**PRACTICAL : CC-III****Time : 3 Hrs****Full Mark : 30 Marks**

## Part - I

List of Practicals (Using any Software) Practical/Lab work to be performed on a Computer.

- To find the general solution of the non-homogeneous system of the form:

$$\frac{dx}{dt} = a_1x + b_1y + f_1(t), \quad \frac{dy}{dt} = a_2x + b_2y + f_2(t), \text{ with given conditions}$$

- Plotting the integral surfaces of a given first order PDE with initial data.

- Solution of wave equation  $\frac{\partial^2 u}{\partial t^2} - c^2 \frac{\partial^2 u}{\partial x^2} = 0$  for the following associated conditions :

(a)  $u(x,0) = \varphi(x), u_t(x,0) = \psi(x), x \in \mathbb{R}, t > 0.$

(b)  $u(x,0) = \varphi(x), u_t(x,0) = \psi(x), u_x(0,t) = 0, x \in (0, \infty), t > 0.$

(c)  $u(x,0) = \varphi(x), u_t(x,0) = \psi(x), u(0,t) = 0, x \in (0, \infty), t > 0.$

(d)  $u(x,0) = \varphi(x), u_t(x,0) = \psi(x), u(0,t) = 0, u(1,t) = 0, 0 < x < 1, t > 0.$

- Solution of wave equation  $\frac{\partial u}{\partial t} - k^2 \frac{\partial^2 u}{\partial x^2} = 0$  for the following associated conditions:

(a)  $u(x, 0) = \varphi(x), u(0, t) = a, u(1, t) = b, 0 < x < 1, t > 0.$

(b)  $u(x, 0) = \varphi(x), x \in \mathbb{R}, 0 < t < T.$

(c)  $u(x, 0) = \varphi(x), u(0, t) = a, x \in (0, \infty), t \geq 0.$

**Book Recommended:**

- J.Sinha Roy and S. Padhy, A Course on Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi, Ludhiana, 2012.

Chapters: 11, 12, 13(13.1-13.5), 15(15.1, 15.5), 16(16.1, 16.1.1), 17(17.1, 17.2, 17.3).

**Books for References:**

- Tyn Myint-U and Lokenath Debnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
- S.L. Ross, Differential equations, 3rd Ed., John Wilcyand Sons, India, 2004.

**+3 SECOND YEAR THIRD SEMESTER**  
**GENERIC ELECTIVE - III (GE-3) - MATHEMATICS**  
**CALCULUS AND ORDINARY DIFFERENTIAL EQUATIONS**

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

**UNIT-I**

Curvature, Asymptotes, Tracing of Curves (Cartenary, Cycloid, Folium of Descartes, Astroid, Limacon, Cissoid & loops), Rectification, Quadrature, Volume and Surface area of solids of revolution.

**UNIT-II**

Cones and Cylinders.

**UNIT-III**

Explicit and Implicit functions, 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 Maclaurins theorem for functions of two variables.

**UNIT-IV**

Ordinary Differential Equations of 1st order and 1st degree (Variables separable, homogenous, exact and linear). Equations of 1st order but higher degree.

**UNIT-V**

Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients, Variation of parameters. Laplace transforms.

**Books Recommended:**

1. Shantinayakan-Text Book of Calculus, Part-II, S. Chand and Co., Chapter-8 (Art. 24,25,26)
2. Shantinayakan-Text Book of Calculus, Part-III, S. Chand and Co., Chapter-1 (Art 1,2), 3, 4(Art. 10 to 12 ommitting Simpsons Rule), 5(Art-13) and 6(Art-15).
3. B.P. Acharya and D.C. Sahu-Analytical Geometry of Quadratic Surfaces, Kalyani Publishers, New Delhi, Ludhiana. Ch-1, 2, 3.
4. Santosh K. Sengar-Advanced Calculus, Chapters: 2,4, 5, 6, 7, 11, 12, 13.
5. J. Sinharoy and S. Padhy-A Course of Ordinary and Partial Differential Equations, Kalyani Pub-lishers. Chapters: 2(2.1 to 2.7), 3, 4(4.1 to 4.4), 5, 9(9.1, 9.2, 9.3, 9.4, 9.5)
6. Mathematical Analysis, Mallik Arora, New Age Publication-Ch-15 (1-5, 8, 9).
7. A Text Book of Calculus - Panda Satpathy.

**Books for References:**

1. Shanti Narayan and P.K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
  2. David V. Weider-Advanced Calculus, Dover Publications.
  3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.
  4. M.D. Raisinghania-Advanced Differential Equations, S. Chand & Company Ltd., New Delhi.
  5. G. Dennis Zill-A First Course In Differential Equations with Modelling Applications, Cengage Learning India Pvt. Ltd.
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## +3 SECOND YEAR FOURTH SEMESTER CORE COURSE - VIII (C-8) - MATHEMATICS

Time : 3 Hours

End Semester Theory : 50 Marks

Credits : 6

Mid-Semester : 20 Marks

### Numerical Methods

#### Unit - I

Convergence, Errors: Relative, Absolute, Round off, Truncation. Transcendental and Polynomial equations: Bisection method, Newtons method. Secant method. Rate or convergence of these methods.

#### Unit - II

System of linear algebraic equations: Gaussian Elimination and Gauss Jordan methods. Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

#### Unit - III

Interpolation: Lagrange and Newtons methods. Error bounds. Finite difference operators. Gregory forward and backward difference interpolation.

#### Unit - IV

Numerical Integration: Trapezoidal rule, Simpsons rule, Simpsons 3/8th rule, Midpoint rule, Composite Trapezoidal rule. Composite Simpsons rule.

#### Unit - V

Numerical solutions of ordinary differential equation using Eulers method Runge-Kuta method of order two and four.

### PRACTICAL PART - II (CC-VI)

Time : 3 Hrs

Full Mark : 30 Marks

List of Practicals (Using any Software) Practical/Lab work to be performed on a Computer.  
From Sl. 4 to Sl. 11, Sl. 12 - Combined Trapezoidal Rule.

1. Bisection Method.
2. Newton Raphson Method.
3. Secant Method.
4. Regula Falsi Method.
5. LU decomposition Method.
6. Gauss-Jacobi Method.
7. SOR Method or Gauss-Siedel Method.
8. Lagrange Interpolation or Newton Interpolation.
9. Combined Trapezoidal Rule

**Note:** For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

#### Book Recommended:

1. B.P. Acharya and R.N. Das, A Course on Numerical Analysis. Kalyani Publishers, New Delhi, Ludhiana. Chapters: 1, 2(2.1 to 2.4, 2.6, 2.8, 2.9), 3(3.1 to 3.4, 3.6 to 3.8, 3.10), 4(4.1, 4.2), 5(5.1, 5.2, 5.3), 6(6.1, 6.2, 6.3, 6.10, 6.11), 7(7.1, 7.2, 7.3, 7.4 & 7.7), 8 (8.1, 8.2).

#### Books For References:

1. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods For Scientific and Engineering Computation, 6th Ed., New age International Publisher, India, 2007.
2. C.F. Gerald and P.O. Wheatley. Applied Numerical Analysis, Pearson Education, India, 2008.

3. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., Pili Learning Private Limited, 2013.
4. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHI Learning Private Limited, 2012.

### **+3 SECOND YEAR FOURTH SEMESTER CORE COURSE - IX (C-9) - MATHEMATICS**

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

#### **Riemann Integration and Series of Functions (Analysis-III)**

**Unit - I**

Limit superior and Limit Inferior conditional convergence, power series, Radius of Convergence.

**Unit - II**

Riemann Integration : upper and lower sums, Riemann condition of Integrability, Riemann Sum, Defn of Riemann Integration. Equivalence of two Definition. Riemann Integrability of functions. Properties of Riemann Integral. Definition of piecewise continuous and monotone functions. Intermediate value Theorem of Integrals. Fundamental Theorems of Calculus.

**Unit - III**

Improper Integrals Convergence of Beta &amp; Gamma functions.

**Unit - IV**

Pointwise and uniform convergence of Sequence of function. Theorems of continuity, differentiability and integrability of the limit function of a sequence of functions.

**Unit - V**

Series of functions. Theorem on the continuity and derivability of the sum function of a series of functions. Cauchy's Criterion for uniform convergence and Weierstrass M . Test.

**Book Recommended:**

1. G. Das and S. Pattanaik-Fundamentals of Mathematics Analysis. TMH Publishing Co., Chapters: 4 (4.8, 4.14), 8(8.1 - 8.6), 9(9.1 - 9.5)

**Books for References:**

1. K.A. Ross, Elementary Analysis, The Theory of Calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. R.G. Bartle D.R. Sherbert, Introduction to Real Analysis, 3rd Ed. John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. Charles G. Denlinger. Elements of Real Analysis, Jones & Bartlett (Student Edition). 2011.
4. S.c. Mallik and S. Arora-Mathematical Analysis. New Age International Ltd., New Delhi. 5. Shanti Narayan and M.D. Raisinghania-Elements of Real Analysis, S. Chand & Co. Pvt. Ltd.

### **+3 SECOND YEAR FOURTH SEMESTER CORE COURSE - X (C-10) - MATHEMATICS**

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

#### **Ring Theory and Linear Algebra-I (Algebra-III)**

**Unit - I**

Definition and Examples of Rings. Zero Divisor of a ring, Field, Ring Homomorphism.

**Unit - II**

Ideals and Quotient Rings. Field of Quotients of an Integral Domain.

**Unit - III**

Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors, linear span, linear independence, basis and dimension, dimension of subspaces.

**Unit - IV**

Linear Transformations, Null space, Range, Rank and nullity of a linear transformation.

**Unit - V**

Matrix Representation of a linear transformation, algebra of linear transformation, Isomorphism Theorems,

**Book Recommended:**

1. I N Herstein - Topics in Algebra - Wiley Eastern Pvt. Ltd. , Ch - 3 (3.1 - 3.6)
2. V. Krishna Murthy, V. P. Mainra, J. L. Arora - An introduction to linear Algebra. Ch-3 (except 3.4), Ch-4 (4.1-4.4), 5(5.1; 5.2)

**Books for References:**

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed .. Pearson. 2011.
3. S. Lang, Introduction to Linear Algebra. 2nd Ed .. Springer, 2005.
4. Gilbert Strang, Linear Algebra and its Applications. Cengage Learning India Pvt. Ltd.
5. S. Kumaresan. Linear Algebra- A Geometric Approach. Prentice Hall of India.1999.
6. Kenneth Iloffrnan, Ray Alden Kunze, Linear Algebra. 2nd Ed., Prentice-Hall of India Pvt. Ltd .. 1971.
7. V. P. Mainra - An introduction to linear Algebra
8. J. L. Arora - An introduction to linear Algebra.
9. Stephen H. Friedberg, Arnold J. Insel. Lawrence E. Spence, Linear Algebra, 4th Ed .. Prentice-Hall of India Pvt. Ltd .. New Delhi, 2004. Chapters: 1(1.2-1.6).2(2.1-2.5).

## **+3 SECOND YEAR FOURTH SEMESTER GENERIC ELECTIVE - IV (GE-4) - MATHEMATICS LINEAR ALGEBRA AND ADVANCED ALGEBRA**

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

**UNIT-I**

Vector space, Subspace, Span of a set, Linear dependence and Independence, Dimensions and Basis. Linear transformations, Range, Kernel, Rank, Nullity, Inverse of a linear map, Rank-Nullity theorem.

**UNIT-II**

Matrices and linear maps, Rank and Nullity of a matrix, Transpose of a matrix, Types of matrices. Elementary row operations, System of linear equations, Matrix inversion using row operations, Determinant and Rank of matrices, Eigen values, Eigen vectors, Quadratic forms.

**UNIT-III**

Group Theory: Definition and examples, Subgroups, Normal subgroups, Cyclic groups, Cosets, Quotient groups, Permutation groups, Homomorphism.

**UNIT-IV**

Ring Theory: Definition and examples, Some special classes of Rings, Ideals, Quotient rings, Ring homomorphism. Isomorphism theorems.

**UNIT-V**

Zero divisors, Integral domain, Finite fields, Finite field  $Z/pZ$ .

**Books Recommended:**



1. V. Krishnamurty, V. P. Mainra, J. L. Arora-An introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd., New Delhi, Chapters: 3, 4(4.1 to 4.4), 5(5.7 - 5.9), 6(6.5, 6.6, 6.8).
2. I. N. Herstein - Topics in Algebra, Wiley Eastern Pvt. Ltd. [Ch-2 (2.1-2.6, 2.7 (except application)) 3 -(3.1 to 3.4)]

**Books for References:**

1. S. Kumaresan-Linear Algebra: A Geometric Approach, Prentice Hall of India.
2. Rao and Bhimasankaran-Linear Algebra, Hindustan Publishing House.
3. S. Singh-Linear Algebra, Vikas Publishing House Pvt. Ltd., New Delhi.
4. Gilbert Strang-Linear Algebra & its Applications, (engage Learning India Pvt. Ltd.
5. Gallian-Contemporary Abstract Algebra, Narosa publishing House.
6. Artin-Algebra, Prentice Hall of India.
7. V.K. Khanna and S.K. Bhambri-A Course in Abstract Algebra, Vikas Publishing House Pvt. Ltd., New Delhi.

### **+3 THIRD YEAR FIFTH SEMESTER CORE COURSE - XI (C-11) - MATHEMATICS**

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

#### **Multivariate Calculus (Cal-II)**

**Unit - I**

Functions of several variables, limit and continuity of functions of two variables Partial derivatives of first and higher orders, differentiability, sufficient condition for differentiability.

**Unit - II**

Total differentiability and differentials of higher order, chain rule, change of variables, Taylor's theorem.

**Unit - III**

Extrema of functions of two and three variables, Jacobians, constrained optimization problems, Methods of Lagrange's multipliers.

Vector field, Differential operators, Directional derivatives, Curl, gradient and divergence.

**Unit - IV**

Integration on  $R^2$ : Line integrals, Double integrals and Repeated integrals, Double integrals over a region, Green's theorem (Statement only), Change of variables.

**Unit - V**

Integration on  $R^3$  : Line Integrals, Surface integrals, Triple Integrals, Stoke's theorem and Gauss Divergence theorem (Statements only).

**Books Recommended:**

1. Mathematical Analysis : Malik & Arora : Chapter-15, 16 (Arts 2,3), 17, 18 (Arts 2, 4, 5, 7, 8).
2. A Text Book of Vector Calculus : Shantinayakan & J. N. Kapoor. Chapter - VI (Art 51 - 68)

**Books for Reference:**

1. Strauss, Bradley, Smith : Calculus
  2. S. K. Sengar : Advanced Calculus
  3. Thomas & Finney : Calculus
  4. Marsden, Tromba, Weinstein : Basic Multivariate calculus.
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## +3 THIRD YEAR FIFTH SEMESTER CORE COURSE - XII (C-12) - MATHEMATICS

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

### Probability and Statistics

#### Unit - I : Probability -

Introduction, Sample space, events, Probability axioms and Probability of an event, Some rules of probability, Conditional Probability, Independent events, Baye's Theorem.

#### Unit - II : Probability Distribution and Probability densities -

Random variables, Probability distributions, Continuous random variables, Probability density functions, Multivariate Distributions, Marginal distributions, Conditional distributions.

#### Unit - III : Mathematical expectation -

Introduction, expected value of Random variable, moments, moment generating functions, product moments (calculation of covariance) moments of linear combination of random variables, conditional expectation.

#### Unit - IV : Special Probability distributions and Special Probability densities -

Discrete distributions, The Discrete Uniform distribution, Binomial Distribution, Negative Binomial distribution, geometric distribution, Poisson distribution.

Continuous distributions, Uniform, exponential, normal distributions, Bivariate normal distribution, correlation coefficient.

#### Unit - V : Regression & Limit Theorems :

Introduction to regression, Linear regression, Introduction to limit theorems, Chebyshev's Inequality and weak law of large numbers, The central limit theorem, The strong law of large numbers.

#### Books Recommended:

1. John E. Freund's : Mathematical statistics with applications (8th edition) : (Applied Exercises of all chapters are excluded) Chapters : Ch2 (Art 1-8), Ch 3(1-7), Ch4 (1-3, 5-8), Ch5 (2, 4, 5, 7), Ch6 (2, 3 (restricted), 5, 7) Ch-14 (1, 2).
2. A First course in Probability (9th Edn) : Sheldon Ross : Ch8 (1, 2, 3, 4)

#### Books for References:

1. S. C. Gupta & V. K. Kapoor : Fundamentals of Mathematical Statistics.
2. Robert V. Hogg, Joseph W. McKean & Allen Tcraig : Introduction to Mathematical statistics.
3. Alexander
4. Ross (Prob. model)

## +3 THIRD YEAR SIXTH SEMESTER CORE COURSE - XIII (C-13) - MATHEMATICS

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

### Metric Space and Complex Analysis (Analysis-IV)

#### Unit - I

Metric spaces: definition and examples, sequences in metric spaces, Diameter.

Open and closed sets : Open and closed balls, neighbourhood, open sets, closed sets, interior, exterior and boundary points, unit points, Dense sets.

#### Unit - II

Convergence and completeness : Cauchy sequences, complete metric space, cantor's theorem.

Continuity and uniform continuity : Homeomorphism. Sequential and other criterion, Banach fixed point theorem, separable space, connectedness : connected subset of  $\mathbb{R}$ .

**Unit - III**

Real numbers and field of complex numbers (Properties of complex numbers). Regions in complex plane, polar representation and roots of complex numbers, power series (Convergence & absolute convergence) Analytic function (exponential, logarithmic, trigonometric), Derivatives, cauchy-Riemann eqns, Necessary and sufficient condition for analyticity.

**Unit - IV**

Complex Integration : Power series representation of analytic functions : cauchy's estimate, Zeros of analytic functions; Liouville's Theorem, Fundamental theorem of algebra, Maximum Modulus Theorem, Index of closed curve, Cauchy Theorem (1st version) Chuchy's integral formula (1st and 2nd version), Morera's theorem.

**Unit - V**

Singularities : classification, Laurent's Theorem (statement only), Residues, Residue Theorem, contours, contour integrals, examples.

**Books Recommended:**

1. S. C. Mallik & S. Arora : Mathematical Analysis. Ch-19 (Arts 1, 2, 3, 4, 6 excluding 6.1)
2. Dr. S. Arumugam : Complex analysis. Ch-1 (1.1), 2(2.1-2.7, 2.9), 4(4.4), 6, 7 (7.1-7.2).
3. P. K. Jain and K. Ahmad : Metric spaces (Narosa Publishing house, New Delhi.)

**Books for References:**

1. Functions of one complex variable : J. B. Conway
2. Metric spaces : P. K. Jain & K. Ahmad.
3. Complex variable & applications : Brown and Churchill.

## +3 THIRD YEAR SIXTH SEMESTER CORE COURSE - XIV (C-14) - MATHEMATICS

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

### Linear Programming

**Unit - I**

Introduction to linear programming problem, Theory or simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format.

**Unit - II**

Introduction to artificial variables. twophase method, BigM method.

**Unit - III**

Duality, formulation or the dual problem, primal-dual relationships.

**Unit - IV**

Transportation problem and its mathematical formulation, northwest corner method.

**Unit - V**

Assignment problem and its mathematical formulation, Hurgarian method for solving Assignment Problems.

**Recommended Books:**

1. Kantiswarup - Gupta and Manmohan - Operations Research, S. Chand & Co. Pvt. Ch-4 (4.1 to 4.4), 5 (5.1-5.4), 10(10.1-10.3, 10.5, 10.9) 11(11.1-11.3)

**Books for Reference:**

1. Mokhtar Bazarra - Jamis and Hanif - Linear Programming and Network flows - 2nd Ed.
2. G. Hadley, Linear programming, Marosa publishing House, New Delhi, 2002.

3. N. V.R. Naidu, G. Rajendra and T. Krishna Rao-operation Research, I. K. International Publishing House Pvt. Ltd. New Delhi, Bangalore.
4. R. Veerachamy and V. Ravikumar - Operation Research I. K. International Publishing House Pvt. Ltd., New Delhi, Bangalore.
5. Hamdy A. Taha - Operating Research - An Introduction PHI. Ch-5 (5.1, 5.3, 5.4)

### +3 THIRD YEAR FIFTH SEMESTER DSE - 1 - MATHEMATICS

Time : 3 Hours

End Semester Theory : 50 Marks

Credits : 6

Mid-Semester : 20 Marks

#### Programming in C++ (Compulsory)

##### Unit - I

###### Introduction to structured programming: data types-

Simple data types, floating data types, character data types, string data types,

##### Unit - II

Arithmetic operators and operators precedence, variables and constant declarations, expressions, input using the extraction operator L.G and lin, output using the insertion operator ii and cout, preprocessor directives, increment (++) and decrement(-) operations, creating a C++ program, input/ output.

##### Unit - III

Relational operators, logical operators and logical expressions, if and if-else statement, switch and break statements. for, while and do-while loops and continue statement.

##### Unit - IV

Nested control system, value returning functions, value versus reference parameters, local and global variables.

