

# BANASTHALI VIDYAPITH

## Bachelor of Science



## Curriculum Structure

First Semester Examination, December, 2019  
Second Semester Examination, April/May, 2020  
Third Semester Examination, December, 2020  
Fourth Semester Examination, April/May, 2021  
Fifth Semester Examination, December, 2021  
Sixth Semester Examination, April/May, 2022

**BANASTHALI VIDYAPITH**  
**P.O. BANASTHALI VIDYAPITH**  
**(Rajasthan)-304022**

**No. F. 9-6/81-U.3**

**Government of India  
Ministry of Education and Culture  
(Department of Education)**

New Delhi, the 25th October, 1983

**NOTIFICATION**

In exercise of the powers conferred by Section 3 of the University Grants Commission Act, 1956 (3 of 1956) the Central Government, on the advice of the Commission, hereby declare that Banasthali Vidyapith, P. O. Banasthali Vidyapith, (Rajasthan) shall be deemed to be a University for the purpose of the aforesaid Act.

Sd/-  
**(M. R. Kolhatkar)**  
Joint Secretary of the Government of India

**NOTICE**

Changes in Bye-laws/Syllabi and Books may from time to time be made by amendment or remaking, and a Candidate shall, except in so far as the Vidyapith determines otherwise, comply with any change that applies to years she has not completed at the time of change.

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<b>First to Sixth Semester</b>	
<b>Disciplinary Courses :</b>	
1. Botany	22
2. Chemistry	47
3. Computer Science	85
4. Electronics	109
5. Geography	127
6. Geology	153
7. Mathematics	180
8. Physics	201
9. Statistics	227
10. Zoology	249

## **Programme Educational Objectives**

The B.Sc. programme aims at holistic development of the students through the innovative and comprehensive educational ideology of Banasthali Vidyapith. The programme include exposure to core disciplines of Botany, Chemistry, Zoology, Computer Science, Electronics, Geography, Geology, Mathematics, Physics, Statistics and foundation courses. The programme aims to provide an understanding of fundamental of all the disciplinary courses chemical. The necessary competencies in the respective areas will be developed for which all essential theoretical, practical and field based skills will be provided.

On completion of the Programme, students will be able to:

- gain in depth knowledge of all core disciplinary courses.
- develop independent learning abilities and analytical thinking through problem-based assignments, laboratory exercises and report writing.
- understand a scientific problem and conduct experiments that would make a substantial contribution to its solution
- apply knowledge and understanding in order to initiate and carry out an extended piece of work or project for societal benefit
- develop team work and awareness amongst students towards the importance of multidisciplinary approach for problem solving skills
- train the students for attainment of technical skills, intellectual capability with exposure to modern technologies to serve as an individual or as a team leader in industries
- To learn and handle various analytical techniques and appreciate its importance
- raise sensitivity to professional ethical codes of conduct, social values and respect for all
- create awareness among students about conservation and sustainability of conduct, social values and respect for all
- create awareness among students about conservation and sustainability of environment.

## Programme Outcomes

- PO1: Knowledge:** Obtain in depth knowledge of science and wide understanding of and on the major concepts, thoughts, and ideas of Botany, Chemistry, Zoology, Computer Science, Electronics, Geography, Geology, Mathematics, Physics and Statistics. It also enriches their analytical, critical, creative faculties.
- PO2: Planning ability:** Demonstrate effective planning abilities including time management, resource management and organizational skills. Develop and implement plans and organize work to meet deadlines.
- PO3: Problem analysis:** Develop the ability to think originally, conceptually, design experiments, conduct experiments, draw important conclusions from obtained data and to use integrated approaches for solving problem.
- PO4: Modern tool usage:** Apply appropriate methods, resources and computational tools with an understanding of their limitations.
- PO5: Leadership skills:** Develop potential among students in sciences who can excel as leaders in entrepreneurship, industry and management.
- PO6: Professional identity:** As biologist, fulfill the needs of society for solving technical, medical, agricultural and environmental problems using biological principles, tools and practices in an ethical and responsible manner.
- PO7: Hands-on training:** Gain hands-on experience in a number of the practical methods and techniques used in basic science research. Expertise in the operation of equipment, adherence to laboratory safety standards and good practices.
- PO8: Ethics:** Develop scientific ethics, including, confidentiality and accountability. Apply ethical principles and commit to professional ethics, responsibilities, and norms of science practices.
- PO9: Communication:** Ability to express effectively, write effective reports, design documentation, make effective presentations, give and receive clear instructions and effectively communicate with professional bodies.
- PO10: Environment and sustainability:** Think creatively (divergently and convergent) to propose novel ideas in explaining facts and figures or providing new solution to the problems. Realized how developments in any science subject helps in the development of other science subjects and vice-versa and how interdisciplinary approach helps in providing better solutions and new ideas for the sustainable developments.
- PO11: Life-long learning:** Ability to recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broad context of biological changes.

**Curriculum Structure**  
**Bachelor of Science**  
**First Year**

**Semester - I**

Course Code	Course Name	L	T	P	C*
BVF 011/ BVF 014	General English/सामान्य हिन्दी	2	0	0	2
	Core Foundation Course - I	2	0	0	2
	Discipline 1 – Course - 1	6	0	4	8
	Discipline 2 – Course - 1	6	0	4	8
	Discipline 3 – Course - 1	6	0	4	8
<b>Semester Total:</b>		<b>22</b>	<b>0</b>	<b>12</b>	<b>28</b>

**Semester - II**

Course Code	Course Name	L	T	P	C*
BVF 014/ BVF 011	सामान्य हिन्दी/General English	2	0	0	2
	Core Foundation Course - II	2	0	0	2
	Discipline 1 – Course - 2	6	0	4	8
	Discipline 2 – Course - 2	6	0	4	8
	Discipline 3 – Course - 2	6	0	4	8
<b>Semester Total:</b>		<b>22</b>	<b>0</b>	<b>12</b>	<b>28</b>

**Second Year**

**Semester - III**

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - III	2	0	0	2
	Elective Foundation Course - I	2	0	0	2
	Discipline 1 – Course - 3	6	0	4	8
	Discipline 2 – Course - 3	6	0	4	8
	Discipline 3 – Course - 3	6	0	4	8
<b>Semester Total:</b>		<b>22</b>	<b>0</b>	<b>12</b>	<b>28</b>

**Semester - IV**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
	Core Foundation Course - IV	2	0	0	2
	Elective Foundation Course - II	2	0	0	2
	Discipline 1 – Course - 4	6	0	4	8
	Discipline 2 – Course - 4	6	0	4	8
	Discipline 3 – Course - 4	6	0	4	8
<b>Semester Total:</b>		<b>22</b>	<b>0</b>	<b>12</b>	<b>28</b>

**Third Year****Semester - V**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
	Vocational Course - I	2	0	0	2
	Core Foundation Course - V/ Elective Foundation Course - III	2	0	0	2
	Discipline 1 – Course - 5	6	0	4	8
	Discipline 2 – Course - 5	6	0	4	8
	Discipline 3 – Course - 5	6	0	4	8
<b>Semester Total:</b>		<b>22</b>	<b>0</b>	<b>12</b>	<b>28</b>

**Semester - VI**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
	Vocational Course - II	2	0	0	2
	Elective Foundation Course - III/ Core Foundation Course - V	2	0	0	2
	Discipline 1 – Course - 6	6	0	4	8
	Discipline 2 – Course - 6	6	0	4	8
	Discipline 3 – Course - 6	6	0	4	8
<b>Semester Total:</b>		<b>22</b>	<b>0</b>	<b>12</b>	<b>28</b>

Course Code	Course Name	L	T	P	C*
<b>Botany</b>					
<b>Semester - I</b>					
BOT 101	Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms	6	0	0	6
BOT 101L	Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms Lab	0	0	4	2
<b>Semester - II</b>					
BOT 102	Angiosperm Anatomy, Embryology and Tissue Culture	6	0	0	6
BOT 102L	Angiosperm Anatomy, Embryology and Tissue Culture Lab	0	0	4	2
<b>Semester - III</b>					
BOT 201	Angiosperm Taxonomy and Economic Botany	6	0	0	6
BOT 201L	Angiosperm Taxonomy and Economic Botany Lab	0	0	4	2
<b>Semester - IV</b>					
BOT 203	Microbiology and Plant Pathology	6	0	0	6
BOT 203L	Microbiology and Plant Pathology Lab	0	0	4	2
<b>Semester - V</b>					
	Discipline Elective - I	6	0	4	8
<b>Semester - VI</b>					
	Discipline Elective - II	6	0	4	8
<b>List of Discipline Elective</b>					
BOT 302	Introduction to Genetics and Genetic Engineering	6	0	0	6
BOT 302L	Introduction to Genetics and Genetic Engineering Lab	0	0	4	2
BOT 303	Plant Physiology and Ecology	6	0	0	6
BOT 303L	Plant Physiology and Ecology Lab	0	0	4	2
BOT 304	Ethnobotany	6	0	0	6
BOT 304L	Ethnobotany Lab	0	0	4	2



BOT 305	Horticulture	6	0	0	6
BOT 305L	Horticulture Lab	0	0	4	2

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**Chemistry**


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**Semester - I**

CHEM 102	Inorganic Chemistry - I	6	0	0	6
CHEM 102L	Inorganic Chemistry - I Lab	0	0	4	2