##### Unit - V

One dimensional array, two dimensional array, pointer data and pointer variables.

##### Book Recommended:

1. E. Balaguruswami: Object oriented programming with C++, fifth edition, Tata McGraw Hill Education Pvt. Ltd.
2. D. S. Malik: C++ Programming Language, Edition-2009, Course Technology, Cengage Learning, India Edition. Chapters: 2(Pages:37-95), 3(Pages:96-129), 4(Pages:134-178), 5(Pages:181-236), 6, 7(Pages:287-304), 9 (pages: 357-390), 14(Pages:594-600).

##### Books for References:

1. R. Johnsonbaugh and M. Kalin-Applications Programming in ANSI C, Pearson Education.
2. S. B. Lippman and J. Lajoie, C++ Primer, 3rd Ed.. Addison Wesley, 2000.
3. Bjarne Stroustrup , The C++ Programming Language, 3rd Ed., Addison Welsley.

### PRACTICAL : DSE - 1

Time : 3 Hrs

Full Mark : 30 Marks

List of Practicals (Using any software) Practical/Lab work to be performed on a Computer.

1. Calculate the sum of the series  $\frac{1}{1} + \frac{1}{2} + \frac{1}{3} + \dots + \frac{1}{N}$  for any positive integer N.
2. Write a user defined function to find the absolute value of an integer and use it to evaluate the function  $(-1)^n / \dots$  for  $n = -2, -1, 0, 1, 2$ .
3. Calculate the factorial of any natural number.
4. Read floating numbers and compute two averages: the average of negative numbers and the average of positive numbers.
5. Write a program that prompts the user to input a positive integer. It should then output a message

- indicating whether the number is a prime number.
6. Write a program that prompts the user to input the value of  $a$ ,  $b$  and  $c$  involved in the equation  $ax^2 + bx + C = 0$  and outputs the type of the roots of the equation. Also the program should output all the roots of the equation.
  7. Write a program that generates random integer between 0 and 99. Given that first two Fibonacci numbers are 0 and 1, generate all Fibonacci numbers less than or equal to generated number.
  8. Write a program that does the following:
    - a. Prompts the user to input five decimal numbers.
    - b. Prints the five decimal numbers.
    - c. Converts each decimal number to the nearest integer.
    - d. Adds these five integers.
    - e. Prints the sum and average of them.
  9. Write a program that uses while loops to perform the following steps:
    - a. Prompt the user to input two integers :first Num and second Num (first Num should be less than second Num).
    - b. Output all odd and even numbers between first Num and second Num.
    - c. Output the sum of all even numbers between first Num and second Num.
    - d. Output the sum of the square of the odd numbers first Num and second Num.
    - e. Output all uppercase letters corresponding to the numbers between first Num and second Num, if any.
  10. Write a program that prompts the user to input five decimal numbers. The program should then add the five decimal numbers, convert the sum to the nearest integer, and print the result.
  11. Write a program that prompts the user to enter the lengths of three sides of a triangle and then outputs a message indicating whether the triangle is a right triangle or a scalene triangle.
  12. Write a value returning function smaller to determine the smallest number from a set of numbers. Use this function to determine the smallest number from a set of 10 numbers.
  13. Write a function that takes as a parameter an integer (as a long value) and returns the number of odd, even, and zero digits. Also write a program to test your function.
  14. Enter 100 integers into an array and sort them in an ascending/ descending order and print the largest! smallest integers.
  15. Enter 10 integers into an array and then search for a particular integer in the array.
  16. Multiplication/ Addition of two matrices using two dimensional arrays.
  17. Using arrays, read the vectors of the following type:  $A = (12345678)$ ,  $B = (02340156)$  and compute the product and addition of these vectors.
  18. Read from a text file and write to a text file.
  19. Write a function, reverse Digit, that takes an integer as a parameter and returns the number with its digits reversed. For example, the value of function reverse Digit 12345 is 54321 and the value of reverse Digit 532 is 235.
-

## +3 THIRD YEAR FIFTH SEMESTER DSE - 2 - MATHEMATICS

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

### 3-Number Theory

#### Unit - I

Divisibility theorem in integers, Primes and their distributions, Fundamental theorem of arithmetic, Greatest common divisor, Euclidean algorithms, Modular arithmetic, Linear Diophantine equation, prime counting function, statement of prime number theorem, Goldbach conjecture.

#### Unit - II

Introduction to congruences, Linear Congruences, Chinese Remainder theorem, Polynomial congruences, System of linear congruences, complete set of residues, Chinese remainder theorem, Fermats little theorem, Wilsons theorem.

#### Unit - III

Number theoretic functions, sum and number of divisors, totally multiplicative functions, definition and properties of the Dirichlet product.

#### Unit - IV

The Mbius inversion formula, the greatest integer function, Eulers phifunction, Eulcrs theorem, reduced set of residues, some properties of Euler's phi-function.

#### Unit - V

Order of an integer modulo  $n$ , primitive roots for primes, composite numbers having primitive roots, Eulers criterion, the Legendre symbol and its properties, quadratic reciprocity, quadratic congruences with composite moduli.

#### Book Recommended:

- I. D.M. Burton-Elementary Number Theory, McGraw Hill, Chapters: 2(2.1 to 2.4), 3(3.1 to 3.3), 4(4.1 to 4.4), 5(5.1 to 5.4), 6(6.1 to 6.3), 7(7.1 - 7.3), 8(8.1 to 8.2), 9(9.1 to 9.3).

#### Books for References:

1. K.H. Rosen-Elementary Number Theory & its Applications, Pearson Addison Wesley.
2. I. Niven and H.S. Zuckerman-An Introduction to Theory of Numbers, Wiley Eastern Pvt. Ltd.
3. Tom M. Apostol-Introduction to Analytic Number Theory, Springer International Student Edn.
4. Neville Robinns, Beginning Number Theory (2nd Edition), Narosa Publishing House Pvt. Limited, Delhi, 2007.

## +3 THIRD YEAR SIXTH SEMESTER DSE - 3 - MATHEMATICS

Time : 3 Hours

End Semester Theory : 80 Marks

Credits : 6

Mid-Semester : 20 Marks

### Differential Geometry

#### Unit - I

Theory of Space Curves: Space curves, Planer curves, Curvature, Torsion and Serret-Frenet formula.

#### Unit - II

Osculating circles, Osculating circles and spheres. Existence of space curves. Evolutes and involutes of curves.

**Unit - III**

Developables: Developable associated with space curves and curves on surfaces, Minimal surfaces.

**Unit - IV**

Theory of Surfaces: Parametric curves on surfaces. Direction coefficients. First and second Fundamental curve. Principal and Gaussian curvatures.

**Unit - V**

Lines of curvature, Eulers theorem. Rodrigues formula, Conjugate and Asymptotic lines.

**Book Recommended:**

1. C.E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003. Chapters:1(1-4, 7,8,10), 2(13,14,16,17),3,4(29-31,35,37,38).

**Books for References :**

1. T.J. Willmore, An Introduction to Differential Geometry, Dover Publications, 2012.
2. S. Lang, Fundamentals of Differential Geometry, Springer, 1999.
3. B. O'Neill, Elementary Differential Geometry, 2nd Ed., Academic Press, 2006.
4. A.N. Pressley-Elementary Differential Geometry, Springer.
5. B.P. Acharya and R.N. Das-Fundamentals of Differential Geometry, Kalyani Publishers, Ludhiana, New Delhi.

**+3 THIRD YEAR SIXTH SEMESTER  
DSE - 4 - MATHEMATICS****PROJECT WORK (COMPULSORY)**

Credit-6

Marks : 100  
Project -80+Viva Voce - 20



# PHYSICS

## +3 FIRST YEAR FIRST SEMESTER

### CORE COURSE - 1 (C-1)

### MATHEMATICAL PHYSICS - I

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

#### UNIT-I

**Calculus** : Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

**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-II

**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.

#### UNIT-III

**Vector Calculus** : 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-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, Gradient, divergence, curl and Laplacian in spherical and cylindrical coordinates.

#### UNIT-V

**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 Stoke's Theorems and their applications (no rigorous proofs).

#### Reference Books :

1. Mathematical Methods for Physicists, G.B. Arfken, J.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction of ordinary differential equations, E.A. Coddington, 2009, PHI Learning.
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
6. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5th Ed., 2012, Jones and Bartlett Learning
7. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
8. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
9. Mathematical Physics and Special Relativity —M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2<sup>nd</sup> Edition 2009.
10. Mathematical Physics—H. K. Dass, Dr. Rama Verma (S. Chand Higher Academics) 6<sup>th</sup> Edition 2011.
11. Mathematical Physics -C. Harper, (Prentice Hall India) 2006.
12. Mathematical Physics-Goswami (Cengage Learning) 2014
13. Mathematical Method for Physical Sciences — M. L. Boas (Wiley India) 2006

### PRACTICAL PHYSICS LAB (C-1)

Time : **2 Hours**End Semester : **30 Marks**

1. To study the random error in observations.
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  $g$  and velocity for a freely falling body using Digital Timing Technique.
6. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
7. To determine the Young's Modulus of a Wire by Optical Lever Method.
8. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
9. To determine the elastic Constants of a wire by Searle's method.
10. To determine the value of  $g$  using Bar Pendulum.
11. To determine the value of  $g$  using Kater's Pendulum.

#### Reference Books :

- Advanced Practical Physics for students, B. L. Flint and H. T. Workshop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.

### +3 FIRST YEAR FIRST SEMESTER CORE COURSE - II (C-2) - PHYSICS MECHANICS

Time : **3 Hours**End Semester Theory : **50 Marks**Credit : **6**Mid-Semester : **20 Marks**

#### UNIT - I

**Rotational Dynamics** : Centre of Mass and Laboratory frames. Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

#### UNIT - II

**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.

**Elasticity** : Relation between Elastic constants. Twisting torque on a Cylinder or Wire.

**Fluid Motion** : Kinematics of Moving Fluids : Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

#### 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. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts.

**UNIT - IV**

**Oscillations:** SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

**UNIT - V**

**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. Energy-Momentum Four Vector.

**Reference Books:**

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.I , C.Kittel, W.Knight, et.a!. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Ana)ytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

**Additional Books for Reference**

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modem Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
- Mechanics - J. C. Slater and N. H. Frank (McGraw-Hill)

### PRACTICAL PHYSICS LAB (C-2)

Time : **2 Hours**End Semester : **30 Marks**

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To compare capacitances using De'Sauty's bridge.
6. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
7. To verify the Thevenin's and Norton's theorems.
8. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
10. 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 .
11. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor Q.
12. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
13. Determine a high resistance by leakage method using Ballistic Galvanometer.

14. To determine self-inductance of a coil by Rayleigh's method.
15. To determine the mutual inductance of two coils by Absolute method.

### Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, LPrakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michel Nelson and Jon M. ogborn, 4th edition, reprinted 1985, Heinmann Educational Publisher.
- A laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985. Vani Pub.

## +3 FIRST YEAR FIRST SEMESTER GE - I - PHYSICS

### MECHANICS & PROPERTIES OF MATTER, OSCILLATION & WAVES, THERMAL PHYSICS, ELECTRICITY, MAGNETISM & ELECTRONICS

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

#### UNIT-I: Mechanics & 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 at external 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, Poiseulles 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's thermodynamic relation (statement only), Clausius-Clap'eyron equation. Black body radiation, Planck radiation formula (No derivation).

#### UNIT-IV: Electricity and Magnetism

Gauss law of electrostatics, use of Gauss law to compute electrostatic field due to a linear charge distribution. Magnetic induction B, Lorentz force law. Biot-Savarts law, Magnetic induction due to long straight current carrying coriductor, and in the axis of a current carrying circular coil. Amperes Circuital law, its differential form: The law of electromagnetic induction, its differential and integral form. Maxwell's electro-magneticequations 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.

#### UNIT-V: Electronics

Extrinsic and intrinsic semiconductors, 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  $\alpha$  and  $\beta$ . JFET, its operation and characteristics of V-I curve.

**Reference Books:**

1. Properties of Matter D.S. Mathur (S, Chand Publication).
2. Heat and Thermodynamics A.B.. Gupta & H.B. Ray (New Central Book Agency).
3. Sound M. Ghosh (S. Chand Publication).
4. Introduction to Electrodynamics D.I. Griffith (Prentice Hall of India).
5. Foundations of Electronics Chattopadhyaya and Rakshit.
6. Physics of Degree students Vol.1 M. Das, P.K. Jena, M. Bhuyan, D.K.,Rout (Srikrishna Prakashan).
7. Physics of Degree students Vol.1 M. Das, P.K. Jena, M. Bhuyan, and others (Srikrishna Prakashan).
8. University Physics Sears, Zemansky, H.D. Young (Addison Wesley).

**PRACTICAL**  
**GE - I**

Time : 3 hours

Full Mark : 30 Marks

1. Measurement of length (or diameter) using Vernier calipers, Screw gauge and travelling micro-scope.
2. To determine the moment of inertia of a fly wheel.
3. To determine the Youngs modulus Y of a wire by Searls method.
4. To determine the modulus of rigidity of a wire by Maxwells needle/Torsion Pendulum (Dynamic method).
5. To determine g by bar pendulum.
6. To determine the elastic constants of a wire by Searls method.
7. To determine the value of Y of a rubber by using travelling microscope.
8. To determine the Rigidity of modulus by static method.
9. To determine the frequency of a telescope by using Sonometer.
10. Verification of Laws of Vibration of a string by using Sonometer.
11. To compare capacitances using DeSauty bridge.
12. To determine the Law of resistance by using Foster bridge.
13. To determine the Mechanical equivalent of heat J by Callender and Barne's constant flow method.
14. To determine the J by Joules Calorimeter.
15. To determine the coefficient of viscosity of water by Capillary flow method (Poiseilles method).
16. Compare the specific heat of two liquids by method of Cooling.

**Reference Books:**

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House B'B. Swain.
2. A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal (1985), Vani Pub-lication.
3. A Text book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition (2011), Kitab Mahal, New Delhi.

**+3 FIRST YEAR SECOND SEMESTER**  
**CORE COURSE - III (C-3) - PHYSICS**  
**ELECTRICITY AND MAGNETISM**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**UNIT - I**

**Electric Field and Electric Potential** : Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical. cylindrical and planar symmetry.  
Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations.  
The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole.

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

Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

**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 **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics.

#### UNIT - III

**Magnetic Field:** Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force of (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

#### UNIT - IV

**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.

#### UNIT - V

**Electrical Circuits:** AC Circuit: Kirchhoffs laws for AC circuits. Complex Reactance and impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.

**Network theorems:** Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton's theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

#### Reference Books:

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, DJ. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
- Elements of Electro magnetics, M. O. Sadiku, 2010, Oxford University' Press.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

### PRACTICAL PHYSICS LAB-3

Time : 3 Hours

Full Mark : 30 Marks

*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 is 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 anyone operating system Linux or Microsoft Windows*



<b>Topics</b>	<b>Description with Applications</b>
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 & overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming	Introduction to Programming, constants, variables and fundamentals data types, operators and Expressions, I/O statements, scanf and printf, cin and cout, Manipulators for data formatting, Control statements (decision making and looping statements) ( <i>If—statement. If—else Statement. Nested if Structure. Else—if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do- While Loop. FOR Loop. Break and Continue Statements. Nested Loops</i> ), Arrays (1 D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs:	Sum & average of a 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 $\pi$ .

**Referred Books :**

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al, 3rd Edn. 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T. Pang, 2<sup>nd</sup> Edn., 2006, Cambridge U. Press.

**+3 FIRST YEAR SECOND SEMESTER  
CORE COURSE - IV (C-4) - PHYSICS  
WAVES AND OPTICS**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit : **6**Mid-Semester : **20 Marks****UNIT - I**

**Geometrical optics** : Fermat's principle, reflection and refraction at plane interface, Matrix formulation of geometrical Optics. Idea of dispersion. Application to thick lense, 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 (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a



Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.

**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 wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive-index.

### UNIT - IV

**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 - V

**Fraunhofer diffraction**: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. 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.

### Reference Books

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 1st Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- Optics - Brijlal & Subramaniam- (S. Chand Publication) 2014.
- Geometrical and Physical Optics - R.S. Longhurst, Orient Blackswan, 01-Jan-1986
- Vibrations and Waves -- A. P. French, (CBS) Indian print 2003
- Optics, E. Hecht (Pearson India)

### PRACTICAL PHYSICS LAB : LAB -4

Time : 3 Hours

Full Mark : 30 Marks

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify  $\lambda^2 - T$  law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster's focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy's constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

**Reference Books**

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, 1. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani

**+3 FIRST YEAR SECOND SEMESTER**  
**GE - II - PHYSICS**  
**OPTICS, SPECIAL THEORY OF RELATIVITY, ATOMIC PHYSICS,**  
**QUANTUM MECHANICS & NUCLEAR PHYSICS**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**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 of by it. Colour of thin films and Newton's rings. Fresnel and Fraunhofer diffraction, diffraction by Single slit Plane transmission grating.

**UNIT-II: Optics-II and Relativity**

Electromagnetic nature of light, polarized and unpolarized light, polarization by reflection and refraction. Brewster's Law, Malus Law, Double refraction. Ordinary and extraordinary rays. Galilean transformation, Newtonian relativity and its limitation, Michelson Morley experiment and its Consequence, postulates of special theory of relativity. Lorentz transformation, length contraction, time dilation, relativistic mass and momentum, mass energy relation.

**UNIT-III: 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 electric effect, 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 of the nucleus. Bohr's correspondence principle, limitations of Bohr's theory. Discrete energy, exchange by atom Frank & Hertz experiment.

**UNIT-IV: Quantum Mechanics**

Heisenberg's Uncertainty relation. Time dependent Schrodinger's wave equation in one dimension and three dimensions. The physical interpretation of the wave function. Probability density and probability current density. Equation of continuity. Normalization of the Wave 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 and eigen functions.

**UNIT-V: 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.

**Reference Books:**

1. Principles of Optics A.B. Gupta-
2. Fundamentals of Optics Jenkins and White.
3. Relativity R. Resnick.
4. Modern Physics H.S. Maniand G.K. Meheta.
5. Quantum Mechanics J.L. Powell and B. Craseman.
6. Atomic and Nuclear Physics Gupta and Ghosh (Books and allied).
7. Physics of Degree students Vol. III M. Das, P.K. Jena and others (Srikrishna Prakashan).
8. Physics of Degree students Vol. IV M. Das, P.K. Jena and others (Srikrishna Prakashan).
9. Concept-of Modern Physics Arthur Beiser (Mc-graw Hill) (2009).
10. University Physics Sears, Zemansky, H.D. Young (Addison Wesley).

**PRACTICAL  
GE -II**

Time : 3 hours

Full Mark : 30 Marks

1. Determination of Horizontal component of Earth's magnetic field and magnetic moment of a bar magnet using deflection and oscillation magnetometer.
2. Determination of E.C.E. of a Copper by taking 3 readings.
3. Familiarization with Schuster: focusing and determination of angle of prism.
4. Determination of Refractive index of the material of a prism using Sodium light. 5.. To determine the wavelength of light using plane diffraction grating.
6. To determine the wavelength: of light using Newton's ring.
7. Determination of refractive index of (a) glass and (b) liquid by using travelling microscope.
8. Determination of radius of curvature of a convex/concave mirror by using Kohlrausch's method.
9. To determine the magnifying: power of a given telescope.
10. Verification of inverse square law of magnetism by using a deflection magnetometer.
11. To draw the static characteristics of a P-N junction diode.
12. Obtain the static characteristics of a P-N-P / N-P-N transistor / Triode Valve.
13. To determine the reduction factor of a tangent Galvanometer.
14. Variation of magnetic field along the axis of a circular coil carrying current.
15. To study the characteristics of a series RC circuit.

**Reference Books:**

1. Advanced Practical Physics for students, B.L. Flint & H.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.

**+3 SECOND YEAR THIRD SEMESTER  
CORE- 5 - PHYSICS  
MATHEMATICAL PHYSICS - II**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**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 co-efficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval.

**Unit-II**

- **Fourier Series II:** Even and odd Functions and their Fourier expansions, Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.
- **Some Special Integrals:** Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

**Unit-III**

- **Frobenius Method and Special Functions:** Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations: Properties of Legendre and Hermite Differential Equations.
- **Legendre and Hermite Polynomials:** Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre polynomials. Associate Legendre polynomials and spherical harmonics.

**Unit-IV**

**Theory of Errors :** Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

**Unit-V**

**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.

**Reference Books:**

- Mathematical Methods for physicist: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier analysis By M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Pub.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Books
- Mathematical Physics and Special Relativity- M. Das, P.K. Jena and B.K. Dash (Srikrishna Prakashan) 2<sup>nd</sup> Edition 2009
- Mathematical Physics - H. K. Dass, Dr. Rama Verma (S.Chand Higher Academics) 6th Edition 2011.
- Mathematical Physics – C. Harper, (Prentice Hall India) 2006.
- Mathematical Physics –Goswami (CENGAGE Learning) 2014.

- Mathematical Method for Physical Science—M.L. Boas (Wiley India) 2006
- Mathematics for Physicists, P. Dennery and A. Krzywicki (Dover)
- Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.

## PRACTICAL C - 5

Time : 2 hours.

Full Mark : 30 Marks

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.

### Topics

Introduction to Numerical Computation software Scilab

### Description With Applications

Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit Window, Variables and arrays, Initialising variables in Scilab, MMultidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching statements and program design, Relational & logical operators, 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, Variable passing in Scilab , optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional 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).

### Topics

Curve fitting, Least square fit, Goodness of fit, standard deviation

### Description With Applications

Ohms law to calculate R, Hooke's law to calculate spring constant

### Topics

Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen Vectors, Eigen values problems.

### Description With Applications

Solution of mesh equations of electric circuits ( 3meshes )Solution of coupled spring mass systems ( 3 masses )

### Topics

Solution of ODE, First order Differential equation Euler, modified Euler and Runge- Kutta second order methods, Second order differential equation. Fixed difference method

### Description With Applications

First order differential equation

- . Radioactive decay
  - . Current in RC, LC circuits with DC source
  - . Newton's law of cooling
  - . Classic as 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:

- . Mathematical Methods for Physics and Engineers, K.F. Riley, M.P. Hobson and S.J. 20 Bence 3<sup>rd</sup> ed., 2006, Cambridge University Press
- . Complex Variables, A.S. Fokas & M.J. Ablowitz, 8<sup>th</sup> Ed., 2011, Cambridge Univ. Press
- . First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940 Jones & Bartlett.
- . Simulation of ODE/PDE Models with MATLAB®, OCTAVATE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernandez. 2014 Springer
- . Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- . Scilab (A free software to Matlab): H.Ramchandran, A.S. Nair. 2011 S.Chand and Company.
- . Scilab Image Processing: Lambert M.Surhone, 2010 Beta script Publishing

## +3 SECOND YEAR THIRD SEMESTER CORE - 6 - PHYSICS THERMAL PHYSICS

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

#### Unit-I

- **Introduction to Thermodynamics:** Recapitulation of Zeroth and First law of Thermodynamics.
- **Second Law of Thermodynamics:** Reversible and Irreversible process with examples. Conversion of Work into Heat and Heat into Work. Heat Engines. Carnot cycle. Carnot's engine and efficiency. Refrigerator and co-efficient of performance, 2<sup>nd</sup> law of Thermodynamics. Kelvin- Planck 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.

#### Unit-II

- **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 principle of Increase of Entropy. Temperature-Entropy diagrams for Carnot's cycle. Third law of Thermodynamics Unattainability of Absolute zero.
- **Thermodynamic Potentials:** Extensive and Intensive Thermodynamic Variables. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free



Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with temperature. Magnetic work, Cooling due to adiabatic demagnetization.

### Unit-III

- **Phase Transitions:** First and Second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equation.
- **Maxwell's Thermodynamic Relations:** Derivations and applications of Maxwell's Relations, Maxwell's Relations: (1) Clausius Clapeyron equation, (2) Values of  $C_p - C_v$ , (3) Tds Equations, (4) Joule- Kelvin co-efficient for Ideal and Vander-Waal Gases, (5) Energy Equations, (6) Changes of Temperature during Adiabatic Process.

### Unit-IV

- **Kinetic Theory of Gases**
- **Distribution of Velocities:** Maxwell- Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Stern's 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 Phenomena in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian motion and its Significance.

### Unit- V

- **Real Gases:** Behaviour of Real Gases: Deviation from The Ideal Gases Equation. The Virial Equation Andrew's Experiments on  $\text{CO}_2$  Gas. Critical Constants, Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Vander-Waal's 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.

### Reference Books:

- Heat and Thermodynamics, M. W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B. N. Srivastava, 1958, Indian Press
- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2<sup>nd</sup> Edition, 1993, Tata McGraw-Hill
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Concept in Thermal Physics, S. J. Blundell and K. M. Blundell, 2<sup>nd</sup> Ed., 2012, Oxford University Press
- Heat and Thermal Physics-Brijal & Subramaiaam (S.Chand Publication) 2014
- Thermal Physics—C. Kittel and H. Kroemer (McMillan Education India) 2010

## PRACTICAL

### C - 6

Time : 2 hours.

Full Mark : 30 Marks

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
  2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
  3. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
  4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
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5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
6. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
7. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method, (2) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.
8. To determine J by Calorimeter.

#### Reference Book:

- Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Ed., 2011, Kitab Mahal
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

### +3 SECOND YEAR THIRD SEMESTER CORE COURSE - VII (C-7) - PHYSICS

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

#### DIGITAL SYSTEM AND APPLICATION

##### 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 Conversion. 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 Morgan's Theorems: Boolean Laws, Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (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: (1) 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 2's complement. Half and Full Adders. Half and Full Subtractors, 4 bit binary Adder/Subtractor.

##### Unit-IV

- **Timers: IC 555:** block diagram and application is Astable multivibrator and Monostable multivibrator.

- **Introduction to Computer Organization:** Input/output Devices. Data storage (idea of RAM and ROM) Computer memory. Memory organization and addressing. Memory Interfacing, Memory Map.

#### Unit-V

- **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.

#### Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt.Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Systems : Principles and Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learning
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghosal, 2012, Cengage Learning.
- Microprocessor Architecture Programming and applications with 8085, 2002, R.S. Goankar, Prentice Hall.
- Concept of Electronics: D.C. Tayal (Himalaya Publication) 2011
- Electronics- V.K. Mehta ( S. Chand Publication) 2013
- The Art of Electronics, P. Horowitz and W. Hill , CUP

### PRACTICAL

#### C - 7

Time : 2 hours.

Full Mark : 30 Marks

1. To measure (a) voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter
3. To design a Switch (NOT gate) using a transistor
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. TO design a combinational logic System for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit
8. Half Adder, Full Adder and 4-bit binary Adder
9. Half Subtractor, Full Sub-tractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specification using 555 Timer.
15. To design a monostable multivibrator of given specification using 555 Timer.

#### Reference Books:

- Modern Digital Electronics, R.P. Jain, 4<sup>th</sup> Edition, 2010, Tata McGraw Hill.
  - Basic Electronics : A text lab manual, P. B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
  - Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
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- Microprocessor 8085: Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

### **+3 SECOND YEAR THIRD SEMESTER**

#### **GE - III - PHYSICS**

#### **MECHANICS & PROPERTIES OF MATTER, OSCILLATION & WAVES, THERMAL PHYSICS, ELECTRICITY, MAGNETISM & ELECTRONICS**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

#### **UNIT-I: Mechanics & 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 at external 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, Poiseulles 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 relations (statement only), Clausius-Clapeyron equation. Black body radiation, Planck radiation formula (No derivation).

#### **UNIT-IV: Electricity and Magnetism**

Gauss law of electrostatics, use of Gauss law to compute electrostatic field due to a linear charge distribution. Magnetic induction B, Lorentz force law. Biot-Savart's law, Magnetic induction due to long straight current carrying coriductor, and in the axis of a current carrying circular coil. Amperes Circuital law, its differential form: The laws of electromagnetic inductions, its differential and integral forn. 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.

#### **UNIT-V: Electronics**

Extrinsic and intrinsic semiconductors, 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  $\pi$  filters, working of PNP and NPN transistors, transistor configurations in CE and CB circuits and relation between  $\alpha$  and  $\beta$  . JFET, its operation and characteristics of V-I curve.

#### **Reference Books:**

- Properties of Matter D.S. Mathur (S, Chand Publication).
- Heat and Thermodynamics A.B.. Gupta & H.B. Ray (New Central Book Agency).
- Sound M. Ghosh (S. Chand Publication).
- Introduction to Electrodynamics D.I. Griffith (Prentice Hall of India).
- Foundations of Electronics Chattopadhyaya and Rakshit.
- Physics of Degree students Vol.1 M. Das, P.K. Jena, M. Bhuyan, D.K.,Rout (Srikrishna Prakashan).
- Physics of Degree students Vol.1 M. Das, P.K. Jena, M. Bhuyan, and others (Srikrishna Prakashan).

8. University Physics Sears, Zemansky, H.D. Young (Addison Wesley).

### PRACTICAL

#### GE - I

Time : 3 hours

Full Mark : 30 Marks

1. Measurement of length (or diameter) using Vernier calipers, Screw gauge and travelling micro-scope.
2. To determine the moment of inertia of a fly wheel.
3. To determine the Youngs modulus  $Y$  of a wire by Searls method.
4. To determine the modulus of rigidity of a wire by Maxwells needle/Torsion Pendulum (Dynamic method).
5. To determine  $g$  by bar pendulum.
6. To determine the elastic constants of a wire by Searls method.
7. To determine the value of  $Y$  of a rubber by using travelling microscope.
8. To determine the Rigidity of modulus by static method.
9. To determine the frequency of a tuning fork by using Sonometer.
10. Verification of Laws of Vibration of a string by using Sonometer.
11. To compare capacitances using DeSauty's bridge.
12. To determine the Law of resistance by using Carry Foster bridge.
13. To determine the Mechanical equivalent of heat  $J$  by Callender and Barnes constants flow method.
14. To determine the  $J$  by Joules Calorimeter.
15. To determine the coefficient of viscosity of water by Capillary flow method (Poiseilles method).
16. Compare the specific heat of two liquids by method of Cooling.

#### Reference Books:

1. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House B'B. Swain.
2. A Laboratory Manual of Physics for Undergraduate Classes, D.P.Khandelwal (1985), Vani Pub-lication.
3. A Text book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition (2011), Kitab Mahal, New Delhi.

## +3 SECOND YEAR FOURTH SEMESTER

### CORE - 8 - PHYSICS

#### MATHEMATICAL PHYSICS - III

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

#### Unit-I

- **Complex Analysis-I:** Brief Revision of Complex Numbers and their Graphical Representation Euler's formula, 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's Integral formula. Simply and multiply connected region.

#### Unit-II

- **Complex Analysis-II :** Laurent and Taylor's expansion. Residues and Residue Theorem Application in solving Definite Integrals.

#### Unit-III

- **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 a Fourier Integral. Fourier transform of derivatives,

Inverse Fourier Transform.

#### Unit-IV

- **Integral Transforms-II** : Convolution theorem. Properties of Fourier Transforms (translation, change of scale, complex conjugation). Three dimension Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion / Heat flow Equations.

#### Unit-V

- **Laplace Transforms** : Laplace Transforms (LT) of Elementary functions, Properties of LTs: 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. Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits.

#### Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S.J. Bence, 3<sup>rd</sup> ed., 2006, Cambridge University Press
- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Advanced Engineering Mathematics, E. Kreyszig (New Age Publication) 2011.
- Mathematics for Physicists, P. Dennerly and A. Krzywicki, 1967, Dover Publications
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8<sup>th</sup> Ed., 2011, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7<sup>th</sup> Ed., 2003, Tata McGraw-Hill
- First course in complex analysis with application, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
- Mathematical Physics-H.K. Dass, Dr. Rama Verma (S.Chand Higher Academics) 6<sup>th</sup> Edition 2011.
- Mathematical Physics—C. Harper, (Prentice Hall India) 2006.
- Mathematical Physics - Goswami (Cengage Learning) 2014.
- Mathematical Method for Physical Sciences—M.L. Boas (Wiley India) 2006
- Introduction to the theory of functions of a complex variable- E.T. Copson (Oxford) Univ. Press, 1970

### PRACTICAL

#### C - 8

Time : 2 hours.

Full Mark : 30 Marks

**Scilab based simulations experiments based on Mathematical Physics problems like**

#### 1. Solve differential equations:

$$dy/dx = e^{-x} \text{ with } y = 0 \text{ for } x = 0$$

$$dy/dx + e^{-x}y = x^2$$

$$d^2y/dt^2 + 2 dy/dt = -y$$

$$d^2y/dt^2 + e^{-t}dy/dt = -y$$

#### 2. Dirac Delta Function:

Evaluate  $\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{-\frac{(x-2)^2}{2\sigma^2}} (x+3) dx$  for  $\sigma = 1, 0.1, 0.01$  and show it tends to 5

#### 3. Fourier Series:

Program to sum  $\sum_{n=1}^{\infty} (0.2)^n$

Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:

$$\int_{-1}^1 P_n(\mu)P_m d\mu = \delta_{n,m}$$

Plot  $P_n(x)$ ,  $J_\nu(x)$

Show recursion relation

5. Calculation of error for each data point of observations recorded in experiments done in previous semesters. (Choose any two)
6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer programme.
7. Evaluation of trigonometric functions e.g. sin Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate  $1/(x^2+2)$  numerically and check with computer integration.
8. Integral transform: Fourier Integral Transform of  $e^{-x^2}$

**Reference Books:**

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S.J. Bence, 3<sup>rd</sup> ed., 2006, Cambridge University Press.
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications.
- Simulation of ODE/PDE Models with MATLAB (R), OCTAVE and SCILAB Scientific and Engineering Applications A. Vande Wouwer, P.Saucez, C.V. Fernandez. 2014 Springer ISBN 978-3319067896
- Scilab by example M. Affouf, 2012. ISBN 978-1479203444
- Scilab(A free software to Matlab): H. Ramchandran, A.S. Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Beta script Publishing

## +3 SECOND YEAR FOURTH SEMESTER CORE - 9 - PHYSICS ELEMENTS OF MORDERN PHYSICS

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**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, Rutherford Scattering Formula, Rutherford Model of atom and its limitations.

**UNIT- II**

- **Atomic Model:** Bohr's Model of H 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 Expt., Sommerfeld's Modification of Bohr's Theory.
- **Wave Particle Duality:** de Broglie hypothesis, Experimental confirmation of matter wave, Davisson Germer Experiment, velocity of de Broglie wave, wave particle duality, Complementarity.

**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.

- **Uncertainty Principle:** Heisenberg Uncertainty Principle, Illustration of the Principle through thought 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- I:** Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of the nuclear force, NZ graph, Liquid Drop model: semi empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

#### UNIT- V

- **Nuclear Physics- II:** Radioactivity, stability of the nucleus; Law of radioactive decay; Mean life and Half life Alpha decay ; 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 – mass deficit, relativity and generation of energy; Fission- nature of fragments and emission of neutrons. Nuclear reactor: slow neutron interacting with Uranium 235; Fusion and thermo nuclear reactions driving stellar energy (brief qualitative discussion).

#### Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for Scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theory & Applications, A.K. Ghatak & S. Lokanathan, 2004, Macmillan
- Modern Physics – Bernstein, Fishbane and Gasiorowicz (Pearson India) 2010
- Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles – R. Eisberg (Wiley India) 2012.

#### Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum's outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw–Hill Publishing Co. Ltd.
- Quantum physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn, Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A. Moore, 2003, McGraw Hill
- Modern Physics – Serway (CENGAGE Learnings) 2014
- Modern Physics — Murugesan and Sivaprasad – (S. Chand Higher Academics)
- Physics of Atoms and Molecules – Bransden (Pearson India) 2003

### PRACTICAL

#### C - 9

Time : 2 hours.

Full Mark : 30 Marks

1. Measurement of Planck's constant using black body radiation and photo-detector.
-



2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of  $e/m$  by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunnelling effect in tunnel diode using  $I - V$  characteristics.
11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

### Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level physics Practical's, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers
- A text Book of Practicals Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> Edn, 20011, Kitab Mahal.

## +3 SECOND YEAR FOURTH SEMESTER CORE - 10 - PHYSICS ANALOG SYSTEM AND APPLICATIONS

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

### 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:**  
(i) Rectifier Diode: Half -wave Rectifiers. entere-tapped and bridge type Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency,(2) Zener Diode and Voltage Regulation, Principle and structure of (1) LEDS, (2) Photo diode(3) Solar Cell.

### UNIT – II

- **Bipolar Junction Transistors:** n-p-n and p-n-p transistors, Characterstics of CB, CE and CC Configurations. Current gains  $a$  and  $b$ . Relation between  $a$  and  $b$  . Load line analysis of Transistors.
-

DC Load line 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.

#### UNIT-III

- **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.
- **Coupled Amplifier:** RC-coupled amplifier and its frequency response.

#### UNIT-IV

- **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 oscillations. RC Phase shift oscillator, determination of Frequency, Hartley and Colpitts oscillators.

#### UNIT-V

- **Operational Amplifiers (Black Box approach):** Characteristics of an Ideal and Practical OP-AMP (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 bridge oscillator.

#### Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Application, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G. Streetman and S.K. Banerjee, 6<sup>th</sup> Edn., 2009, PHI Learning
- Electronic Devices and circuits, S. Salivahanan and N.S. Kumar, 3<sup>rd</sup> Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R.A. Gayakwad, 4<sup>th</sup> edition, 2000, Prentice Hall.
- Electronic Circuits: Handbook of design and applications, U. Tietze, C. Schenk, 2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2<sup>nd</sup> Ed., 2002, Wiley India
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
- Concept of Electronics: D.C. Tayal (Himalaya Publication) 2011
- Electronic devices: Circuits and Application : W.D. Stanley Prentice Hall
- Electronics- V.K. Mehta (S.Chand Publication) 2013
- Electronic Circuits : L.Schilling and Velove : 3<sup>rd</sup> Ed McGraw Hill
- Electronics- Raskhit and Chattopadhyaya (New age International Publication) 2011
- Electricity and Electronics – D.C. Tayal (Himalaya Pub.)2011
- Electronic devices and circuits –R.L. Boylstad (Pearson India) 2009

### PRACTICAL

#### C-10

Time : 2 hours.

Full Mark : 30 Marks

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.

3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To study the various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of a voltage gain of a RC- coupled transistor amplifier.
8. To design a Wein bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt's oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital converter (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain.
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a 1<sup>st</sup>/2<sup>nd</sup> order differential equation.

**Reference Books:**

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R.A. Gayakwad, 4<sup>th</sup> edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
- Electronic devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

**+3 SECOND YEAR FOURTH SEMESTER****GE - IV - PHYSICS****OPTICS, SPECIAL THEORY OF RELATIVITY, ATOMIC PHYSICS,  
QUANTUM MECHANICS & NUCLEAR PHYSICS**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**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 of by it. Colour of thin films and Newton's rings. Fresnel and Fraunhofer diffraction, diffraction by Single slit, Plane transmission grating.

**UNIT-II: Optics-II and Relativity**

Electromagnetic nature of light, polarized and unpolarized light, polarization by reflection and re-refraction. Brewster's Law, Malus Law, Double refraction. Ordinary and extraordinary rays. Galilean transformation, Newtonian relativity and its limitation, Michelson Morley experiment and its consequence, postulates of special theory of relativity. Lorentz transformation, length contraction, time dilation, relativistic mass and momentum, mass energy relation.

**UNIT-III: Atomic Physics**

Inadequacy of classical physics brief outline of Rayleigh Jeans theory and Plancks quantum theory of radiation, particle nature of electromagnetic radiation photo electric effect, Compton effect, dual nature of radiation, wave nature of particles, de-Broglie hypothesis, matter wave, wave-particle duality, Davisson-Germer experiment.

Bohrs theory of Hydrogen atom, explanation of Hydrogen Spectra correction for finite mass of the nucleus. Bohr's correspondence principle, limitations of Bohrs theory. Discrete energy exchange by atom Frank Hertz experiment.

**UNIT-IV: Quantum Mechanics**

Heisenbergs Uncertainty relation. Time dependent Schrodingers wave equation in one dimension and three dimensions. The physical interpretation of the wave function. Probability density and probability current density. Equation of continuity. Normalization of the Wave function, Expectation value of an observable, Ehrenfests theorem.

Time independent Schrodinger's wave equation in one dimension, particle in a box, energy eigen values and eigen functions.

**UNIT-V: 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.(8 classes) 14 Marks

**Reference Books:**

1. Principles of Optics A.B. Gupta-
2. Fundamentals of Optics Jenkins and White.
3. Relativity R. Resnick.
4. Modern Physics H.S. Maniand G.K. Meheta.
5. Quanturri Mechanics J.L. Powel and B. Craseman.
6. Atomic and Nuclear Physics Gupta and Ghosh (Books and allied).
7. PPhysics of Degree students Vol. III M. Das, P.K. Jena and others (Srikrishna Prakashan).
8. Physics of Degree students Vol. IV M. Das, P.K. Jena and others (Srikrishna Prakashan).
9. Concept-of Modern Physics Arthur Beiser (Mc-graw Hill) (2009).
10. University Physics Sears, Zemansky, H.D. Young (Addison Wesley).

**PRACTICAL****GE -II**

Time : 3 hours

Full Mark : 30 Marks

1. Determination of Horizontal component of Earths magnetic field and magnetic moment of a bar magnet using deflection and oscillation magnetometer.
2. Determination of E.C.E. of a Copper by taking 3 readings.
3. Familiarization with Schuster: focussing and determination of angle of prism.
4. Determination of Refractive index of the material of a prism using Sodium light.
5. To determine the wavelength of light using plane diffraction grating.
6. To determine the wavelength: of light using Newtons ring.
7. Determination of refractive index of (a) glass and (b) liquid by using travelling microscope.
8. Determination of radius of curvature of a convex/concave mirror by using Kohlrauschs method.
9. To determine the magnifying power of a given telescope.
10. Verification of inverse square law of magnetism by using a deflection magnetometer.
11. To draw the static characteristics of a P-N junction diode.
12. Obtain the static characteristics of a P-N-P / N-P-N transistor / Triode Valve.