**Semester - II**

CHEM 103	Organic Chemistry - I	6	0	0	6
CHEM 103L	Organic Chemistry - I Lab	0	0	4	2

**Semester - III**

CHEM 202	Physical Chemistry - I	6	0	0	6
CHEM 202L	Physical Chemistry - I Lab	0	0	4	2

**Semester - IV**

CHEM 201	Inorganic Chemistry - II	6	0	0	6
CHEM 201L	Inorganic Chemistry - II Lab	0	0	4	2

**Semester - V**

Discipline Elective - I	6	0	4	8
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**Semester - VI**

Discipline Elective - II	6	0	4	8
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**List of Discipline Elective**

CHEM 302	Organic Chemistry - II	6	0	0	6
CHEM 305	Molecular Modeling and Drug Design	6	0	0	6
CHEM 303	Physical Chemistry - II	6	0	0	6
CHEM 304	Analytical Methods in Chemistry	6	0	0	6
CHEM 302L	Organic Chemistry - II Lab	0	0	4	2
CHEM 305L	Molecular Modeling and Drug Design Lab	0	0	4	2
CHEM 303L	Physical Chemistry - II Lab	0	0	4	2
CHEM 304L	Analytical Methods in Chemistry Lab	0	0	4	2

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**Computer Science**


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**Semester - I**

CS 107	Computer Fundamentals and Programming	6	0	0	6
CS 108L	Computer Fundamentals and Programming Lab	0	0	4	2

**Semester - II**

CS 103	Computer Architecture and Object Oriented Programming	6	0	0	6
CS 104L	Computer Architecture and Object Oriented Programming Lab	0	0	4	2

**Semester - III**

CS 210	Data Structures	6	0	0	6
CS 210L	Data Structures Lab	0	0	4	2

**Semester - IV**

CS 208	Computer Oriented Numerical and Statistical Methods	6	0	0	6
CS 208L	Computer Oriented Numerical and Statistical Methods Lab	0	0	4	2

**Semester - V**

Discipline Elective - I	6	0	4	8
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**Semester - VI**

CS 310L	Project Lab	0	0	4	2
	Discipline Elective - II	6	0	0	6

**List of Discipline Elective**

CS 316	Business Data Processing and Database Management System	6	0	0	6
CS 316L	Business Data Processing and Database Management System Lab	0	0	4	2
CS 301	Communication and Networking	6	0	0	6
CS 215	Systems Programming	6	0	0	6
CS 320	Programming in Java	6	0	0	6
CS 320L	Programming in Java Lab	0	0	4	2
CS 323	Web Development and .NET Framework	6	0	0	6
CS 323L	Web Development and .NET Framework Lab	0	0	4	2

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**Electronics****Semester - I**

ELE 102	Circuits and Signals	6	0	0	6
ELE 102L	Circuits and Signals Lab	0	0	4	2

**Semester - II**

ELE 103	Principles of Electronics	6	0	0	6
ELE 103L	Principles of Electronics Lab	0	0	4	2

**Semester - III**

ELE 204	Fundamentals of Digital Electronics	6	0	0	6
ELE 204L	Fundamentals of Digital Electronics Lab	0	0	4	2

**Semester - IV**

ELE 203	Electronic Instrumentation and Measurements	6	0	0	6
ELE 203L	Electronic Instrumentation and Measurements Lab	0	0	4	2

**Semester - V**

Discipline Elective - I	6	0	4	8
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**Semester - VI**

Discipline Elective - II	6	0	4	8
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**List of Discipline Elective**

ELE 305	Microprocessors	6	0	0	6
ELE 305L	Microprocessors Lab	0	0	4	2
ELE 302	Communication Systems	6	0	0	6
ELE 302L	Communication Systems Lab	0	0	4	2
ELE 312	Antenna Theory and Wave Propagation	6	0	0	6
ELE 312L	Antenna Theory and Wave Propagation Lab	0	0	4	2
ELE 313	Introduction to Photonics	6	0	0	6
ELE 313L	Introduction to Photonics Lab	0	0	4	2

**Geography****Semester - I**

GEOG 103	Physical Geography	6	0	0	6
GEOG 101L	Fundamentals of Cartography Lab	0	0	4	2

**Semester - II**

GEOG 102	Human Geography	6	0	0	6
GEOG 104L	Statistical Techniques and Data Representation Lab	0	0	4	2

**Semester - III**

GEOG 202	Introduction to Geography of India	6	0	0	6
GEOG 203L	Mapping and Prismatic Compass Survey Lab	0	0	4	2

**Semester - IV**

GEOG 201	Economic Geography	6	0	0	6
GEOG 204L	Relief Representation and Topographical Maps Lab	0	0	4	2