13. To determine the reduction factor of a tangent Galvanometer.
14. Variation of magnetic field along the axis of a circular coil carrying current.
15. To study the characteristics of a series RC circuit.

**Reference Books:**

1. Advanced Practical Physics for students, B.L.Flint & H.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.

**+3 THIRD YEAR FIFTH SEMESTER  
CORE - 11 - PHYSICS  
QUANTUM MECHANICS AND APPLICATIONS**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit : **6**Mid-Semester : **20 Marks****UNIT- I**

- **Schrodinger equation and the operators:** Time dependent Schrodinger equation and dynamical evolution of a quantum state; 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 Superposition Principles.

**Unit-II**

- Hermitian operator. Eigen values and Eigen functions. Position Momentum and Energy operators; Commutator of position and momentum operators; Expectation values of position and momentum. Wave function of a Free Particle. Angular momentum and Commutation of Angular momentum. Application to spread of Gaussian wave packet for a free particle in one dimension, wave packets. Fourier transforms and momentum space wave function, Position momentum uncertainty principle.

**Unit-III**

- **Time Independent Schrodinger equation:** 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.

**Unit-IV**

- **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, ground state, zero point energy and uncertainty principle. One dimensional infinitely rigid box – energy eigen 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-V**

- **Atoms in Electric & Magnetic Fields:** Electron angular momentum. Space quantization, Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyro magnetic Ratio and Bohr Magneton.



**Atoms in External Magnetic Fields:-** Normal and Anomalous Zeeman Effect. Paschen back and Stark Effect (qualitative Discussion only)

### Reference Books

- A Text Book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2<sup>nd</sup> Ed., 2010, McGraw Hill.
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2<sup>nd</sup> Edn. 2002, Wiley.
- Quantum Mechanics, Leonard I. Schiff, 3<sup>rd</sup> Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldas, 2<sup>nd</sup> Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics, Foundations & Applications, Arno Bohm, 3<sup>rd</sup> Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum Physics — S. Gasiorowicz (Wiley India) 2013
- Quantum Mechanics- J.L. Powell and B. Craseman (Narosa) 1988
- Introduction to Quantum Mechanics- M. Das, P.K.Jena, (SriKrishna Prakashan)
- Basic Quantum Mechanics- A. Ghatak (Mc Millan India) 2012
- Introduction to Quantum Mechanics, R. Dicke and J. Wittke
- Quantum Mechanics- Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2<sup>nd</sup> Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4<sup>th</sup> Edn., 2001, Springer
- Quantum Mechanics – F. Mandl (CBS) 2013
- Cohen – Tannoudji, B Diu and F Laloe, Quantum Mechanics (2 Vols) Wiley –VCH 1977

## PRACTICAL

### C - 11

Time : 2 hours.

Full Mark : 30 Marks

**Use C/C++/Scilab for solving the following problems based on Quantum Mechanics like**

**1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:**

Here,  $m$  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  $-13.6$  eV. Take  $e = 3.795$  (eVÅ)<sup>1/2</sup>,  $\hbar c = 1973$  (eVÅ) and  $m = 0.511 \times 10^6$  eV/c<sup>2</sup>.

**2. Solve the s-wave radial Schrodinger equation for an atom:**

Where  $m$  is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

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  $e = 3.795$  (eVÅ)<sup>1/2</sup>,  $m = 0.511 \times 10^6$  eV/c<sup>2</sup>, and  $a = 3$  Å,  $5$  Å,  $7$  Å. In these units  $\hbar c = 1973$  (eV Å). The ground state energy is expected to be above  $-12$  eV in all three cases.

**3. Solve the s-wave radial Schrodinger equation for a particle of mass  $m$ :**

For the anharmonic oscillator potential

for the ground state energy (in Me V) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose  $m = 940$  Me V/c<sup>2</sup>,  $k = 100$  Me V fm<sup>-2</sup>,  $b = 0, 10, 30$  Me V fm<sup>-3</sup> In these units,  $c\hbar = 197.3$  Me V fm. The ground state energy  $I$  expected to lie



between 90 and 110 Me V 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 the two-atom system for the Morse potential

Find the lowest vibrational energy (in Me V) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take:  $m = 940 \times 10^{-36} \text{ kg}$ ,  $D = 0.755501 \text{ eV}$ ,  $a = 1.44$ ,  $r_0 = 0.131349 \text{ \AA}$

**Laboratory based experiments:**

5. Study of Electron spin resonance – determine magnetic field as a function of the resonance frequency.
6. Study of Zeeman Effect: with external magnetic field; Hyperfine splitting
7. To show the tunnelling effect in tunnel diode using I-V characteristics
8. Quantum efficiency of CCDs

**Reference Books**

- Schaum's outline of Programming with C++. J. Hubbard, 2000, McGraw—Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Press et al., 3<sup>rd</sup> Edn. 2007, Cambridge University Press.
- An introduction to computational Physics, T. Pang, 2<sup>nd</sup> Edn., 2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE, and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, and C.V. Fernandez. 2014 Springer.
- Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
- Scilab Image Processing: L.M. Surhone. 2010 Betascript Publishing ISBN : 978-6133459274

**+3 THIRD YEAR FIFTH SEMESTER  
CORE - 12 - PHYSICS  
SOLID STATE PHYSICS**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

**Unit-1**

- **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 by crystals. Bragg Law. Atomic and Geometrical Factor

**Unit-II**

- **Elementary Lattice Dynamics:** Lattice vibrations and Phonons: Linear Monatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the phonon spectrum in solids Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids.  $T^3$  Law

**Unit-III**

- **Magnetic Properties of Matter:** Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin's theory of dia- and Paramagnetic Domains. Curie's law, Weiss Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.
- **Dielectric Properties of Materials:** Polarization Local Electrical Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical theory of Electronic Polarizability.

**Unit-IV**

- **Elementary band theory:-** Kronig Penny model band Gap, Conductor , Semi conductor (P and N type) and insulator. Conductivity of Semi conductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) and Hall Co-efficient.

**Unit-V**

- **Super conductivity:** - 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)
- **Lasers:-** Einstein's A and B co-efficientnts , Metastable States, Spontaneous and Stimulated emissions.Optical Pumping and poplation Inversion, Three –Level and Four Level Lasers. Ruby Laser and He-Ne Laser.

**Reference books:**

- Introduction to Solid State Physics, Charles Kittel, 8th edition, 2004, Wiley India Pvt. Ltd.
- Element of solid state physics, j.p. srivastava, 2<sup>nd</sup> edition ,2006, prentice-hall of India
- Introduction to solids,leonid V.azaroff,2004, Tata Mc-Graw Hill
- Solid state physics , N.W. Ashcroft and N.D. Mermin, 1976 , Cengage Learning
- Solid State Physics, H. Ibach and H. Luth, 2009, Springer
- Elementary Solid State Physics, I/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications
- Solid State Physics – S.O. Pillai (New Age Publication)
- Solid State Physics – R.K. Puri & V.k Babbar (S. Chand Publication)2013
- Lasers and Non linear Optics – B.B. Laud- Wiley Eastern.
- LASERS: Fundamentals and Applications – Thyagarajan and Ghatak (McMillan India) 2012

**PRACTICAL****C - 12**

Time : 2 hours.

Full Mark : 30 Marks

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Material with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon Resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid and determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150° C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

**Reference Books:**

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers.

- A Text Book of Practical Physics, I. Prakash and Ramakrishna, 11<sup>th</sup> Ed., 2011, Kitab Mahal
- Elements of Solid State Physics, J.P. Srivastava, 2<sup>nd</sup> Ed., 2006, Prentice-Hall of India.

### +3 THIRD YEAR SIXTH SEMESTER CORE- 13 - PHYSICS ELECTROMAGNETIC THEORY

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

#### UNIT – I

- **Maxwell Equations:** Maxwell's equations, displacement current, vector and scalar potentials, gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations, Plane Wave in Dielectric Media. Poynting Theorem and poynting Vector. Electromagnetic (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, skin depth, Electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation 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-Law of Reflection and refraction. Fresnel's Formula for perpendicular and parallel polarization cases. Brewster's law reflection and Transmission co-efficiencies Total internal reflection, evanescent waves, Metallic reflection (normal incidence)

#### UNIT – IV

- **Polarization of Electromagnetic Waves:** Description of Linear, Circular and Elliptical Polarization. Propagation of E.M Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary and extraordinary refractive indices. 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.

#### UNIT- V

- **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. Laurent's half-shade polarimeter.
- **Optical Fibres:** Numerical Aperture. Step and Graded Indices (Definition Only). Single and Multiple Mode Fibres (Concept and Definition Only).

#### Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3<sup>rd</sup> Ed., 1998, Benjamin Cummings.
  - Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
  - Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
-

- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic Field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
- Electricity and Magnetism —D C Tayal ( Himalaya Publication) 2014
- Introduction to Electrodynamics-A.Z. Capri & P.V. Panat (Alpha Science) 2002
- Optics E.Hecht, (Pearson India)

#### **Additional Books for Reference**

- Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
- Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press
- Electromagnetic Theory-A. Murthy (S. Chand Publication)2014
- Classical Electrodynamics, J.D. Jackson (Wiley India)

### **PRACTICAL**

#### **C-13**

Time : 2 hours.

Full Mark : 30 Marks

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study the polarization and double slit interference in microwaves.
8. To determine the refractive Index of liquid by total internal reflection using Wollaston's air film.
9. To determine the refractive index of (1) glass and (2) a liquid by total internal reflection using Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
11. To verify the Stefan's law of radiation and to determine Stefan's constant.
12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

#### **Reference Books:**

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
  - Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4<sup>th</sup> Edition, reprinted 1985, Heinemann Educational Publishers
  - A text Book of Practical Physics, I. Prakash & Ramakrishna, 11<sup>th</sup> ed., 2011, Kitab Mahal
  - Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
-

**+3 THIRD YEAR SIXTH SEMESTER  
CORE - 14 - PHYSICS  
STATISTICAL MECHANICS**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit : 6

Mid-Semester : 20 Marks

**UNIT- I**

- **Classical Statistics-I:** Macrostate and Microstate, Elementary Concept of Ensemble, Microcanonical, 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, Gibb's 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, Negative Temperature.

**UNIT-III**

- **Radiation:** Properties of Thermal Radiation. Blackbody Radiation. Pure Temperature dependence. Kirchhoff's law. Stefan – Boltzmann law: Thermodynamic proof. Radiation Pressure. Weins Displacement law. Wien's distribution Law. Saha's Ionization Formula. Rayleigh – Jean's Law. Ultra – Violet catastrophe.

**UNIT-IV**

- **Planck's Law of Black body Radiation:** Experimental verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh – Jeans Law, (3) Stefan – Boltzmann Law, (4) Wein's Displacement Law from Planck's Law.
- **Quantum Statistics:** Identical particles, macrostates and microstates. Fermions and Bosons Bose Einstein distribution function and Fermi- Dirac distribution function.

**UNIT-V**

- Bose- Einstein Condensation, Bose deviation from Planck's law, Effect of temperature on F-D distribution function, degenerate Fermi gas, Density of States Fermi energy.

**Reference Books:**

- Statistical Mechanics – R.K. Pathria & Paul D. Beale (Academic Press) 3<sup>rd</sup> Edition (2011)
  - Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw – Hill
  - Statistical and Thermal Physics, S.Lokanathan and R.S. Gambhir. 1991, Prentice Hall
  - Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
  - Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
  - An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press
  - An Introduction to Equilibrium Statistical Mechanics : Palash Das (I.K. International Publication) 2012
  - Statistical Physics – F. Mandl (CBS) 2012
  - Statistical Physics of Particles- M. Kardar (CUP 2007)
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## PRACTICAL C - 14

Time : 2 hours.

Full Mark : 30 Marks

**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 Wein's Law and Raleigh- Jeans Law 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) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases.
3. Plot Maxwell – Boltzmann distribution function versus temperature.
4. Plot Fermi – Dirac distribution function versus temperature.
5. Plot Bose- Einstein distribution functions versus temperature.

### Reference Books:

- Elementary Numerical Analysis, K.E. Atkinson, 3<sup>rd</sup> Edn. 2007, Wiley India Edition
- Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2<sup>nd</sup> Ed., 1996, Oxford University press.
- Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986 Narosa.
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Simulation of ODE/PDE Models with MATLAB(R), OCTAVE and SCILAB: Scientific and Engineering Application: A. Vande Wouwer, P. Saucez, and C.V. Fernandez. 2014 Springer ISBN : 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN : 978- 1479203444
- Scilab Image Processing: L.M. Surhone. 2010, Betascript Pub., ISBN : 978- 6133459274

## +3 THIRD YEAR FIFTH SEMESTER DSE - 1 - PHYSICS CLASSICAL DYNAMICS

Time : 3 Hours

End Semester Theory : 80 Marks

Credit : 6

Mid-Semester : 20 Marks

**Unit 1:** Generalised co-ordinates and Velocities, Generalised Force, Principle of virtual work Derivation of Lagrange's equation of motion from D'Alemberts Principles, Lagrangian and its Application to Simple, Compound and Double Pendulums, Single Particle in Space, Atwoods Machine, Dumm-bell, Linear harmonic oscillator.

**Unit 2:** Hamilton's Principle Calculus of Variation and derivation of Euler-Lagrange's equation. Langrange'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.

**Unit 3:** The Equations of motion and first integrals, The equivalent one-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 4:** 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 & Twin paradox Variation of mass with velocity mass energy relation)

**Unit 5:** Four Vector Space Like, Time-like & 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.

**Reference Books:**

- Classical Mechanics, H. Goldstein, C.P. Poole, J.L. Safko, 3<sup>rd</sup> Edn. 2002, Pearson Education.
- Mechanics, L. D. Landau and E.M. Lifshitz, 1976, Pergamon.
- Classical Mechanics: An Introduction, Dieter Strauch, 2009, Springer.
- Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press.
- Classical Mechanics- J.C. Upadhyay (Himalaya Publication) 2014
- Classical Dynamics of Particles and Systems – S.T. Thornton (Cengage Learning) 2012
- Introduction to classical Mechanics – R. K. Takwale , S. Puranik – (Tata McGraw Hill)
- Classical Mechanics- M. Das, P.K. Jena, M. Bhuyan, R.N. Mishra (Srikrishna Prakashan)

**PARTICAL- D.S.E 1**

Time : **3 Hours**

Full Marks : **30**

1. Fourier Analysis of periodic wave forms.
2. Verification of Keplers Third Law of Planatory Motion
3. Study of Power Source
4. To determine Thermal Conductivity of copper
5. To determine electrical Conductivity of copper and determine Lorentz number
6. To determine thermal Conductivity of a poor conductor
7. Passive Filters

**+3 THIRD YEAR FIFTH SEMESTER  
DSE - II - PHYSICS**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit : **6**

Mid-Semester : **20 Marks**

**NUCLEAR AND PARTICLE PHYSICS**

**Unit 1: General properties of Nuclei:** Constituents of nucleus and their intrinsic properties, Quantitative facts about mass radil, charge density (matter density), binding energy, average binding energy and its vriation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment electric moments, nuclear excites states.

**Unit 2: Nuclear Models:** Liquid drop model approach, semi empirical mass formula and significance of its various terms, conditions of nuclear stability, two cucleon separation energies, evidence for nuclear shell structure, nuclear magic number, basic assumption of shell models.

**Unit 3: Radioactivity decays:** (a) Alpha decay: basic 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 4: 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-multiplr 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 5: 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.

#### Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill, 1998).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Basic Ideas and concepts in Nuclear Physics – An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub. Inc., 1991)
- Atomic and Nuclear Physics –A.B. Gupta, Dipak Ghosh. (Book and Allied Publishers)
- Physics of Atoms and Molecules – Bransden (Pearson India) 2003
- Subatomic Physics – Henley and Gracia (World Scientific) 2012
- Introduction to Nuclear and Particle Physics – A. Das and T. Ferbel (World Scientific)
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

#### PARTIAL- D.S.E 11

Time : **3 Hours**

Full Marks : **30**

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

### +3 THIRD YEAR SIXTH SEMESTER DSE - III - PHYSICS

Time : **3 Hours**

End Semester Theory : **50** Marks

Credit : **6**

Mid-Semester : **20** Marks

#### NANO MATERIALS AND APPLICATIONS

Unit 1: Nanoscale Systems: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, size effects in nano systems, Quantum confinement:

Unit 2: Applications of Schrodinger equation-infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructure and its consequences.

Unit 3: Synthesis of Nanostructure Materials: Top down and bottom up approach, Photolithography Ball milling. Gas phase condensation. Vacuum deposition. Physical vapour deposition (PVT): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition, Chemical vapour deposition

(CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots.

Unit 4: Characterization: X-Ray Diffraction, Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

Unit 5: Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron devices (no derivation). CNT based transistors. Nonmaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots-magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS)

#### Reference Books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyaya and A.N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
5. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).

#### PARTIAL- D.S.E 111

Time : **3 Hours**

Full Marks : **30**

1. Dielectric Constant of a Non Polar Liquid
2. Dipole Moment of an organic molecule Acetone.
3. Verification of Curie Weiss Law for a ferromagnetic material
4. Temperature Dependence of a Ceramic Capacitor
5. Calibration of Lock-IN Amplifier
6.  $\gamma$  by Flexural Vibration
7.  $n$  by Flexural Vibration
8. Energy Band Gap of Silicon

#### +3 THIRD YEAR SIXTH SEMESTER DSE - IV - PHYSICS

Time : **3 Hours**

Full Mark : **100 Marks**

Credit : **6**

#### PROJECT



# STATISTICS

## +3 FIRST YEAR FIRST SEMESTER CORE COURSE-1 (C-1) DESCRIPTIVE STATISTICS-I & LINEAR ALGEBRA

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****UNIT-I:**

Statistical Methods: Definition & scope of Statistics, concepts of Statistical population and sample, quantitative and qualitative data, attributes, variables. scales of measurement- nominal, ordinal, interval and ratio. Presentation: tabular and graphical including histogram and ogives,

**UNIT- II:**

Measures of Central Tendency: mathematical and positional. Measures of Dispersion: range, quartile deviation, standard deviation, coefficient of variation, Moments, absolute moments, skewness and kurtosis, Shephard's correction.

**UNIT-III**

Permutation & Combination, Binomial Theorem, Logarithmic & Exponential Series, Determinant.

**UNIT-IV**

Matrices: types of matrices(orthogonal matrix and idempotent matrix); operation on matrices (including inverse); partitioned matrices; singular and non-singular matrices.

**UNIT-V**

Rank of a matrix: row-rank and column-rank; properties of rank; rank of sum and product of matrices. Linear equations: homogeneous and non-homogeneous equations. Solution space: consistency and general solution.

**PRACTICAL****CORE COURSE-1 (C-1) LAB-1**Time : **3 Hours**Full Mark : **30 Marks**

1. Calculation of different measures of Central tendency, dispersion, skewness and kurtosis.
2. Calculation of 1st. Four moments from grouped and ungrouped data.

**BOOKS RECOMMENDED:**

1. Intermediate Algebra by Ghanshyam Samal, Vidyapuri Publication, 2007.
2. A text book of matrices by Shanti Narayan, S. Chand, 1962.
3. Fundamentals of Statistics by S.C Gupta, Himalayan Publishing House, 2014
4. Fundamentals of Mathematical Statistics by s.c. Gupta & V.K. Kapoor, Sultan Chand, 2013.

## +3 FIRST YEAR FIRST SEMESTER CORE COURSE- II (C-2) - STATISTICS DESCRIPTIVE STATISTICS-II & CALCULUS

Time : **3 Hours**End Semester Theory : **60 Marks**Full Mark : **75**Mid-Semester : **15 Marks**Credit: **04 + 02****UNIT-I**

Bivariate Data: Scatter diagram, *curve* fitting by the method of least squares (linear and quadratic), fitting of *curves* reducible to polynomials by log and inverse transformation.

**UNIT -II**

Correlation Coefficient: Product moment correlation coefficient and its properties, coefficient of determination, correlation ratio, rank correlation, intra class correlation.

**UNIT-III**

Regression Analysis: Concept of regression, fitting of regression lines, regression coefficients and their properties.

**UNIT-IV**

Function of one variable; limit, continuity and differentiability; *successive* differentiation; mean *value* theorem (statement only); maxima and minima. Function of Several Variables: Partial derivatives, transformations and Jacobians.

**UNIT-V**

Integral Calculus: Review of Integration and definite integral, differentiation under Integral sign and integration by parts.

**PRACTICAL**  
**CORE COURSE-2 (C-2) LAB-2**

Time : 3 Hours

End Semester : 25 Marks

1. Fitting of 1st., 2nd. degree polynomial and exponential *curve*.
2. Calculation of simple correlation coefficient, regression lines, rank correlation coefficient.