**Semester - V**

GEOG 303L	Map Projection Lab	0	0	4	2
	Discipline Elective - I	6	0	0	6

**Semester - VI**

GEOG 301L	Fundamentals of Geoinformatics Lab	0	0	4	2
	Discipline Elective - II	6	0	0	6

**List of Discipline Elective**

GEOG 305	Environment and Disaster Management	6	0	0	6
GEOG 302	Geographical Thought	6	0	0	6
GEOG 306	Settlement Geography	6	0	0	6
GEOG 304	World Regional Geography	6	0	0	6

**Geology****Semester - I**

GEOL 103	Physical Geology	6	0	0	6
GEOL 103L	Physical Geology Lab	0	0	4	2

**Semester - II**

GEOL 104	Structural Geology and Plate Tectonics	6	0	0	6
GEOL 104L	Structural Geology and Plate Tectonics Lab	0	0	4	2

**Semester - III**

GEOL 203	Mineralogy, Crystallography and Geochemistry	6	0	0	6
GEOL 203L	Mineralogy, Crystallography and Geochemistry Lab	0	0	4	2

**Semester - IV**

GEOL 204	Petrology and Economic Geology	6	0	0	6
GEOL 204L	Petrology and Economic Geology Lab	0	0	4	2

**Semester - V**

Discipline Elective - I	6	0	4	8
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**Semester - VI**

Discipline Elective - II	6	0	4	8
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**List of Discipline Elective**

GEOL 304	Applied Geology	6	0	0	6
GEOL 304L	Applied Geology Lab	0	0	4	2
GEOL 305	Field Geology: Tools and Techniques	6	0	0	6
GEOL 305L	Field Geology: Tools and Techniques Lab	0	0	4	2
GEOL 306	Geology of Rajasthan	6	0	0	6
GEOL 306L	Geology of Rajasthan Lab	0	0	4	2
GEOL 201	Palaeontology and Stratigraphy	6	0	0	6
GEOL 201L	Palaeontology and Stratigraphy Lab	0	0	4	2

**Mathematics****Semester - I**

MATH 106	Introduction to Calculus	4	0	0	4
STAT 104	Introduction to Probability and Statistics	4	0	0	4

**Semester - II**

MATH 101	Analytical Solid Geometry	4	0	0	4
MATH 104	Differential Equations	4	0	0	4

**Semester - III**

MATH 201	Abstract Algebra	4	0	0	4
MATH 206	Real Analysis	4	0	0	4

**Semester - IV**

MATH 202	Introduction to Linear Algebra	4	0	0	4
MATH 301	Complex Analysis	4	0	0	4

**Semester - V**

MATH 302	Introduction to Discrete Mathematics	4	0	0	4
	Discipline Elective - I	4	0	0	4

**Semester - VI**

MATH 303	Introduction to Numerical Analysis	4	0	0	4
	Discipline Elective - II	4	0	0	4

**List of Discipline Elective**

MATH 203	Introduction to Mechanics	4	0	0	4
MATH 304	Linear Programming and its Applications	4	0	0	4
MATH 312	Vector Calculus	4	0	0	4
MATH 310	Number Theory	4	0	0	4

**Physics****Semester - I**

PHY 103	Electricity and Electronics	6	0	0	6
PHY 108L	Electronics Lab	0	0	4	2

**Semester - II**

PHY 107	Optics	6	0	0	6
PHY 107L	Optics Lab	0	0	4	2

**Semester - III**

PHY 201	Mechanics	6	0	0	6
PHY 201L	Mechanics Lab	0	0	4	2

**Semester - IV**

PHY 204L	Physics Lab	0	0	4	2
PHY 205	Thermodynamics, Statistical and Mathematical Physics	6	0	0	6

**Semester - V**

Discipline Elective - I	6	0	4	8
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**Semester - VI**

Discipline Elective - II	6	0	4	8
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**List of Discipline Elective**

PHY 306	Quantum Mechanics and Spectroscopy	6	0	0	6
PHY 306L	Quantum Mechanics and Spectroscopy Lab	0	0	4	2
PHY 304	Advance Quantum Mechanics	6	0	0	6
PHY 304L	Advance Quantum Mechanics Lab	0	0	4	2
PHY 302	Nuclear and Solid State Physics	6	0	0	6
PHY 302L	Nuclear and Solid State Physics Lab	0	0	4	2
PHY 305	Advanced Semiconductor Devices	6	0	0	6
PHY 305L	Advanced Semiconductor Devices Lab	0	0	4	2

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**Statistics**


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**Semester - I**

STAT 106	Probability and Descriptive Statistics	6	0	0	6
STAT 106L	Probability and Descriptive Statistics Lab	0	0	4	2

**Semester - II**

STAT 109	Measures of Association and Probability Distributions	6	0	0	6
STAT 109L	Measures of Association and Probability Distributions Lab	0	0	4	2

**Semester - III**

STAT 209	Sampling Distributions	6	0	0	6
STAT 209L	Sampling Distributions Lab	0	0	4	2

**Semester - IV**

STAT 207	Statistical Inference and Quality Control	6	0	0	6
STAT 207L	Statistical Inference and Quality Control Lab	0	0	4	2

**Semester - V**

Discipline Elective - I	6	0	4	8
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**Semester - VI**

Discipline Elective - II	6	0	4	8
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**List of Discipline Elective**

STAT 302	Sampling Techniques and Design of Experiments	6	0	0	6
STAT 302L	Sampling Techniques and Design of Experiments Lab	0	0	4	2
STAT 301	Applied Statistics	6	0	0	6
STAT 301L	Applied Statistics Lab	0	0	4	2
STAT 303	Financial Statistics	6	0	0	6
STAT 303L	Financial Statistics Lab	0	0	4	2
STAT 304	Health Statistics and Population Dynamics	6	0	0	6
STAT 304L	Health Statistics and Population Dynamics Lab	0	0	4	2

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**Zoology**


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**Semester - I**

ZOO 102	Taxonomy, Classification and Evolution	6	0	0	6
ZOO 104L	Taxonomy, Classification and Evolution Lab	0	0	4	2

**Semester - II**

ZOO 101	Non - Chordates and Proto - Chordates	6	0	0	6
ZOO 103L	Non - Chordates and Proto - Chordates Lab	0	0	4	2

**Semester - III**

ZOO 203	Cell Biology, Molecular Biology, Histology and Genetics	6	0	0	6
ZOO 203L	Cell Biology, Molecular Biology, Histology and Genetics Lab	0	0	4	2

**Semester - IV**

ZOO 202	Comparative Anatomy and Embryology of Chordates	6	0	0	6
ZOO 202L	Comparative Anatomy and Embryology of Chordates Lab	0	0	4	2

**Semester - V**

Discipline Elective - I	6	0	4	8
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**Semester - VI**

Discipline Elective - II	6	0	4	8
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**List of Discipline Elective**

ZOO 301	Animal Physiology	6	0	0	6
ZOO 301L	Animal Physiology Lab	0	0	4	2
ZOO 305	Environmental Biology and Biostatistics	6	0	0	6
ZOO 305L	Environmental Biology and Biostatistics Lab	0	0	4	2
ZOO 304	Developmental Biology	6	0	0	6
ZOO 304L	Developmental Biology Lab	0	0	4	2
ZOO 303	Applied Zoology	6	0	0	6
ZOO 303L	Applied Zoology Lab	0	0	4	2



**List of Core Foundation Course**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
BVF 002	Environment Studies	2	0	0	2
BVF 013	Indian Cultural Heritage	2	0	0	2
BVF 015	Parenthood and Family Relation	2	0	0	2
BVF 017	Selected Writings of Great Authors - I	2	0	0	2
BVF 020	Women in Indian Society	2	0	0	2

**List of Elective Foundation Course**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
BVF 010	Design Thinking	2	0	0	2
BVF 012	Human Body and Health	2	0	0	2
BVF 016	Science of Happiness	2	0	0	2
BVF 019	Universal Human Values	2	0	0	2
BVF 018	Selected Writings of Great Authors - II	2	0	0	2

**List of Vocational Course**

<b>Course Code</b>	<b>Course Name</b>	<b>L</b>	<b>T</b>	<b>P</b>	<b>C*</b>
VOC 011L	Basic Dress Making	0	0	4	2
VOC 011L	Basic Dress Making	0	0	4	2
VOC 014	Entrepreneurship - I	2	0	0	2
VOC 009	Library Science - I	1	0	0	1
VOC 009L	Library Science - I Lab	0	0	2	1
VOC 018	Photography - I	0	0	4	2
VOC 020	Radio Production - I	2	0	0	2
VOC 012	Computer Assisted Learning and Teaching	1	0	0	1
VOC 012L	Computer Assisted Learning and Teaching Lab	0	0	2	1
VOC 016	Introduction to Artificial Intelligence - I	2	0	0	2
VOC 022	Web Designing and Internet Technology - I	1	0	0	1
VOC 022L	Web Designing and Internet Technology - I Lab	0	0	2	1
VOC 005L	Dress Designing	0	0	4	2