**BOOKS RECOMMENDED:**

1. Differential calculus by Das & Mukherjee, U.N Dhar Publication, Kolkatta, 2010.
2. Integral Calculus by Das & Mukherjee, U.N Dhar, Kolkatta, 2010.
3. Fundamentals of Statistics by S.C Gupta, Himalayan Publishing House, 2014
4. Fundamentals of Mathematical Statistics by S.c. Gupta & V.K. Kapoor, Sultan Chand,2013.
5. Statistical Methods by P.N. Arora, S. Arora & S. Arora, S. Chand, 2014.

**+3 FIRST YEAR SECOND SEMESTER**  
**CORE COURSE- III (C-3) - STATISTICS**  
**PROBABILITY - I & NUMERICAL ANALYSIS**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

**UNIT-I**

Random experiment: trials, sample point and samples space, event, operations of events, concepts of mutually exclusive and exhaustive events. Definition of Probability: Classical, relative frequency and axiomatic approach; discrete and continuous probability space, addition law of probability.

**UNIT-II**

Multiplication law of probability, conditional probability and independence of events, Bayes' theorem and its applications.

**UNIT-III**

Difference table. Methods of interpolation: Newton's forward and backward interpolation formulae. Newton's divided difference formula.

**UNIT-IV**

Lagrange's interpolation formulae, inverse interpolation, central difference formula ..

**UNIT-V**

Numerical differentiation and integration: Trapezoidal, Simpson's one-third, three-eighth rules.

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**PRACTICAL**  
**CORE COURSE-3 (C-3) LAB-3**

Time : 3 Hours

Full Mark : 30 Marks

1. Interpolation with equal intervals, unequal intervals using Lagrange's and Newton's formula.
2. Problems on central difference formula
3. Problems on numerical differentiation and integration.

**BOOKS RECOMMENDED:**

1. Fundamentals of Mathematical Statistics by s.c. Gupta & V.K Kapoor, Sultan Chand, 2012.
2. An Outline of Statistical Theory, Vol-I, Gun, Gupta & Dasgupta, 4th Edn., World Press, 2003.
3. Numerical Methods by P.Kandasamy, K Thilagavathy & KGunavathi, S. Chand, 2012.
4. Numerical Methods & Applications by E. Ward Cheney & David R. Kincaid, Cengage Publication, 2010.
5. Numerical Analysis by Goel and Mittal, Pragati Prakashan, NO, 2008.

**+3 FIRST YEAR SECOND SEMESTER**  
**CORE COURSE- IV (C-4) - STATISTICS**  
**PROBABILITY - II & DESCRIPTIVE STATISTICS - III**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

**UNIT-I**

Random variables: Definition, properties, probability mass function, probability density function; distribution function, joint, marginal and conditional distributions.

**UNIT- II**

Mathematical expectation of a random variable and its properties, moment generating function, cumulant generating function and probability generating function.

**UNIT-III**

Characteristic function (simple applications), *convergence* in probability, *convergence* in distribution. Hally-Bray theorem and its application.

**UNIT-IV**

Multivariate Data: Multiple and Partial correlations and plane of regression (three variables only).

**UNIT-V**

Analysis of categorical Data: Consistency of categorical data, independence and association of attributes.

**PRACTICAL**  
**CORE COURSE-4 (C-4) LAB-4**

Time : 3 Hours

Full Mark : 30 Marks

1. Problems on multiple and partial correlation and regression
2. Problems on theory of attributes (consistency, coefficient of association), Independence of attributes.

**BOOKS RECOMMENDED:**

1. Fundamentals of Mathematical Statistics by s.c. Gupta & V.K. Kapoor, Sultan Chand, 2012.
2. Mathematical Statistics by J.N. Kapoor & H.C. Saxena, S. Chand, 2011.
3. An Outline of Statistical Theory, Vol-I, Gun, Gupta & Dasgupta, 4th Edn., World Press, 2003.



**+3 SECON YEAR THIRD SEMESTER  
CORE - 5 - STATISTICS  
PROBABILITY DISTRIBUTIONS**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****UNIT-I**

Discrete probability distributions: Uniform, Bernoulli, Binomial, Poisson, Negative Binomial.

**UNIT-II**

Continuous probability distributions: Uniform, Normal, Beta, Gamma.

**UNIT-III**

Exact sampling distributions: Chi-square, Students 't' and Snedecor's 'F'.

**UNIT-IV**

Weak law of large numbers: Bernoulli's WLLN, Chebyshev's inequality, Chebychev's WLLN, Poisson's WLLN and applications.

**UNIT-V**

Strong Law of large numbers, Kolmogorov's SLLN (Statement only). Central limit theorem, Lindeberg-Levy theorem and applications.

**PRACTICAL****C - 5**Time : **3 Hours**Full Markl : **30 Marks**

1. Fitting of Binomial, Poisson, Fitting of normal distribution.

**BOOKS RECOMMENDED:**

1. Fundamentals of Mathematical Statistics by s.c. Gupta & V.K. Kapoor, Sultan Chand, 2013.
2. An Outline of Statistical Theory, Vol-I, Gun, Gupta & Dasgupta, 4th Edn., World Press, 2003.

**+3 SECOND YEAR THIRD SEMESTER  
CORE - 6 - STATISTICS  
SAMPLING DISTRIBUTION & BASICS OF COMPUTER**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****UNIT-I**

Concept of population, sample, parameter, statistic and sampling distribution; standard error of moments, distribution of sample mean and variance from normal distribution.

**UNIT-II**

Tests of significance based on large sample: the normal test of significance (Z-test) for both one-sample and two-sample problems.

**UNIT-III**Tests of significance based on exact sampling distributions, i.e.  $X^2$ , t and F distributions.**UNIT-IV**

Introduction of world of computer, The system unit: Processing &amp; Memory- System Unit, CPU, Storage-Storage Systems: Magnetic and Optical Disks, Input and Output, Key board, Pointing Devices, Scanners,

Audio Inputs & Output, Display Devices. Operating Systems: Desktop, PC, Servers and Other Devices.

#### UNIT-V

Application Software: Concept of Word Processing, Use of MS-Word, Basics of Word Processing, Printing of Documents,

#### PRACTICAL

##### C - 6

Time : **3 Hours**

Full Mark : 30 Marks

1. Tests of significance based on Normal distribution, Chi-square, t, F distribution.

#### **BOOKS RECOMMENDED:**

1. Fundamentals of Mathematical Statistics by S.C: Gupta & V.K. Kapoor, Sultan Chand, 2013.
2. Statistical Methods:- P.N. Arora, S. Arora & S. Arora, S. Chand, 2014.
3. Statistical methods by S.P. Gupta, Himalayan Publication, Mumbai, 2013.
4. Fundamentals of Computers by Morles & Parker, Cengage publication, 2013.
5. Computer Fundamentals and office by Sanjay Saxena and Rajneesh Agrawal, Vik s publication, 2014.

### **+3 SECOND YEAR THIRD SEMESTER**

#### **CORE - 7 - STATISTICS**

#### **THEORY OF ESTIMATION**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

#### UNIT-I

Point Estimation: Introduction, Properties of Estimator: unbiasedness, consistency, efficiency and sufficiency.

#### UNIT-II

Minimum Variance Unbiased Estimation, Rao-Cramer inequality, Rao-Blackwell theorem and applications.

#### UNIT-III

Methods of Estimation: Method of maximum likelihood, properties of MLE.

#### UNIT-IV

Interval Estimation: Concepts of confidence interval and confidence coefficient, confidence intervals for the parameters of univariate normal distribution.

#### UNIT-V

Theory of linear estimation, concept of Gauss Markov linear model, Estimation of parameters in linear models.

#### PRACTICAL

##### C - 7

Time : **3 Hours**

Full Mark : 30 Marks

1. Estimation of parameters in linear models.
2. Estimation of MLE

#### **BOOKS RECOMMENDED:**

1. Fundamentals of Mathematical Statistics by s.c. Gupta & V.K. Kapoor, Sultan Chand, 2012.
2. An Outline of Statistical theory (Vol-II) Goon, Gupta and Dasgupta, World Press, 2007.
3. Fundamentals of applied Statistics - s.c. Gupta and V.K. Kapoor, Sultan Chand, 2013

## **+3 SECOND YEAR THIRD SEMESTER GE - 3 - STATISTICS**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks**

### **UNIT-I**

Ideas about types of data, Collection, Classification of data. Frequency distributions : graphic and diagrammatic representation of data.

### **UNIT-II**

Analysis of Quantitative Data : Univariate data - Concepts of central tendency, dispersion and relative dispersion, skewness and Kurtosis and their measures including those based on quantiles and moments.

### **UNIT-III**

Bivariate Data : Curve fitting by the method of least squares (Linear). Scatter diagram, product moment correlation coefficient and its properties, rank correlation, linear regression.

Analysis of categorical Data : Consistency, independence and association of attributes.

### **UNIT-IV**

Random Experiment : trial, sample point, sample space, event, its operation mutually exclusive and exhaustive events, axiomatic approach, conditional probability, independence of events, Laws of probability.

### **UNIT-V**

Random Variables : Definition, probability mass function (pmf), probability density function (pdf), distribution function, joint marginal and conditional (definition). Expectation of a random variable. Idea about Binomial, Poisson and normal distribution.

### **Books Recommended :**

1. Fundamentals of statistics by S. C. Gupta, Himalayan Publishing House.
2. Fundamentals of Mathematical Statistics by S. C. Gupta & V. K. Kapoor, Sultan Chand.

## **PRACTICAL**

### **GE - 3**

Time : **3 Hours**

Full Mark : 30 Marks

1. Computation of different measures of central tendency & dispersion.
2. Curve fitting by least squares method
3. Computation of Correlation Coefficient.
4. Computation of rank Correlation
5. Fitting of Regression lines.

## **+3 SECOND YEAR FOURTH SEMESTER CORE - 8 - STATISTICS TESTING OF HYPOTHESIS**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks**

### **UNIT-I**

Statistical Hypotheses: Simple and composite, statistical tests, critical region, type-I and type-II error, size and power of a test, definition of Most powerful (MP), Uniformly Most Powerful (UMP) and Uniformly

Most Powerful Unbiased (UMPU) tests.

#### UNIT-II

Neyman-Pearson lemma and its applications in testing of hypothesis based on Binomial, Poisson and Normal distributions.

#### UNIT-III

Tests of composite hypothesis: likelihood ratio test and problems based on LR test.

#### UNIT-IV

Non-parametric inference: Introduction, ordinary sign test, paired-sample sign test. Wilcoxon signed-rank test. Wilcoxon paired sample sign ranked test..

#### UNIT-V

Non-parametric inferences: Wald-Wolfowitz runs test, U statistic, Mann-Whitney U-test.

### PRACTICAL

C - 8

Time : **3 Hours**

Full Mark : 30 Marks

1. Problems on Sign Test (One sample and paired sample) Run test. Mann -whitney U test

#### **BOOKS RECOMMENDED:**

1. Fundamentals of Mathematical Statistics by S.c.. Gupta & V.K. Kapoor, Sultan Chand, 2012.
2. Outline of Statistical theory (Vol-II) Goon, Gupta and Dasgupta, World Press, 2008.
3. Statistical Inference: Testing of Hypothesis by Srivastava & Srivastava, Oscar,2009.

## **+3 SECOND YEAR FOURTH SEMESTER CORE - 9 - STATISTICS SAMPLING THEORY**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

#### UNIT-I

Population and sample, sampling versus census, steps involved in sample surveys, principles of sample survey,

#### UNIT-II

Sampling and non-sampling errors. Simple Random Sampling: Drawing of random sample by different methods, SRSWR & SRSWOR, estimation of mean and variance.

#### UNIT-III

Stratified Random Sampling: Advantages & disadvantages, uses, allocation of sample sizes into various strata: proportional and optimum, estimation of mean and variance.

#### UNIT-IV

Systematic sampling: Advantages and disadvantages, uses, drawing of systematic samples, estimation of mean and variance. systematic sampling versus stratified random sampling, systematic sampling when the population consists of a linear trend.

#### UNIT-V

Ratio, product and regression methods of estimation, estimation of mean and variance, comparison of efficiencies.

**PRACTICAL****C - 9**Time : **3 Hours**

Full Mark : 30 Marks

1. Problems on SRS, Stratified R.S, systemic sampling

**BOOKS RECOMMENDED:**

1. Fundamentals of Applied Statistics-S.C. Gupta and V.K. Kapoor, Sultan Chand, 2013.
2. Sampling Techniques - W.G. Cochran, Wiley & Sons, 2007.
3. Sampling Theory of Survey with Applications by P.V. Sukhatme, B.V. Sukhatme,
- S. Sukhatme and C.Asok, ISAS, New Delhi, 1984.

**+3 SECOND YEAR FOURTH SEMESTER  
CORE - 10 - STATISTICS  
INDEX NUMBER & LINEAR PROGRAMMING**

Time : **3 Hours**End Semester Theory : **60** MarksFull Mark : **75**Mid-Semester : **15** Marks

Credit : 04 + 02

**UNIT-I**

Index numbers: Introduction, Base year and current year, price relatives and quantity relatives. Problems involved in construction of index number.

**UNIT-II**

Unweighted and weighted index number, Laspayer's, Paasche's Drobish- Browley.Fisher's ideal index number

**UNIT-III**

Criteria of good index number: Unit, Time Reversal, Factor Reversal & Circular tests, cost of living index number, its construction: Aggregate Expenditure & Family Budget method and uses.

**UNIT-IV**

Introduction, definition, scope of Operations Research, phases of Operations Research, models of Operations Research, Elementary idea about Linear programming, and its formulation.

**UNIT-V**

Pocedure of solving LPP by graphical method, Definition of Feasible solution, basic feasible solution, Slack and surplus & artificial variables.

**PRACTICAL****C - 10**Time : **3 Hours**

Full Mark : 30 Marks

1. Computation of index number by Laspere's.Paasche's Drobish-Browley.Fisher's Formula
2. Time reversal Tests consumer price index number,
- 3 LPP by Graphical method.

**BOOKS RECOMMENDED:**

1. Operations Research by S.Kalavathy, Vikas, 2009.
2. Introduction to Operations Research by Prem Kumar Gupta, D.S. Hira and Aarti Karnboj, S.Chand and Company, 2012.
3. Operations Research by Anand Sharma, Himalayan Publishing House, 2014.
4. Operations Research by P.K Tripathy, Kalyani Publications, 1997

## +3 SECOND YEAR FOURTH SEMESTER GE - 4 - STATISTICS

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****(A) Sampling Techniques****UNIT-I**

Population, Sample, Sampling Unit, basic principles of sample surveys, sample survey verses complete enumeration, steps in large scale sample surveys, sampling and non-sampling errors.(Definition only)

**UNIT-II**

Methods of sampling : Random numbers tables, simple random sampling with and without replacement, stratified random sampling, systematic sampling, estimation of population mean with standard errors.

**B. Time Series****UNIT-III**

Components of Time series, methos of measurement of trend : least squares method (linear) moving average method.

**C. Vital Statistics****UNIT-IV**

Method of obtaining vital statistics, rates and ratio of vital events, measurement of mortality and fertility : construction and uses of life table.

**D. Sampling Distributions and Tests of Signification****UNIT-V**

Large sample theory and small sample theory. Test of signification based on Z, chi-square and t.

**Books Recommended :**

1. Goon A. M., Gupta M. K., Das Gupta B. (1991) : Fundamentals of statistics, Vol-I, World Press, Calcutta.
2. Gupta S. C., Kapoor V. K. (1994) : Fundamentals of applied statistics, Sultan Chand and Sons, Educationl Publishers, New Delhi.
3. Gupta S. C., Kapoor V. K. (2002) : Fundamentals of Mathematical Statistics, Sultan Chands and Sons, Educational Publishers, New Delhi.
4. Fundamentals of Statistics (Vol.II) - Goon, Gupta and Dasgupta

**PRACTICAL****GE - 4**Time : **3 Hours**Full Mark : **30 Marks**

1. Time Series - Measurement of trend
2. Construction of Life Table
3. Tests of Significance based on Normal, t and  $\chi^2$  distributions.

## +3 THIRD YEAR FIFTH SEMESTER CORE - 11 - STATISTICS

### STATISTICAL QUALITY CONTROL & OFFICIAL STATISTICS

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****UNIT-I**

Meaning and uses of Statistical Quality control(SQC), Process and product control, chance and assignable causes of variation, 3- sigma control limits X and R charts.



**UNIT-II**

Control chart for attributes, control chart for Standard Deviation, p-chart, d- chart and their interpretation.

**UNIT-III**

Natural tolerance limit and specification limit, acceptance sampling by attributes, AQL, LTPD, AOQL & ASN consumer's risk and producer's risk, O.C. curve. Idea about single and double sampling plans.

**UNIT-IV**

Present official Statistical System in India. Methods of collection of official statistics, their reliability and limitations.

**UNIT-V**

Central Statistical organisation-CSO & NSSO: their functions and publications. State Statistical Organisations: functions and publications. Idea about population statistics, Agricultural, Yield and Area statistics

**PRACTICAL****C - 11**Time : **3 Hours**

Full Mark : 30 Marks

1. Computation of x- Chart and R Chart
2. Computation of p- Chart

**BOOKS RECOMMENDED:**

1. Fundamentals of applied Statistics - S.c. Gupta and V.K. Kapoor, Sultan Chand, 2013.
2. Fundamentals of Statistics (Vol-H)-Goon, Gupta and Dasgupta, World Press, 2007.
3. Indian Official Statistical System: M.R. Saluja, Publication Society, 2006

**+3 THIRD YEAR FIFTH SEMESTER  
CORE - 12 - STATISTICS  
VITAL STATISTICS**Time : **3 Hours**End Semester Theory : **60 Marks**Full Mark : **75**Mid-Semester : **15 Marks**

Credit : 04 + 02

**UNIT-I**

Introduction to Vital Statistics, Different Vital events, rates and ratio of vital events. Vital Statistics in the study of population trend, Uses of Vital statistics.

**UNIT-II**

Population Census: Methods of census, salient features, its uses and problems, registration method, sample surveys, sources of demographic data.

**UNIT-III**

Measurement of mortality: Crude death rate, age-specific death rates, IMR, standardized death rate, Direct and indirect method of standardisation and uses.

**UNIT-IV**

Mortality table or Life table, its uses, columns of life table, assumptions, and construction of life table, Abridged life table ( Reed Merell),

**UNIT-V**

Measurement of fertility: crude birth rate, general fertility rate, age-specific birth rate, total fertility rate, gross reproduction rate, net reproduction rate.

**PRACTICAL****C - 12**Time : **3 Hours**

Full Mark : 30 Marks

1. Calculation of different measures of mortality and fertility.
2. Construction of Life table

**BOOKS RECOMMENDED:**

1. Fundamentals of Applied Statistics, S.c. Gupta & V.K. Kapoor, Sultan Chand, 2012.
2. Indian Official Statistical System: M.R. Saluja, Publication Society, 2006
3. Statistical System in India: Asthna & Srivastav, S. Chand, 2009.

**+3 THIRD YEAR SIXTH SEMESTER  
CORE - 13 - STATISTICS  
DESIGN OF EXPERIMENTS**

Time : **3 Hours**End Semester Theory : **50** MarksCredit: **6**Mid-Semester : **20** Marks**UNIT-I**

Design of Experiments: Introduction, Experimental units and errors. Efficiency of a design. Basic principles of a design. Randomisation, Replication and local control.

**UNIT-II**

Completely Randomised Design, Layout and complete analysis of CRD. Advantages and uses.

**UNIT-III**

Randomised Block Design, Layout and complete analysis, Missing plot technique in RBD With analysis. Efficiency of RBD, with respect to CRD. Advantages and uses

**UNIT-IV**

Latin square Design, and its analysis Estimation of missing value in LSD and analysis. Comparison of efficiency with RBD and CRD

**UNIT-V**

Factorial Experiments: Introduction, main and interaction effects, Yate's method of computing factorial effect totals. Analysis of  $2^2$  and  $2^3$  factorial design.

**PRACTICAL****C - 13**Time : **3 Hours**

Full Mark : 30 Marks

1. Analysis of CRD, RBD and LSD
2. One Missing plot technique in RBD, LSD with analysis.
3. Analysis of  $2^2$  and  $2^3$  factorial experiments.

**BOOKS RECOMMENDED:**

1. Fundamentals of applied Statistics - s.c. Gupta and V.K. Kapoor, Sultan Chand, 2012
2. Design and Analysis of Experiments by Das and Giri, Wiley Eastern, NO, 200
3. Fundamentals of Statistics (Vol-H)-Goon, Gupta and Dasgupta, World Press, 2007.

**+3 THIRD YEAR SIXTH SEMESTER  
CORE - 14 - STATISTICS  
STATISTICS FOR PUBLIC POLICY**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****UNIT-I**

Descriptive Statistics: What is Statistics all about? Presentation of Data, Summarizing Data in Descriptive Statistics.