VOC 013	Emerging Technologies for Learning and Teaching	2	0	0	2
VOC 015	Entrepreneurship - II	2	0	0	2
VOC 017	Introduction to Artificial Intelligence - II	2	0	0	2
VOC 010	Library Science - II	1	0	0	1
VOC 010L	Library Science - II Lab	0	0	2	1
VOC 019	Photography - II	0	0	4	2
VOC 021	Radio Production - II	2	0	0	2
VOC 023	Web Designing and Internet Technology - II	1	0	0	1
VOC 023L	Web Designing and Internet Technology - II Lab	0	0	2	1

1. Student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester from Semesters III onwards with prior permission of respective heads and time table permitting.
2. Every Student shall also opt for:  
 Five Fold Education: Physical Education I, Physical Education II,  
 Five Fold Education: Aesthetic Education I, Aesthetic Education II,  
 Five Fold Education: Practical Education I, Practical Education II  
 one each semester

\* **L - Lecture hrs/week ; T - Tutorial hrs/week;**

**P - Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C- Credit Points of the Course**

**Note:** Syllabus of Foundation and Vocational courses are available in separate booklet, "Curriculum Structure and Syllabus Foundation and Vocational Courses"

## Five Fold Activities

Fine Arts		Physical Education and Sports	
BVFF 101	Classical Dance (Bharatnatyam)	BVFF 201	Aerobics
BVFF 102	Classical Dance (Kathak)	BVFF 202	Archery
BVFF 103	Classical Dance (Manipuri)	BVFF 203	Athletics
BVFF 104	Creative Art	BVFF 204	Badminton
BVFF 105	Folk Dance	BVFF 205	Basketball
BVFF 106	Music-Instrumental (Guitar)	BVFF 206	Cricket
BVFF 107	Music-Instrumental (Orchestra)	BVFF 207	Equestrian
BVFF 108	Music-Instrumental (Sarod)	BVFF 208	Flying - Flight Radio Telephone Operator's Licence (Restricted)
BVFF 109	Music-Instrumental (Sitar)	BVFF 209	Flying - Student Pilot's Licence
BVFF 110	Music-Instrumental (Tabla)	BVFF 229	Aeromodelling
BVFF 111	Music-Instrumental (Violin)	BVFF 210	Football
BVFF 112	Music-Vocal	BVFF 211	Gymnastics
BVFF 113	Theatre	BVFF 212	Handball
		BVFF 213	Hockey
	<b>Social Service and Extension Activities</b>	BVFF 214	Judo
BVFF 301	Banasthali Sewa Dal	BVFF 215	Kabaddi
BVFF 302	Extension Programs for Women Empowerment	BVFF 216	Karate – Do
BVFF 303	FM Radio	BVFF 217	Kho-Kho
BVFF 304	Informal Education	BVFF 218	Net Ball
BVFF 305	National Service Scheme	BVFF 219	Rope Mallakhamb
BVFF 306	National Cadet Corps	BVFF 220	Shooting
		BVFF 221	Soft Ball
		BVFF 222	Swimming
		BVFF 223	Table Tennis
		BVFF 224	Tennis
		BVFF 225	Throwball
		BVFF 226	Volleyball
		BVFF 227	Weight Training
		BVFF 228	Yoga

### Evaluation Scheme and Grading System

Continuous Assessment (CA) (Max. Marks)					End-Semester Assessment (ESA) (Max. Marks)	Grand Total (Max. Marks)
Assignment		Periodical Test		Total (CA)		
I	II	I	II			
10	10	10	10			
					60	100

In all theory, laboratory and other non classroom activities (project, dissertation, seminar, etc.), the Continuous and End-semester assessment will be of 40 and 60 marks respectively. However, for Reading Elective, only End semester exam of 100 marks will be held. Wherever desired, the detailed breakup of continuous assessment marks (40), for project, practical, dissertation, seminar, etc shall be announced by respective departments in respective student handouts.

Based on the cumulative performance in the continuous and end-semester assessments, the grade obtained by the student in each course shall be awarded. The classification of grades is as under:

Letter Grade	Grade Point	Narration
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C+	5	Average
C	4	Below Average
D	3	Marginal
E	2	Exposed
NC	0	Not Cleared

Based on the obtained grades, the Semester Grade Point Average shall be computed as under:

$$SGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + \dots + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + \dots + CC_n} = \frac{\sum_{i=1}^n CC_i * GP_i}{\sum_{i=1}^n CC_i}$$

Where n is the number of courses (with letter grading) registered in the semester,  $CC_i$  are the course credits attached to the  $i^{th}$  course with letter

grading and  $GP_i$  is the letter grade point obtained in the  $i^{\text{th}}$  course. The courses which are given Non-Letter Grades are not considered in the calculation of SGPA.

The Cumulative Grade Point Average (CGPA) at the end of each semester shall be computed as under:

$$CGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + \dots + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + \dots + CC_n} = \frac{\sum_{i=1}^n CC_i * GP_i}{\sum_{i=1}^n CC_i}$$

Where n is the number of all the courses (with letter grading) that a student has taken up to the previous semester.

Student shall be required to maintain a minimum of 4.00 CGPA at the end of each semester. If a student's CGPA remains below 4.00 in two consecutive semesters, then the student will be placed under probation and the case will be referred to Academic Performance Review Committee (APRC) which will decide the course load of the student for successive semester till the student comes out of the probationary clause.

To clear a course of a degree program, a student should obtain letter grade C and above. However, D/E grade in two/one of the courses throughout the UG/PG degree program respectively shall be deemed to have cleared the respective course(s). The excess of two/one D/E course(s) in UG/PG degree program shall become the backlog course(s) and the student will be required to repeat and clear them in successive semester(s) by obtaining grade C or above.

**After successfully clearing all the courses of the degree program, the student shall be awarded division as per following table.**

Division	CGPA
Distinction	7.50 and above
First Division	6.00 to 7.49
Second Division	5.00 to 5.99
Pass	4.00 to 4.99

**CGPA to % Conversion Formula: % of Marks Obtained = CGPA \* 10**

## Disciplinary Courses

### BOTANY

#### First Semester

#### **BOT 101 Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Acquaint with the general characters and classification of cryptogams and phanerogams.
- Understand the evolutionary relationship among lower to higher plant species with differentiating characteristics.
- Appreciate and understand economic importance and application of every group of plants.

#### **Unit 1**

- Algae: Classification, general account with special reference to *Anabaena*, *Oscillatoria*, *Volvox*, *Chara*, *Oedogonium*, *Ectocarpus*, *Polysiphonia*. Economic importance of algae.

#### **Unit 2**

- Fungi: Classification, general account with special reference to *Albugo*, *Aspergillus*, *Puccinia*, *Ustilago* and *Alternaria*. Economic importance of fungi.

#### **Unit 3**

- Bryophytes: Classification, general account with special reference to important features in the life cycles of *Riccia*, *Marchantia*, *Anthoceros* and Mosses: *Funaria*, *Sphagnum*.

#### **Unit 4**

- Pteridophytes: Classification, general account, evolution of stelar systems, apospory, apogamy and seed habit. Outline of life cycle of *Selaginella*, *Equisetum* and *Marsilea*.

## Unit 5

- Gymnosperms: Classification and evolution, distribution with special reference to Indian gymnosperms. Special features in life cycle of *Cycas*, *Pinus* and *Ephedra*. Economic importance.

### Suggested Books:

- Alam, A. (2015). *Text book of Bryophyta*. New Delhi: I K International Publishers.
- Alexopoulos, C. (1979). *Introductory Mycology*. New York: John Wiley & Sons.
- Bhatia, K. (1975). *A Treatise on Algae*. New Delhi: S. Chand & Company.
- Biswas, C., & Johri, B.M. (2010). *Gymnosperm*. Springer-Verlag Berlin and Heidelberg GmbH & Co. KG
- Chamberlain, C.J. (1919). *Morphology of Gymnosperms*. Allahabad: Central Book Depot.
- Chapman, V.J. (2013). *An Introduction to the Study of Algae*. UK: Cambridge University Press.
- Dubey, H.C. (2011). *Introduction to Fungi*. India: Vikas Publishing House.
- Dutta, S.C. (1967). *Introduction to Gymnosperms*. Asia Publishing House.
- Ganguli, H.C., Das, K.S., & Dutta C. (2011). *College Botany Vol. I*. India: New Central Book Agency.
- Kumar, H.D. (1999). *Introductory Phycology*. New Delhi: Affiliated East-West.
- Parihar, N.S. (1956). *Bryophyta Pteridophyta*. Allahabad: Central Book Depot.
- Rashid, A. (1999). *An Introduction to Pteridophyta*. New Delhi: Vikas publications.
- Saxena, S. (2000). *A text book of Botany (Vol. I & II)*. Agra: Ratan Prakash Mandir.
- Sharma, O.P., & Gupta, R.C. (2010). *Text Book of Fungi*. IBH. New Delhi, India: Vedams eBooks (P) Ltd.
- Sporne, K.R. (1966). *Morphology of Pteridophytes*. London: Hutchinson University Library.

- Vashistha, B.R., & Sinha, A.K. (2010). *Botany for Degree Students-Algae*. New Delhi: S. Chand Publication.
- Vashistha, B.R., & Sinha, A.K. (2016). *Botany for Degree Students-Fungi*. New Delhi: S. Chand Publication.
- Vashistha, B.R., Sinha, A.K., & Kumar, A. (1987). *Botany for Degree classes- Gymnosperms*. New Delhi: S. Chand Publication.
- Vashistha, B.R., Sinha, A.K., & Kumar, A. (2010). *Botany for Degree Students-Bryophyta*. New Delhi: S. Chand Publication.
- Vashisthai, B.R., & Vashistha, P.C. (1987). *Botany for Degree Students Pteridophyta*. New Delhi: S. Chand Publication.
- Webster, J., & Weber, R. (2007) *Introduction to Fungi*. New York: Cambridge University Press.