**UNIT-II**

Basic probability and Probability Distributions: Theory and applications, Sampling and the Normal Distribution, The Central Limit Theorem.

**UNIT-III**

Hypothesis Testing: Introduction to Inferential Statistics, Estimating Means, Proportions and Sample size with Confidence, Validating a Hypothesis about a Population Mean using a sample. Validating a Hypothesis between two population means, Validating a Hypothesis about a single Population proportion, validating Hypothesis about two population proportions.

**UNIT-IV**

Measures of Association: Comparing more than two population means with ANOVA, Measures of Consistency and independence of data with reference to attributes.

**UNIT-V**

Fitting of Curves by principle of Least square. Determining relationships for two variables using correlation. Measuring Relationship with Simple regression Analysis.

**PRACTICAL****C - 14**Time : **3 Hours**

Full Mark : 30 Marks

1. Problems on measures of Association, Consistency and Independence of
2. Computation and interpretation of Correlation & Regression Coefficients

Attributes. .

**BOOKS RECOMMENDED:**

1. Applied Statistics for Public Policy: Brian P. Macfie and Philip M. Nufrio, PHI
2. Fundamentals of Mathematical Statistics by s.c. Gupta & V.K. Kapoor, Sultan Chand, 2014.

**+3 THIRD YEAR FIFTH SEMESTER  
DSE - 1 - STATISTICS  
TIME SERIES ANALYSIS**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****UNIT-I**

Time Series: Introduction to time series data and application in various fields, Components of time series, Methods of measuring trend: graphic, semi-average, moving average and curve fitting by least squares.

**UNIT-II**

Growth curves: Fitting of modified exponential and Gompertz curve.

**UNIT-III**

Measurement oftrend: Moving average method by fitting Polynomials of  $t = 0$  to  $t = m$  degree to 'm' terms, Iterated averages and **Spencer's** 15- point and 21- point formula.

**UNIT-IV**

Measurement of seasonal fluctuations: Simple average, Ratio-to-trend, Ratio-to-moving average & Link relatives method.

**UNIT-V**

Measurement Cyclic component: Harmonic analysis. Measurement of irregular variation (variate difference method).

**PRACTICAL****DSE - I**

Time : **3 Hours**

Full Mark : 30 Marks

1. Measurement of Trend and seasonal fluctuations
2. Problems on Spencer's 15- point and 21- point formula.

**BOOKSRECOMMENDED:**

1. Fundamentals of Applied Statistics by S.c. Gupta & V.K. Kapoor, Sultan Chand, 2012.
2. Fundamentals of Statistics, Voll-II, Gun, Gupta & Dasgupta, World Press, 2007.

**+3 THIRD YEAR FIFTH SEMESTER****DSE - 2 - STATISTICS  
POPULATION STUDIES**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

**UNIT-I**

Measures of Population Change and Distribution: Introduction, rate of population change, doubling time for a population; population distribution: Population density, percentage distribution by rural-urban category, Lorentz curve and Gini concentration ratio.

**UNIT-II**

Analysis of Age Distribution: Percent distribution and percent change in distribution, index of relative difference and dissimilarity; Graphic representation of age data: Population pyramid, Measurement of ageing.

**UNIT-III**

Quality of Population Data: Introduction, Whipple's Index, Myer's Blended Index, UN Joint Index.

**UNIT-IV**

The Malthusian Theory of Population: The theory, criticisms, applicability, Neo-Malthusian theory. Optimum Theory of Population: Introduction, definition, assumptions, the theory, its superiority over the Malthusian theory its criticisms. Karl Marx's Theory of surplus population; Introduction, definition, its criticisms.

**UNIT-V**

Theory of Demographic Transition: Introduction, explanation, its criticisms. Nature of information collected in 1971, 1981, 1991 and 2001 census in 'India. National Family Health Survey's (NFHS-1 & NFHS-2) and Household Economic Behaviour.

**PRACTICAL****DSE - 2**

Time : **3 Hours**

Full Mark : 30 Marks

1. Construction of Lorentz curve and Gini concentration ratio.
2. Construction of population pyramid.
3. Computation of Whipple's index and Myre's Blended index.

**BOOKS RECOMMENDED:**

1. Techniques of Demographic Analysis By K.B. Pathak and F.Ram, Himalaya Publishing House, 2013.
2. Basic Demographic Techniques and Application By K. Srinivasan, Sage Publication.
3. Principles of Population Studies - A. A. Bhende & T. Kantikar, Himalayan Publication
4. Population Studies- B.D. Mishra

**+3 THIRD YEAR SIXTH SEMESTER  
DSE - 3 - STATISTICS  
OPERATIONS RESEARCH**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****UNIT-I**

Solution to Linear Programming Problems by simplex method, Big M-Method, Two- phase simplex method.

**UNIT-II**

Duality: Introduction, formulation, determination of dual, Primal to dual and vice-versa.

**UNIT-III**

Transportation Problems: Introduction and mathematical formulation definition of important terms initial basic feasible solution by north-west corner rule, least cost method and Vogel's approximation method.

**UNIT-IV**

Networking: Introduction, basic terms, rules of network construction, numbering the events, forward pass and backward pass computations. Critical Path Method(CPM), Floats & Slacks.

**UNIT-V**

Simulation; Types of simulation generation of random numbers by mid-square and congruential methods, Monte-Carlo simulation.

**PRACTICAL****DSE - 3**Time : **3 Hours**Full Mark : **30 Marks**

1. Solution of LPP by simplex method, Big-M Method and two-phase method.
2. Finding out dual from primal and vice-versa.
3. Computation of initial basic feasible solution to a transportation problem by north-west corner rule, least cost and Vogel's approximation method.

**BOOKS RECOMMENDED:**

1. Operations Research By S.Kalavathy, Vikas Publication, 2013.
2. Operations Research By Pradip Kumar Tripathy, Kalyani Publisher, 2013.
3. Operations Research By Prem Kumar Gupta and D.S. Hira, S. Chand, 2014.

**+3 THIRD YEAR SIXTH SEMESTER  
DSE - 4 - STATISTICS**

Time : **3 Hours**Full Mark : **100 Marks****PROJECT REPORT**

**ZOOLOGY**  
**+3 FIRST YEAR FIRST SEMESTER**  
**CORE COURSE - I (C-1)**  
**DIVERSITY AND EVOLUTION OF NON-CHORDATA**  
**(PROTISTA TO PSEUDOCOELOMATES)**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

**Unit-1**

General characteristics and classification up to classes: Life cycle, pathogenicity and prophylaxis of *Plasmodium vivax*, *Trypanosoma gambiense* and *Entamoeba histolytica*: Locomotion and reproduction in Protozoa; Evolution of Parazoa and Metazoa.

**Unit 2:****Phylum Porifera and Ctenophora**

General characteristics and classification up to classes: Canal system in sponges: General characteristics and evolutionary significance of Ctenophora .

**Unit 3:****Phylum Cnidaria**

General characteristics and classification up to classes; Metagenesis in *Obelia*: Polymorphism in Cnidaria: Corals and coral reefs.

**Unit 4:****Phylum Platyhelminthes**

General characteristics and classification up to classes: Life cycle, pathogenicity and prophylaxis of *Fasciola hepatica* and *Taenia solium*: Parasitic adaptations.

**Unit 5:****Phylum Nemathelminthes**

General characteristics and classification up to classes: Life cycle, pathogenicity and prophylaxis of *Ascaris lumbricoides* and *Wuchereria bancrofti*; Parasitic adaptations.

**PRACTICAL**  
**CORE COURSE-1 (C-1) LAB-1**

Time : 3 Hours

Full Mark : 30 Marks

**Protozoa :**

1. Morphology of *Paramecium*. Binary fission and Conjugation in *Paramecium*.
2. Life stages of *Plasmodium vivax*, *Trypanosoma gambiense* and *Entamoeba histolytica* (Slides/Micro-photographs).
3. Examination of pond water for protists.

**Porifera :**

4. Study of *Sycon* (including T.S. and L.S.). *Hyalonema* and *Euplectella*.
5. Temporary mounts of spicules, gemmules and spongin fibres.

**Cnidaria :**

6. Study of *Obelia*, *Physalia*, *Millepora*, *Aurelia*, Ephyra larva. *Tubipora*, *Corallium*. *Alcyonium*. *Gorgonia* and *Metridium* (including T.S. and L.S.).



**Ctenophora :**

7. Any one specimen/slide.

**Platyhelminthes :**

8. Study of adult *Fasciola hepatica*, *Taenia solium* and their life stages (Slides/ microphotographs).

**Nemathelminthes :**

9. Study of adult *Ascaris lumbricoides*, *Wuchereria bancrofti* and their life stages (Slides/ microphotographs).

**SUGGESTED READINGS**

1. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House, New Delhi.
2. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House, New Delhi.
3. Barnes RD (1982) Invertebrate Zoology. 6th Edition. Holt Saunders International Edition.
4. Barnes RSK, Calow P. Olive PJW. Golding DW & Spicer JI (2002) The Invertebrates: A New Synthesis. 3rd Edition. Blackwell Science. USA.
5. Barrington EJW (1979) Invertebrate Structure and Functions. 2nd Edition. ELBS and Nelson.
6. Boradale LA and Potts EA (1961) Invertebrates: A Manual for the use of Students. Asia Publishing Home.
7. Jordan EL and Verma PS (1963) Invertebrate Zoology. Revised Edition. S. Chand. New Delhi.
8. Invertebrate zoology - R. L. Kotpal
9. Invertebrate phyla (series)- R. L. Kotpal
10. Invertebrate zoology V.B Rastogi
11. Parasitology (medical zoology) - H. S Singh & P. Rastogi
12. Zoology for degree students-V. K. Agarwal

**+3 FIRST YEAR FIRST SEMESTER  
CORE COURSE - II (C-2) - ZOOLOGY  
PERSPECTIVES IN ECOLOGY**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

**Unit 1: Introduction to Ecology**

Relevance of studying ecology: History of ecology; Autecology and synecology; Levels of organization: Laws of limiting factors: Detailed study of temperature and light as physical factors.

**Unit 2: Population**

Unitary and modular populations; Unique and group 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: dominance, diversity, species richness, abundance, stratification; Ecotone and edge effect: Ecosystem development (succession) with example and Theories pertaining to climax community.

**Unit 4: Ecosystem**

Types of ecosystem; Food chain. Detritus and grazing food chains, Linear and Y-shaped food chains; Food web; Energy flow through the ecosystem; Ecological pyramids and Ecological efficiencies; Nutrient and biogeochemical cycle, Nitrogen cycle and Sulphur cycle.

Conservation of Biodiversity

Types of biodiversity, its significance, loss of biodiversity: Conservation strategies (in situ and ex situ); Role of ZSI. WWF, IUCN: Wildlife (Protection) Act. 1972.

**Unit 5: Biostatistics**

Definition, concept of sample and population, frequency distribution graphical representation of data (Frequency Polygon and Histogram) concept of central tendency- mean, median, mode, standard deviation, Standard error, test of significance, t-test and chi-square test.

**PRACTICAL****CORE COURSE-2 (C-2) LAB-2**

Time : 3 Hours

Full Mark : 30 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 quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: fauna and flora Measurement of area, temperature, turbidity/penetration of light, determination of pH. and Dissolved Oxygen content (Winkler's method). Chemical Oxygen Demand and free CO<sub>2</sub>.
4. Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary.

**SUGGESTED READINGS**

1. Colinvaux PA (1993) *Ecology*. II Edition. John Wiley and Sons. Inc.. USA.
2. Dash MC (1993) *Fundamentals of Ecology*. McGraw Hill Book Company, New Delhi.
3. Joshi N and Joshi PC (2012) *Ecology and Environment*. 1st Edition. Himalaya Publishing House. New Delhi.
4. Odum EP (2008) *Fundamentals of Ecology*. Indian Edition. Brooks/Cole.
5. Ricklefs. R.E., (2000). *Ecology*. 5th Edition. Chiron Press.
6. Robert Leo Smith *Ecology and field biology* Harper and Row.
7. Singh. JS, Gupta SR and Singh SP (2014) *Ecology, Environmental Science and Conservation*. S. Chand. New Delhi.
8. A text book of ecology - S. K. Dubey
9. Ecology and environment - P. D. Sharma
10. Ecology - M. P. Arora
11. Biodiversity conservation - S. Biswas
12. Understanding wild life - Rajeev Tyagi
13. Environmental biology - P. S. Verma. V. K. Agarwal

**+3 FIRST YEAR FIRST SEMESTER**  
**GE - I - ZOOLOGY**  
**NON-CHORDATES, PHYSIOLOGY AND ENDOCRINOLOGY**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

**General characters & classification of the Phyla up to Classes and study of types mentioned.**

**Unit -1**

**Protozoa:** Paramecium with reference to structure & reproduction.

**Porifera:** Sycon with reference to structure & canal system.

**Cnidaria:** Aurelia with reference to structure, reproduction and life cycle.

**Unit- II**

**Platyhelminthes:** Fasciola with reference to structure, reproduction & lifecycle.

**Nemathelminthes:** Ascaris with reference to structure, reproduction and life cycle.

**Annelida:** Leech with reference to structure, digestion & excretion.

**Unit- III**

**Arthropoda:** Prawn with reference to external morphology, digestion & respiration.

**Mollusca:** Pila with reference to structure, respiration

**Echinodermata:** Asterias- External morphology, water vascular system.

**Unit- IV**

**Physiology:** Elementary knowledge of mammalian physiology with reference to Digestion and absorption of food, Respiration- Breathing, Transport of respiratory gases. Blood-Composition, Function, Blood Clotting, Blood Group.

**Unit-V**

**Endocrinology:** General organization of mammalian Endocrine system (Names of Endocrine Glands, their location in body, Names of their hormones and brief idea about Other function)

General idea about the structure and function of the following endocrine organs in Mammals :- Pituitary, Thyroid

**BOOKS RECOMMENDED:**

01. Invertebrate zoology R.L. Kotpal
  02. Invertebrate Zoology- Jordan and Verma
  03. Invertebrate Zoology- V.B. Rastogi
  04. Invertebrate Zoology- P.C. Majpuria
  05. Zoology For Degree Students - V.K. Agarwal
  06. Animal Physiology (2 vol.)- D.Khemka
  07. Human Physiology (2 vol)- C.C. Chatterjee
  08. A Text Book of Medical Physiology- Guyton/Hall
  09. A Text Book of Physiology and Functional Histology- A.K. Berry
  10. Animal Physiology- Goyal and Sastry
  11. Animal Physiology-M.P. Arora
  12. Text Book of Endocrinology- P.R. Yadav
  13. Vertebrate Endocrinology- D.O. Norris
-

**General Elective Practical - I (GE-1-Lab-1)**  
**NON-CHORDATES & PHYSIOLOGY**

Time : 3 Hours

Full Mark : 30 Marks,

**Experiment (Physiology):**

Estimation of haemoglobin concentration in man, Quantitative estimation of casein in milk, Estimation of lipid content of Liver.

**Spotting:** Museum Specimen and Slides, 05 spots are to be set in the examination**Museum Specimens:** Porifera : Spongilla, Sycon

Coelenterata : Gorgonia, Physalia, Porpita, Penatulla.

Annelida : Nereis, Heteronereis, Aphrodite.

Arthropoda : Kingcrab, Sacculina, Eupagurus

Mollusca : Chiton, Aplysia, Octopus, Nautilus

Echinodermata : Starfish, Antedon, Sea-Urchin, Sea Cucumber.

**Slides :** Related to Syllabus

**+3 FIRST YEAR SECOND SEMESTER**  
**CORE COURSE - III (C-3) - ZOOLOGY**  
**DIVERSITY AND EVOLUTION OF NON-CHORDATA (COELOMATE**  
**NONCHORDATES)**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

**Unit 1: Phylum Annelida**

General characteristics and classification up to classes; tivolution of Coelom: Metamerism and Excretion in Annelida.

**Unit 2: Phylum Arthropoda I**

General characteristics and classification up to classes; Vision in Arthropoda: Respiration in Arthropoda; Moulting in insects. Metamorphosis in insects

**Unit 3: Phylum Arthropoda II & Onychophora**

Social life in insects (bees and termites) and Larval forms in Crustacea General characteristics, evolutionary significance and affinities of Peripatus.

**Unit 4: Phylum Mollusca**

General characteristics and classification up to classes; Respiration in Mollusca: Torsion and detorsion in Gastropoda; Pearl formation in bivalves and Evolutionary significance of trochophore larva.

**Unit 5: Phylum Echinodermata**

General characteristics and classification up to classes: Water-vascular system in Asteroidea; Larval forms in Echinodermata and Evolutionary significance (Affinities with Chordates).

**PRACTICAL**  
**CORE COURSE-3 (C-3) LAB-3**

Time : 3 Hours

Full Mark : 30Marks

**Annelida :**

1. Study of *Aphrodite*, *Nereis*, *Heteronereis*, *Sabella*, *Terebella*, *Serpula*, *Chaetopterus*, *Pheretima* and *Hirudinaria*.

2. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm.
3. T.S. through crop of leech.

**Arthropoda :**

4. Study of *Limulus*, *Palaemon*, *Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, termite, louse, honeybee, silk moth, wasp and dragon fly.

**Onychophora :**

5. Any one specimen/slide.

**Mollusca :**

6. Study of *Chiton*, *Dentalium*, *Pila*, *Doris*, *Helix*, *Unio*, *Ostrea*, *Mytilus*, *Loligo*, *Sepia*, *Octopus* and *Nautilus* and *Cypraea* (cowrie).

**Echinodermata :**

7. Study of echinoderm larvae.
8. Study of *Pentaceros*, *Asterias*, *Ophiura*, *Clypeaster*, *Echinus*, *Echinoearclium*, *Cucumaria* and *Antedon*.

**SUGGESTED READINGS**

1. Arora MP (2006) Non-Chordata-I. 1st edition. Himalaya Publishing House. New Delhi.
2. Arora MP (2008) Non-Chordata-II. 1st edition. Himalaya Publishing House. New Delhi.
3. Barnes RD (1982) Invertebrate Zoology. 6th Edition. Holt Saunders International Edition.
4. Barnes RSK, Calow P. Olive P.JW. Golding DW & Spicer . JI (2002) The Invertebrates: A New Synthesis. 3rd Edition. Blackwell Science. USA.
5. Barrington EJW (1979) *Invertebrate Structure and Functions*. 2nd Edition. ELBS and Nelson.
6. Boradale EA and Potts EA (1961) *Invertebrates: A Manual for the use of Students*. Asia Publishing Home.
7. Jordan EL and Verma PS (1963) Invertebrate Zoology. Revised Edition. S. Chand. New Delhi.
8. Invertebrate zoology R. L. Kotpal
9. Invertebrate phyla (series) R. L. Kotpal
10. Invertebrate zoology V.B Rastogi
11. Parasitology (medical zoology) - H. S Singh & P. Rastogi
12. Zoology for degree students V. K. Agarwal

**+3 FIRST YEAR SECOND SEMESTER  
CORE COURSE - IV (C-4) - ZOOLOGY  
PHYSIOLOGY : LIFE SUSTAINING SYSTEMS**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

**Unit-1 : Digestive System**

Structural organisation, histology and functions of gastrointestinal tract and its associated glands: Mechanical and chemical digestion of food: Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins; Role of gastrointestinal hormones on the secretion and control of enzymes of gastrointestinal tract.

**Unit-2 : Respiratory System**

Histology of trachea and lung: Mechanism of respiration, pulmonary ventilation; Respiratory volume

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and capacity: Transport of oxygen in the blood: Oxygen- hemoglobin and myoglobin. dissociation curve and the factors influencing it: Carbon monoxide poisoning; Carbon dioxide transport in the blood: buffering action of blood and haemoglobin and Control of respiration.

### Unit 3 : Excretory System

Structure of kidney and its histological details: Ultrastructure and functions of nephrons. renal blood supply: Mechanism of urine formation and its regulation and Regulation of acid-base balance.

### Unit 4: Blood

Components of blood and their functions: Structure and functions of haemoglobin: Haemopoiesis: Haemostasis and Coagulation of blood and Disorders of blood.

### Unit 5: Heart

Structure of heart: Coronary circulation; Structure of conducting and working of myocardial fibers: Origin and conduction of cardiac impulses functions of AV node; Cardiac cycle; Cardiac output and its regulation-Frank-Starling Law of the heart: Nervous and chemical regulation of heart rate: Blood pressure and its regulation and Electrocardiogram.

## PRACTICAL CORE COURSE-4 (C-4) LAB-4

Time : 3 Hours

Full Mark : 30 Marks

1. Enumeration of red blood cells using haemocytometer.
2. Estimation of haemoglobin using Sahli's haemoglobinometer.
3. Preparation of haemin and haemochromogen crystals.
4. Recording of blood pressure using a Sphygmomanometer.
5. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum, liver, trachea, lung and kidney.

### SUGGESTED READINGS

1. Arey LB (1974) Human Histology. 4th Edition. W.B. Saunders, USA.
  2. Chatterjee CC (2008) Human Physiology. Vol. I and II. Medical Allied Agency, Kolkata.
  3. Guyton AC and Hall JE (2006) Textbook of Medical Physiology. 9th Edition. W.B. Saunders Company, Philadelphia.
  4. Tortora GJ and Derrickson B (2012) Principles of Anatomy & Physiology. 13th Edition John Wiley and sons, USA.
  5. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12th Edition. Lippincott W. & Wilkins, USA.
  6. Animal physiology (2 vol) - D. Khemka
  7. Animal physiology - Goyal & Sastri
  8. Animal physiology - M. P. Arora
  9. Animal physiology & biochemistry - Verma, Tyagi & Agarwal
  10. A text book on physiology and functional histology - A. K. Berry
  11. A text book on human physiology - H. D. Singh
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**+3 FIRST YEAR SECOND SEMESTER**  
**GE - II - ZOOLOGY**  
**PROTOCHORDATA, CHORADATA, IMMUNOLOGY AND DEVELOPMENTAL**  
**BIOLOGY**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

**Unit-1 Protochordata:**

Hemichordata: Balanoglossus - Structure, Digestive and Respiratory System Urochordata: Herdmania - Structure, Digestive System and Respiratory System Cephalochordata: Amphioxus - Structure, Digestive System and Respiratory System

**Unit - 2**

Brief Classification of Pisces Up to Subclasses and Amphibian Up to Orders, Subclass in Reptilia, Aves and Mammals

Pisces: Scoliodon - Digestive and Respiratory System Amphibia: Frog - Circulatory System & Nervous System (Brain and Cranial Nerves)

**Unit - 3**

Reptilia: Urinogenital System of Calotes

Aves: Respiratory System of Pigeon & Flight Adaptation in Birds

Mammalia: Digestive and Nervous System (Brain and Cranial Nerves) Of Rabbit

**Unit - 4**

Developmental Biology: Gametogenesis, Structure of Gametes, Mechanism of Fertilization, Cleavage and Its Patterns, Development of Amphioxus and Frog Up to the Formation of three Germ Layers

**Unit - 5**

Immunology: Innate and Acquired Immunity, Antigen, Structure and Types of Antibodies, Antigen -Antibody Reaction, Immunodeficiency, Vaccines of Human

**BOOKS RECOMMENDED:**

1. Life Of Vertebrates-J. Young
  2. Chordate Zoology-Jordan And Verma
  3. Modern Text Book Of Zoology (Vertebrates) - R. L Kotpal
  4. Text Book Of Vertebrate Zoology -S.N Prasad And V. Kashyap
  5. Immunology (Concepts And Mechanism) - A. Sharma
  6. Cellular And Molecular Immunology-T. Taneja
  7. Medical Immunology - G. Virella
  8. Immunology A Text Book - C. V. Rao
  9. Immunology - Ian Tydd
  10. Modern Text Book Of Zoology (Invertebrates) - R. L Kotpal
  11. A Text Book Of Immunology And Immunotechnology - B. Annadurai
  12. A Text Book Of Immunology - P. Madhavee Latha
  13. Principles Of Immunology—N. V. Shastri
  14. Immunology - S. S. Lal And Sanjeev Kumar
  15. Immunology - Introductory - Nandini Shetty
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**General Elective Practical-II (GE-2-Lab-2)**  
**PROTOCHORDATES, CHORDATES AND IMMUNOLOGY**

Time : 3 Hours

Full Mark : 30 Marks,

**Experiment (Immunology)**

Blood Grouping (ABO system) Rh Test

**Spotting:** (Slides, Bones and Museum Specimen)

(Two Slides, Two Bones and Two Museum Specimens)

06 Spots are to be Set In the examination

**Slides:** Protochordates, Mammal (T. S of Stomach, T. S of Liver, T. S of Pancreas),  
Embryological Slides of Frog**Museum Specimens:**

Protochordates - Balanoglossus, Amphioxus

Pisces -Zygaena, Torpedo, Pristis, Exocoetus, Hippocampus, Echeneis, Anabas

Amphibia -Ambystoma, Axolotl Larva, Hyla, Rhacophorous, Ichthyophis

Reptiles - Draco, Turtle, Chamaeleon, Cobra, Krait, Viper, Sea Snake

Aves - Crow, Pigeon

Mammals - Bat, Rat

**Bones:** Amphibia and Mammals (Excluding Skull Bones)

**+3 SECOND YEAR THIRD SEMESTER**  
**CORE - 5 - ZOOLOGY**  
**DIVERSITY AND DISTRIBUTION OF CHORDATA**

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

**Unit 1: Protochordata and Origin of Chordates**

General characters and affinities of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata; Dipleurula concept and the Echinoderm theory of origin of chordates.

**Unit 2: Introduction to Vertebrata and Agnatha**

Advanced features of vertebrates over Protochordata; General characters and classification of cyclostomes up to class; Structural peculiarities and affinities of *Petromyzon* and *Myxine*, Ammocoete larva and its metamorphosis.

**Unit 3: Pisces and Amphibia**

General characters of Chondrichthyes and Osteichthyes and classification up to order; Migration and Osmoregulation in fishes; Scales in fishes; Origin of *Tetrapoda* (Evolution of terrestrial ectotherms); General characters and classification up to order and Parental care in Amphibians.

**Unit 4: Reptilia and Aves**

General characters and classification of Reptilia up to order; Skull in Reptilia; Affinities of *Sphenodon*; Poison apparatus and Biting mechanism in snakes; General characters and classification of Aves up to order; Principles and aerodynamics of flight, Flight adaptations; *Archaeopteryx*- a connecting link and Migration in birds.

**Unit 5: Mammals and Zoogeography**

General characters and classification up to order; Affinities of Prototheria and Metatheria; Dentition in mammals; Adaptive radiation with reference to locomotory appendages; Zoogeographical realms; Distribution of vertebrates in different realms.

**SUGGESTED READINGS**

1. Agarwal VK (2011) Zoology for degree students. S. Chand, New Delhi.
2. Arora MP (2006) Chordata-1. 1<sup>st</sup> Edition. Himalaya Publishing House, New Delhi.
3. Hall BK and Hallgrímsson B (2008) *Strickberger's Evolution*. 4<sup>th</sup> Edition. Jones and Bartlett Publishers Inc., USA.
4. Jordan EL and Verma PS (1963) Chordate Zoology. Revised Edition. S. Chand, New Delhi.
5. Young JZ (2004) *The Life of Vertebrates*. 3<sup>rd</sup> Edition. Oxford University Press, USA.
6. Kotpal RL Modern text book of Zoology (Vertebrates). Rastogi Publications, Meerut.
7. Khanna SS An Introduction to Fishes. Central Book Depot, Allahabad

**PRACTICAL****C - 5****Time : 3 Hrs****Full Mark : 30 Marks****1. Protochordata**

1. *Balanoglossus*, *Herdmania*, *Branchiostoma* and Colonial Urochordata.
2. Sections of *Balanoglossus* through proboscis and branchiogenital regions.
3. Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions.
4. Permanent slide of spicules of *Herdmania*.

**2. Agnatha**

5. *Petromyzon* and *Myxine*.

**3. Fishes**

6. *Sphyrna*, *Pristis*, *Trygon*, *Torpedo*, *Chimaera*, *Notopterus*, *Mystus*, *Heteropneustes*, *Hippocampus*, *Exocoetus*, *Echeneis*, *Anguilla*, *Tetrodon*, *Diodon*, *Anabas* and Flat fish.

**4. Amphibia**

7. *Ichthyophis/Ureotyphlus*, *Necturus*, *Duttaphrynus*, *Polypedates*, *Hyla*, *Alytes* and *Salamandra*.

**5. Reptiles**

8. *Chelone*, *Trionyx*, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Draco*, *Ophiosaurus*, *Bungarus*, *Vipera*, *Naja*, *Hydrophis*, *Zamenis* and *Crocodylus*.
9. Key for Identification of poisonous and non-poisonous snakes.

**6. Aves**

10. Study of six common birds from different orders.
11. Types of beaks and claws.
12. Types of feathers.

**7. Mammalia**

13. *Sorex*, Bat (Insectivorous and Frugivorous), Hedgehog, *Funambulus*, *Loris*, *Herpestes* and *Hemiechenis*.

**+3 SECOND YEAR THIRD SEMESTER****CORE - 6 - ZOOLOGY****PHYSIOLOGY – CONTROLLING AND COORDINATING SYSTEM****Time : 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid-Semester : 20 Marks****Unit 1: Tissues and Glands, Bone and cartilage**

Structure, location, function and classification of Epithelial tissue, Connective tissue, Muscular tissue, Nervous tissue; Types of glands and their functions; Structure and types of bones and cartilages.

**Unit 2: Nervous System**

Structure of neuron, resting membrane potential; Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; types of synapsis, Synaptic transmission; Neuromuscular junction; Reflex action and its types, Reflex arc and Physiology of hearing and vision.

**Unit 3: Muscle**

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor Unit, summation and tetanus.

**Unit 4: Reproductive System**

Histology of male and female human reproductive organs; Puberty; Physiology of reproduction of male and female; Methods of contraception (depicted through flow chart).

**Unit 5: Endocrine System**

Functional Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, thymus, pancreas, adrenals; Hormones secreted by them and their mechanism of action; Gonadal hormones; Classification of hormones; Regulation of their secretion; Mode of hormone action; Signal transduction pathways utilized by steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland), principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system and Placental hormones.

**SUGGESTED BOOKS**

1. Arey LB (1974) Human Histology. 4<sup>th</sup> Edition. W.B. Saunders, USA.
2. Chatterjee CC (2008) Human Physiology. Vol. I and II. Medical Allied Agency, Kolkata.
3. Guyton AC and Hall JE (2006) Textbook of Medical Physiology. 9<sup>th</sup> Edition. W.B. Saunders Company, Philadelphia.
4. Tortora GJ and Derrickson B (2012) Principles of Anatomy & Physiology. 13<sup>th</sup> Edition John Wiley and sons, USA.
5. Victor PE (2008) diFiore's Atlas of Histology with Functional Correlations. 12<sup>th</sup> Edition. Lippincott W. and Wilkins, USA.
6. Berry AK A Text Book of Physiology & Functional Histology. Emkay Publications, Delhi.
7. Verma, Agarwal & Tyagi Animal Physiology and Biochemistry. S.Chand, New Delhi.

**PRACTICAL****C - 6****Time : 3 Hrs****Full Mark : 30 Marks**

1. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex).
2. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibers and nerve cells.
3. Examination of sections of mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid.

**+3 SECOND YEAR THIRD SEMESTER****CORE - 7 - ZOOLOGY****COMPARATIVE ANATOMY OF VERTEBRATES****Time : 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid-Semester : 20 Marks****Unit 1: Integumentary System and Skeletal System**

Structure, functions and derivatives of integument; Axial and appendicular skeletons; Jaw suspensorium in vertebrates.

**Unit 2: Digestive and Respiratory System**

Alimentary canal and associated glands; Skin, gills, lungs and air sacs and Accessory respiratory organs in fishes.

**Unit 3: Circulatory System**

General plan of circulation; Evolution of heart and aortic arches.

**Unit 4: Urinogenital System**

Succession of kidney; Evolution of urinogenital ducts and Types of mammalian uteri.

**Unit 5: Nervous System and Sense Organs**

Comparative account of brain; Autonomic nervous system; Spinal Nerves; Spinal cord; Cranial nerves in Mammals; Classification of receptors; visual receptors, chemo-receptors and mechanoreceptors.

**SUGGESTED READINGS**

1. Hilderbrand M and Gaslow GE. Analysis of Vertebrate Structure. John Wiley and Sons., USA.
2. Kardong KV (2005) Vertebrates' Comparative Anatomy, Function and Evolution. 4<sup>th</sup> Edition. McGraw-Hill Higher Education, New York.
3. Kent GC and Carr RK (2000) Comparative Anatomy of the Vertebrates. 9<sup>th</sup> Edition. The McGraw-Hill Companies, New York.
4. Weichert CK and William Presch (1970) Elements of Chordate Anatomy. Tata McGraw Hill, New York.
5. Jasra OP Comparative Anatomy.
6. Puri R A Text Book of Comparative Anatomy of Vertebrates.
7. Kotpal RL Modern text book of Zoology (Vertebrates). Rastogi Publications, Meerut.

**PRACTICAL****C-7****Time : 3 Hrs****Full Mark : 30 Marks**

1. Study of placoid, cycloid and ctenoid scales through permanent slides/photographs.
2. Disarticulated skeleton of Frog, *Varanus*, Fowl and Rabbit.
3. Carapace and plastron of turtle or tortoise.
4. Mammalian skulls (One herbivorous and one carnivorous animal).

**+3 SECOND YEAR FOURTH SEMESTER  
CORE - 8 - ZOOLOGY  
BIOCHEMISTRY OF METABOLIC PROCESSES**

**Time : 3 Hours****End Semester Theory : 50 Marks****Credit: 6****Mid-Semester : 20 Marks****Unit 1: Biomolecules**

Structures and properties of important mono-, di- and polysaccharides; Fatty acids, triglycerides and steroids; and amino acids and proteins.

**Unit 2: Carbohydrate Metabolism**

Glycolysis; Citric acid cycle; pentose phosphate pathway; Gluconeogenesis; Shuttle systems (Malate-aspartate shuttle, Glycerol 3-phosphate shuttle); Glycogenolysis; Glycogenesis.

**Unit 3: Lipid Metabolism**

$\beta$ -oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid and Ketogenesis and its regulation.

**Unit 4: Protein Metabolism**

Catabolism of amino acids: Transamination, Deamination; Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

**Unit 5: Enzymes and Oxidative Phosphorylation**

Chemical nature and Classification of enzymes, Coenzymes & Cofactors, Kinetics and Mechanism of action of enzymes; Inhibition of enzyme action; Allosteric enzymes; Oxidative phosphorylation in mitochondria; Respiratory chain, ATP synthase, Inhibitors and Uncouplers.

**SUGGESTED READINGS**

1. Berg JM, Tymoczko JL and Stryer L (2007) Biochemistry. 6<sup>th</sup> Edition, W.H. Freeman and Co., New York.

2. Cox MM and Nelson DL (2008) Lehninger Principles of Biochemistry. 5<sup>th</sup> Edition. W.H. Freeman and Co., New York.
3. Devesena T (2014) Enzymology. 2<sup>nd</sup> Edition. Oxford University Press, UK.
4. Hames BD and Hooper NM (2000) Instant Notes in Biochemistry. 2<sup>nd</sup> Edition. BIOS Scientific Publishers Ltd., U.K.
5. Murray RK, Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Well PA (2009) Harper's Illustrated Biochemistry. 28<sup>th</sup> Edition. International Edition. The McGraw-Hill Companies Inc., New York.
6. Jain & Jain Essentials of Biochemistry. S.Chand , New Delhi.
7. Satyanarayan U Biochemistry. Books & Allied (P) Ltd. Kolkota

## PRACTICAL

### C - 8

**Time : 3 Hrs**

**Full Mark : 30 Marks**

1. Identification of unknown carbohydrates in given solutions (Starch, Sucrose, Lactose, Galactose, Glucose, Fructose).
2. Colour tests of functional groups in protein solutions.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH on the action of salivary amylase.
5. Effect of temperature on the action of salivary amylase.
6. Estimation of total protein in given solutions by Lowry's method.
7. Estimation of Protein( the Casein content of Milk).
8. Estimation of total Lipid of Tissue ( Liver & Brain ).

## +3 SECOND YEAR FOURTH SEMESTER

### CORE - 9 - ZOOLOGY

#### CELL BIOLOGY AND BIOINSTRUMENTATION

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

#### **Unit 1: Cells and Plasma Membrane**

Prokaryotic and Eukaryotic cells; Structure of Mycoplasma, Virus, Viroids, Virions and Prions; Various models of plasma membrane; Transport across membranes; Cell junctions: Occluding junctions (Tight junctions), Anchoring junctions (desmosomes), Communicating junctions (gap junctions) and Plasmodesmata.

#### **Unit 2: Endomembrane System, Mitochondria and Peroxisomes**

The Endoplasmic Reticulum; Golgi apparatus; Mechanism of vesicular transport; Lysosomes; Structure and function of mitochondria: Chemi-osmotic hypothesis; Semiautonomous nature of mitochondria; Endosymbiotic hypothesis and Peroxisomes.

#### **Unit 3: Cytoskeleton and Nucleus**

Structure and functions of intermediate filament, microtubules and microfilaments; Ultra structure of nucleus; Nuclear envelope: Structure of nuclear pore complex; Chromosomal DNA and its packaging; Structure and function of Nucleolus.

#### **Unit 4: Cell Cycle , Apoptosis and Cancer**

Cell cycle, Regulation of cell cycle , Apoptosis: Extrinsic (Death Receptor) Pathway and Intrinsic (Mitochondrial) Pathway; Growth and development of tumors and Metastasis.

#### **Unit 5: Bioinstrumentation**

Microscopy: Principles and uses of Light microscope ( light & compound), Electron microscope; Microtomy; Principles and applications of Centrifugation (clinical & ultra ), Chromatography ( Paper &



thin layer ) and Electrophoresis (Gel).

### SUGGESTED READINGS

1. Becker WM, Kleinsmith LJ, Hardin J and Bertoni G P (2009) The World of the Cell. 7<sup>th</sup> Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008) Molecular Biology of the Cell. 5<sup>th</sup> Edition. Garland publishing Inc., New York.
3. Cooper GM and Hausman RE (2009) The Cell: A Molecular Approach. 5<sup>th</sup> Edition. ASM Press, Washington D.C.
4. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology. 8<sup>th</sup> Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments. 6<sup>th</sup> Edition. John Wiley and Sons. Inc., USA.
6. Boyer R (2000) Modern Experimental Biochemistry. 3<sup>rd</sup> Edition. Addison Wesley Longman, Inc., USA.
7. Wilson K and Walker J (2010) Principles and techniques of Biochemistry and Molecular Biology. 7<sup>th</sup> Edition. Cambridge University Press, UK.
8. BajpaiPK Biological Instrumentation and Methodology. S.Chand, New Delhi.

## PRACTICAL

### C - 9

Time : 3 Hrs

Full Mark : 30 Marks

1. Gram's staining technique for visualization of prokaryotic cells.
2. Study various stages of mitosis from permanent slides.
3. Study various stages of meiosis from permanent slides.
4. Study the presence of Barr body in human female blood cells/cheek cells. (Preparation of permanent slides).
5. Cytochemical/ Cytological demonstration (Preparation of permanent slides).
  - i. DNA by Feulgen reaction.
  - ii. Mucopolysaccharides by PAS reaction.
  - iii. Proteins by Mercurbromophenol blue.
  - iv. DNA and RNA by Methyl Green Pyronin.
  - v. Stages of Mitosis.
  - vi. Stages of Meiosis.
6. Instrumentation -Microtomy, Micrometry, Centrifuge and Chromatography
7. Microtomy – Preparation of blocks, section cutting, stretching, staining and mounting of materials( different parts of alimentary canal, liver, kidney , gonads) of Rat/Frog or Toad.(Section cutting and stretching of two slides from prepared block have to be given in the examination)

## +3 SECOND YEAR FOURTH SEMESTER

### CORE - 10 - ZOOLOGY PRINCIPLES OF GENETICS

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

#### Unit 1: Mendelian Genetics and its Extension

Principles of inheritance(Mendelism); Incomplete dominance and co-dominance; Multiple alleles, Lethal alleles; Epistasis; Pleiotropy; Sex-linked inheritance.

#### Unit 2: Linkage, Crossing Over and Chromosomal Mapping

Linkage and crossing over; Cytological basis of crossing over; Molecular mechanisms of crossing over;



Recombination frequency as a measure of linkage intensity; Two factor and three factor crosses; Interference and coincidence and Somatic cell hybridization.

### Unit 3: Mutations

Gene mutations; Chromosomal mutations: Deletion, duplication, inversion, translocation; Aneuploidy and polyploidy; Induced versus spontaneous mutations; Backward and forward mutations; Suppressor mutations; Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method and DNA repair mechanisms.

### Unit 4: Sex Determination and Quantitative Genetics

Chromosomal mechanisms of sex determination; Sex-linked, sex-influenced and sex limited characters; Polygenic inheritance and Transgressive variation.

### Unit 5: Extra-chromosomal Inheritance

Criteria for extra-chromosomal inheritance; Antibiotic resistance in *Chlamydomonas*; Mitochondrial mutations and Maternal effects (Plasmid inheritance, Kappa particles of Paramecium & Molluscan shell structure).

### SUGGESTED READINGS

1. Gardner EJ, Simmons MJ, Snustad DP (2008) Principles of Genetics. 8<sup>th</sup> Edition. Wiley India.
2. Griffiths AJF, Wessler SR, Lewontin RC and Carroll SB. Introduction to Genetic Analysis. 9<sup>th</sup> Edition. W. H. Freeman and Co., New York.
3. Klug WS, Cummings MR, Spencer CA and Palladino MA (2012) Concepts of Genetics. 10<sup>th</sup> Edition. Pearson Education, Inc., USA.
4. Russell PJ (2009) Genetics- A Molecular Approach. 3<sup>rd</sup> Edition. Benjamin Cummings, USA.
5. Snustad DP and Simmons MJ (2012) Principles of Genetics. 6<sup>th</sup> Edition. John Wiley and Sons Inc., USA.
6. Verma PS and Agarwal VK (2010) Genetics. 9<sup>th</sup> Edition. S. Chand, New Delhi.
7. Gupta PK Genetics. Rastogi Publications, Meerut.
8. Rastogi VB Genetics. Kedar Nath Ram Nath, Meerut.

### PRACTICAL

#### C - 10

Time : 3 Hrs

Full Mark : 30 Marks

1. To study the Mendelian laws and gene interactions and their verification by Chi-square analyses using seeds/beads/*Drosophila*.
2. Identification of various mutants of *Drosophila*.
3. To calculate allelic frequencies by Hardy-Weinberg Law.
4. Linkage maps based on data from crosses of *Drosophila*.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.
7. Study/ Preparation of polytene chromosomes from larva of *Chironomous/Drosophila*.

## +3 THIRD YEAR FIFTH SEMESTER CORE - 11 - ZOOLOGY DEVELOPMENTAL BIOLOGY

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

### Unit 1: Introduction

History and basic concepts: Epigenesis, preformation, Mosaic and regulative development; Discovery of induction; Cell-Cell interaction; Pattern formation; Differentiation and growth; Differential gene expression; Cytoplasmic determinants and asymmetric cell division.

**Unit 2: Early Embryonic Development**

Gametogenesis (Spermatogenesis, Oogenesis); Types of eggs; Egg membranes; Fertilization: Changes in gametes, monospermy and polyspermy; Planes and patterns of cleavage; Early development of frog and chick up to gastrulation; Fate maps; Embryonic induction and organizers.

**Unit 3: Late Embryonic Development**

Fate of germ layers; Extra-embryonic membranes in birds; Implantation of embryo in humans and Placenta (Structure, types and functions of placenta).

**Unit 4: Post Embryonic Development**

Metamorphosis: Changes, hormonal regulations in amphibians; Regeneration: Modes of regeneration (epimorphosis, morphallaxis and compensatory regeneration); Ageing: Concepts and models.

**Unit 5: Implications of Developmental Biology**

Teratogenesis: Teratogenic agents and their effects on embryonic development; *in vitro* Fertilization and embryo transfer; Stem cell culture and Amniocentesis.

**SUGGESTED READINGS**

1. Balinsky BI and Fabian BC (1981) An Introduction to Embryology. 5<sup>th</sup> Edition. International Thompson Computer Press.
2. Gilbert SF (2010) Developmental Biology. 9<sup>th</sup> Edition. Sinauer Associates, Inc., USA.
3. Kalthoff (2008) Analysis of Biological Development. 2<sup>nd</sup> Edition. McGraw-Hill, New York.
4. Wolpert L, Beddington R, Jessell T, Lawrence P, Meyerowitz E and Smith J (2002) Principles of Development. 1<sup>st</sup> Edition, Oxford University Press, New York.
5. Rastogi VB Developmental Biology. KedarNath Ram Nath, Meerut
6. Verma & Agrawal Chordate Embryology. S. Chand, New Delhi

## PRACTICAL C- 11

Time : 3 Hrs

Full Mark : 30 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 developmental stages (above mentioned) by raising chick embryo in the laboratory.
4. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
5. Study of different types of placenta ( Model / Chart / Photograph ).
6. Project report on *Drosophila* culture/chick embryo development.

## +3 THIRD YEAR FIFTH SEMESTER CORE - 12 - ZOOLOGY MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Time : 3 Hours

End Semester Theory : 50 Marks

Credit: 6

Mid-Semester : 20 Marks

**Unit 1: Nucleic Acids and DNA Replication**

Salient features of DNA double helix; Watson and Crick model of DNA; DNA denaturation and renaturation; DNA topology - linking number and DNA topo-isomerases; Cot curves; Structure of RNA, tRNA and DNA and RNA associated proteins; DNA Replication in prokaryotes and eukaryotes; Mechanism of DNA replication; Role of proteins and enzymes in replication; Licensing factors; Semi-conservative, bidirectional and semi-discontinuous replication; RNA priming; Replication of circular and linear *ds*-DNA and replication of telomeres.

**Unit 2: Transcription and 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, aminoacyl tRNA synthetases 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: Gene Regulation and Regulatory RNAs**

Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from *lac* operon and *trp* operon; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing.

**Unit 4: Techniques in Gene Manipulation**

Recombinant DNA technology, Restriction and modifying enzymes, Cloning vectors and Expression vectors, Construction and screening of DNA libraries; Molecular analysis of DNA, RNA and proteins (*i.e.*, Southern, Northern and Western blotting), DNA sequencing (Sanger's method and automation), Polymerase Chain Reaction, DNA fingerprinting and RAPD.

**Unit 5: Biotechnology and Human Welfare**

Production of transgenic animals: Retroviral method, DNA microinjection method, embryonic stem cell method, nuclear transplantation; Recombinant DNA in health (Recombinant insulin and human growth hormone), Production of recombinant vaccines, Ethical issues concerning: Transgenesis, Biosafety and Intellectual Property Rights.

**SUGGESTED READINGS**

1. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) *The World of the Cell*. 7<sup>th</sup> Edition. Pearson Benjamin Cummings Publishing, San Francisco.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter (2008) *Molecular Biology of the Cell*, 4<sup>th</sup> Edition. Garland publishing Inc., New York.
3. Cooper GM and Hausman RE (2007) *The Cell: A Molecular Approach*. 4<sup>th</sup> Edition, ASM Press, USA.
4. De Robertis EDP and De Robertis EMF (2006) *Cell and Molecular Biology*. 8<sup>th</sup> Edition. Lippincott Williams and Wilkins, Philadelphia.
5. Karp G (2010) *Cell and Molecular Biology: Concepts and Experiments*. 6<sup>th</sup> Edition. John Wiley and Sons. Inc., USA.
6. Satyanarayana U *Biotechnology*. Books & Allied (P) Ltd. Kolkota.
7. Dubey RC *A Textbook of Biotechnology*. S. Cahnd, New Delhi.
8. Gupta PK *Elements of Biotechnology*. Rastogi Publications, Meerut.

**PRACTICAL****C -12****Time : 3 Hrs****Full Mark : 30 Marks**

1. Study of DNA replication using Photographs or slides and special cases, e.g., Polyteny using permanent slides of polytene chromosomes.
2. Preparation of liquid culture medium (LB) and raise culture of *E. coli*.
3. Preparation of solid culture medium (LB) and growth of *E. coli* by spreading and streaking.
4. Demonstration of antibiotic sensitivity/resistance of *E. coli* to antibiotic pressure and interpretation of results.
5. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A<sub>260</sub> measurement).
6. Study of the following techniques using photographs or slides : Transcription, Translation, Retroviral method in production of transgenic animals & DNA microinjection method in production of transgenic animals.

**+3 THIRD YEAR SIXTH SEMESTER  
CORE - 13 - ZOOLOGY  
IMMUNOLOGY**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

**Unit 1: Immune System and Immunity**

Historical perspective of Immunology, Early theories of Immunology, Haematopoiesis, 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 and Immune dysfunctions.

**Unit 2: Antigens & Immunoglobulins**

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T - Cell epitopes. Structure and functions of different classes of immunoglobulins, Antigen-antibody interactions, Immunoassays, Monoclonal antibodies and Hybridoma technology.

**Unit 3: Major Histocompatibility Complex and Complement System**

Structure and functions of endogenous and exogenous pathway of antigen presentation; Components and pathways of complement activation.

**Unit 4: Autoimmunity & Immune deficiency**

Immune response mechanism, Immune tolerance, Autoimmunity, Autoimmune diseases, immune deficiency & immune deficiency diseases.

**Unit 5: Cytokines, Hypersensitivity and Vaccines**

Properties and functions of cytokines; Cytokine-based therapies; Gell and Coombs' classification and Brief description of various types of hypersensitivities; Types of vaccines: Recombinant vaccines and DNA vaccines.

**SUGGESTED READINGS**

1. Abbas KA and Lichtman HA (2003) Cellular and Molecular Immunology. 5<sup>th</sup> Edition. Saunders Publication, Philadelphia.
2. David M, Jonathan B, David RB and Ivan R (2006) Immunology. 7<sup>th</sup> Edition. Elsevier Publication, USA.
3. Kindt TJ, Goldsby RA, Osborne BA and Kuby J (2006) Immunology. 6<sup>th</sup> Edition. W.H. Freeman and Company, New York.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Madhava Latha PA Text Book of Immunology. S. Chand, New Delhi.
6. Rao CV A Text Book of Immunology
7. Shetty Nandini Introductory Immunology

**PRACTICAL**

**C - 13**

Time : **3 Hrs**

Full Mark : **30 Marks**

1. Demonstration of lymphoid organs( Photograph / Chart / Model ).
2. Ouchterlony's double immuno-diffusion method.
3. Determination of ABO blood group.
4. Preparation of single cell suspension of splenocytes from chick spleen, cell counting and viability test.
5. ELISA/ dot Elisa (using kit).
6. Principles, experimental set up and applications of immuno-electrophoresis, RIA, F.

**+3 THIRD YEAR SIXTH SEMESTER  
CORE - 14 - ZOOLOGY  
EVOLUTIONARY BIOLOGY**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

**Unit 1: History of Life, theories of Evolution and Extinction**

Major Events in History of Life; Lamarckism; Darwinism; Neo-Darwinism; Background of extinction, Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail) and Role of extinction in evolution.

**Unit 2: Evidences of Evolution**

Evidences from morphology, embryology, biochemistry & palaeontology :Fossils and its types; Dating of fossils, Phylogeny of horse and Molecular clock concept.

**Unit 3: Processes of Evolutionary Change**

Organic variations; Isolating mechanisms; Natural selection (Industrial melanism, Pesticide/Antibiotic resistance); Types of natural selection (Directional, Stabilizing, Disruptive), Sexual Selection and Artificial selection.

**Unit 4: Principles of population genetics**

Concept of gene pool, Gene frequencies – equilibrium frequency (Hardy-Weinberg equilibrium), Shift in gene frequency without selection – Genetic drift, Mutation pressure and Gene flow and Shifts in gene frequencies with selection.

**Unit 5: Species Concept and Evolution above species level**

Biological concept of species (Advantages and Limitations); Sibling species, Polymorphic species, Polytropic species, Ring species; Modes of speciation (Allopatric, Sympatric); Macro-evolutionary Principles (Darwin's Finches); Convergence, Divergence and Parallelism.

**SUGGESTED READINGS**

1. Barton NH, Briggs DEG, Eisen JA, Goldstein DB and Patel NH (2007) Evolution. Cold Spring Harbour Laboratory Press.
2. Campbell NA and Reece JB (2011) Biology. 9<sup>th</sup> Edition. Pearson Education Inc., New York.
3. Douglas JF (1997) Evolutionary Biology. Sinauer Associates, USA.
4. Hall BK and Hallgrímsson B (2008) Evolution. 4<sup>th</sup> Edition. Jones and Bartlett Publishers, USA.
5. Pevsner J (2009) Bioinformatics and Functional Genomics. 2<sup>nd</sup> Edition. Wiley-Blackwell, USA.
6. Ridley M (2004) Evolution. 3<sup>rd</sup> Edition. Blackwell Publishing, USA.
7. Rastogi VB Organic Evolution. KedarNath Ram Nath, Meerut.

**PRACTICAL**

**C - 14**

Time : **3 Hrs**

Full Mark : **30 Marks**

1. Study of fossil evidences from plaster cast models and pictures.
2. Study of homology and analogy from suitable specimens/ pictures.
3. Demonstration of changing allele frequencies with and without selection.
4. Construction of cladogram based on morphological characteristics.
5. Construction of phylogenetic tree with bioinformatics tools (Clustal X and Phylip).
6. Interpretation of phylogenetic trees.
7. An exercise to demonstrate the concept of genetic drift.
8. An exercise to demonstrate the role of natural selection in evolving adaptations.
9. An exercise to demonstrate the role of natural selection in fixing favoured adaptations & eliminating maladaptations.



**+3 THIRD YEAR FIFTH SEMESTER  
DSE - I - ZOOLOGY  
ANIMAL BEHAVIOUR**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks****Unit 1: Introduction and Mechanisms of 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**

**Reflexes:** Types of reflexes, reflex path, characteristics of reflexes (latency, after discharge, summation, fatigue, inhibition) and its comparison with complex behavior.

**Orientation:** Primary and secondary orientation; kinesis-orthokinesis, klinokinesis; taxis tropotaxis and klinotaxis and menotaxis (light compass orientation) and mnemotaxis.

**Learning:** Associative learning, classical and operant conditioning, Habituation and Imprinting.

**Unit 3: Social Behaviour**

Insects' society; Honey bee: Society organization, polyethism, foraging, round dance, waggle dance, Experiments to prove distance and direction component of dance, learning ability in honey bee, formation of new hive/queen; Reciprocal altruism. Hamilton's rule.

**Unit 4: Sexual Behaviour**

Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Infanticide, Consequences of mate choice for female fitness, Sexual conflict for male versus female parental care and Courtship behaviour in three spine stickleback.

**Unit 5: Biological Clocks**

Circadian rhythm, Tidal rhythm, Lunar rhythm, Advantages of biological clocks, Jet lag and Entrainment.

**SUGGESTED READINGS**

1. David McF. Animal Behaviour. Pitman Publishing Limited, London, UK.
2. John A (2001) Animal Behaviour. 7<sup>th</sup> Edition. Sinauer Associate Inc., USA.
3. Manning A and Dawkins MS. An Introduction to Animal Behaviour. Cambridge University Press, USA.
4. Mohanty PK (2000) Illustrated Dictionary of Biology. Kalyani Publishers, Ludhiana.
5. Paul WS and John A (2013) Exploring Animal Behaviour. 6<sup>th</sup> Edition. Sinauer Associate Inc., Massachusetts, USA.
6. Mathur R Animal Behaviour. Rastogi Publications, Meerut
7. Agarwal VK Animal Behaviour. S.Chand, New Delhi

**PRACTICAL  
(DSE-1)**

Time : **3 Hrs**Full Mark : **30 Marks**

1. To study different types of animal behaviour such as habituation, social life, courtship behaviour in insects, and parental care from short videos/movies and prepare a short report.
2. To study nests and nesting habits of the birds and social insects.
3. To study the behavioural responses of wood lice to dry condition.
4. To study behavioural responses of wood lice in response to humid condition.
5. To study geotaxis behaviour in earthworm.
6. To study the phototaxis behaviour in insect larvae.
7. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.



**+3 THIRD YEAR FIFTH SEMESTER  
DSE - II - ZOOLOGY  
ECONOMIC ZOOLOGY**

Time : **3 Hours**

End Semester Theory : **50 Marks**

Credit: **6**

Mid-Semester : **20 Marks**

**Unit 1: Bee-keeping and Bee Economy (Apiculture)**

Varieties of honey bees and Bee pasturage; Setting up an apiary: Langstroth's/Newton's hive, bee veil, brood and storage chambers, iron frames and comb sheets, drone excluder, rearing equipments, handling of bees, artificial diet; Diseases of honey bee, American and European Foulbrood, and their management; Honey extraction techniques; Physico-chemical analysis of honey; Other beneficial products from bee.

**Unit 2: Silk and Silk Production (Sericulture)**

Different types of silk and silkworms in India; Rearing of *Bombyxmori*, Rearing racks and trays, disinfectants, rearing appliances, black boxing, Chawki rearing, bed cleaning, mountages, harvesting of cocoons; Silkworm diseases: Pebrine, Flacherie, Grasserie, Muscardine and Aspergillosis, and their management; Silkworm pests and parasites: Uzi fly, Dermestid beetles and their management; Silk reeling techniques and Quality assessment of silkfiber.

**Unit 3: Aquaculture I**

Brood stock management; Induced breeding of fish; Management of hatchery of fish; Management of nursery, rearing and stocking ponds; Preparation and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish; Fishery by-products.

**Unit 4: Aquaculture II**

Prawn farming; Culture of crab; Pearl culture and Culture of air breathing fishes.

**Unit 5: Dairy and Poultry Farming**

Introduction; Indigenous and exotic breeds; Rearing, housing, feed and rationing; Commercial importance of dairy and poultry farming; Varietal improvement techniques; Diseases and their management; Dairy or poultry farm management.

**SUGGESTED READINGS**

1. Dhyani Singh Bisht, Apiculture, ICAR Publication.
2. Dunham RA (2004) Aquaculture and Fisheries Biotechnology – Genetic Approaches. CABI publications, U.K.
3. Hafez ESE (1962) Reproduction in Farm Animals. Lea and Fabiger Publishers.
4. Knobil E and Neill JD (2006) The Physiology of Reproduction. Vol. 2. Elsevier Publishers, USA.
5. Prost PJ (1962) Apiculture. Oxford and IBH, New Delhi.
6. Singh S. Beekeeping in India, Indian council of Agricultural Research, New Delhi.
7. Srivastava CBL (1999) Fishery Science and Indian Fisheries. KitabMahal publications, India.

**PRACTICAL**

(DSE-2)

Time : **3 Hrs**

Full Mark : **30 Marks**

1. Study of different types of bees (Queens, Drones and Worker bees).
2. Study of different types of silk moths.
3. Study of different types of pearls.
4. Study of different types of fish diseases.
5. Identification of different types of scales in fishes.
6. Study of different types of fins.
7. Study of different modified structures of fishes (Saw of sawfish, Hammer of hammer head fish, tail of sharks etc.)
8. Identification of various types of natural silks.
9. Submission of report on visit to any one of the following : apiculture unit , dairy farm & poultry farm.

**+3 THIRD YEAR SIXTH SEMESTER  
DSE - III - ZOOLOGY  
MICROBIOLOGY**

Time : **3 Hours**End Semester Theory : **50 Marks**Credit: **6**Mid-Semester : **20 Marks**

**Unit 1:**History of Microbiology; Microbial World – Characterization, Classification and identification of microbes.

**Unit 2:** Prokaryotes: General morphology and classification of bacteria, their characters and economic importance; Gram-positive and Gram-negative bacteria.

**Unit 3:**Eukaryotes: General morphology of Protista and Fungi – classification and economic importance.

**Unit 4:**Viruses: structure, genome, replication cycle; Epidemiology of infectious diseases with reference of human hosts – Bacterial(Tuberculosis), Viral (Hepatitis), Protozoan (Amoebiasis) and Fungal ( Candidiasis ) disease.

**Unit 5:**Microbe interactions-Immune Responses-Antibiotics and other chemotherapeutic agents; Role of microbiology in the fields of food, agriculture, industry and environment.

**SUGGESTED READINGS**

1. Ahsan J and Sinha SP (2010) A Hand book on Economic Zoology. S Chand, New Delhi.
2. Arora DR and Arora B (2001) Medical Parasitology. 2<sup>nd</sup> Edition. CBS Publications and Distributers.
3. Atwal AS (1993) Agricultural Pests of India and South East Asia. Kalyani Publishers, Ludhiana.
4. Dubey RC and Maheshwari DK (2013) A Textbook of Microbiology. S. Chand, New Delhi.
5. Dunham RA (2004) Aquaculture and Fisheries Biotechnology Genetic Approaches. CABI publications.
6. Pelczar MJ, Chan ECS and Krieg NR (1993) Microbiology. 5<sup>th</sup> Edition, Tata McGraw Hill Publishing Co.Ltd.
7. Pradhan, S (1983) Insect Pests of Crops. National Book Trust of India, New Delhi.
8. Shukla, G.S. and Upadhya, V.B. (2013) Economic Zoology. 5<sup>th</sup> Edition, Rastogi Publications, Meerut.
9. Tortora GJ, Funke BR & Case CL Microbiology An Introduction. Pearson Education

**PRACTICAL****(DSE-3)**Time : **3 Hrs****Full Mark : 30 Marks**

1. Cleaning of glasswares, sterilisation principle and methods - moist heat - dry heat and filtration methods.
2. Media preparation: Liquid media, Solid media, Agar slants, Agar plates. Basal, enriched, selective media preparation - quality control of media, growth supporting properties, sterility check of media.
3. Pure culture techniques: Streak plate, pour plate and decimal dilution.
4. Cultural characteristics of microorganisms: Growth on different media, growth characteristics and description and demonstration of pigment production.
5. Staining techniques: Smear preparation, simple staining, Gram's staining, Acidfast staining and staining for metachromatic granules.
6. Morphology of micro organisms.
7. Antibiotic sensitivity testing: Disc diffusion test - Quality control with standard strains
8. Physiology characteristics: IMViC test, H<sub>2</sub>S, Oxidase, catalase, urease test, Carbohydrate fermentation, Maintenance of pure culture, Paraffin method, Stab culture and maintenance of mold culture.

**+ 3 THIRD YEAR SIXTH SEMESTER  
DSE- 4 - ZOOLOGY  
(PROJECT)**

Credit : **6****Marks : 100**