#### **Suggested e-Resources:**

- **Bryophytes: General account, classification and structure**  
<http://nsdl.niscair.res.in/jspui/bitstream/123456789/150/1/BRYOPHYTES%20.pdf>
- **Gymnosperms**  
<http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter24nf.pdf>
- **Pteridophytes**  
<http://nsdl.niscair.res.in/jspui/bitstream/123456789/556/1/PTERIDOPHYTES%20april609%20-%20formatted.pdf>

## **BOT 101L Algae, Fungi, Bryophyta, Pteridophyta and Gymnosperms Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Identify bryophyte and pteridophyte.
  - Interpret the characteristics & life cycles of various lower plants.
  - Learn about practical technique in lab for detail study of plant structure, anatomy and reproduction.
1. Study of algae and fungi as mentioned in the syllabus (museum specimen of the affected plants and permanent prepared slides).



2. Study of vegetative and reproductive parts in *Selaginella*, *Equisetum* and *Marsilea*.
3. Study of vegetative and reproductive parts in *Riccia*, *Marchantia*, *Anthoceros* and *Funaria* by the preparation of temporary slides.
4. Gymnosperms: Study of *Cycas* (coralloid root, rachis, leaflet, male cone, megasporophyll), *Pinus* (needle, dwarf shoot, long shoot, male cone, female cone) *Ephedra* (morphology, stem, male cone, female cone) by the preparation of temporary slides.

#### **Suggested Books:**

- Bendre, A., & Kumar, A. (2009). *A Textbook of Practical Botany- I*. Meerut: Rastogi Publications.

## **Second Semester**

### **BOT 102 Angiosperm Anatomy, Embryology and Tissue Culture**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Gain knowledge of plant cells, tissues and their functions.
- Identify and compare structural differences among different taxa of vascular plants.
- Correlate anatomical structure with ecological adaptation of plants for survival under drought, salinity & aqueous environment.

#### **Unit 1**

- Angiosperm: Tissues, structure and function.
- Meristematic and permanent tissues, simple, complex and secretory tissue.
- Anamolous secondary growth in stem and roots: *Boerhaavia*, *Bignonia*, *Salvadora*, *Nycatanthes*, *Dracaena* and *Aristolochia*.

## Unit 2

- Ecological Anatomy: General adaptations of Hydrophytes, Xerophytes and Halophytes.
- Anatomical adaptations of Hydrophytes: *Hydrilla*, *Nymphaea*.
- Anatomical adaptation of Xerophytes: *Calotropis*, *Nerium*, *Capparis*.
- Halophytes: Mangrove plants- *Rhizophora*, *Avicennia*.

## Unit 3

- Angiosperm Embryology: Structure and development of culture, male gametophyte, ovule.
- Monosporic, bisporic and tetrasporic types of embryo sacs (one example each of *Polygonum*, *Allium* and *Adoxa*).
- Pollination and Fertilization.

## Unit 4

- Experimental Embryology: Apomixis, Agamospermy and Apospory, Parthenocarpy.
- Adventive embryony.
- Control of fertilization.
- Endosperm and embryo development.

## Unit 5

- Tissue culture: Basic techniques-sterilization and media preparation.
- Concept of totipotency.
- Protoplast isolation and culture; somatic hybridization; anther, embryo and organ culture.
- Tissue culture as a technique in regeneration of plants and its role in Industry.

## Suggested Books:

- Bhojwani, S.S., Bhatnagar, S.P., & Dantu, P.K. (2014). *The embryology of Angiosperms* (6th ed.). Vikas Publishing House Pvt. Ltd.
- Eames, A.J. (1961). *Morphology of the Angiosperms*. New York: McGraw Hill.

- Eames, A.J., & MacDaniels, L.H. (1947). *Introduction to Plant Anatomy*. New York: McGraw Hill.
- Fahn, A. (1997). *Plant Anatomy*. New Delhi: Aditya Books (Pvt) Ltd.
- Kumar, V. (2011). *Methods in Plant tissue culture* (3rd ed.). Jodhpur: Agrobios.
- Maheswari, P. (1950) *Introduction to the Embryology of Angiosperms*. New York: McGraw Hills.
- Pandey, B.P. (2018). *A Text Book of Botany: Angiosperms Taxonomy, Anatomy and embryology*. New Delhi: S Chand and Company Ltd.
- Pandey, S.N., & Chadha, A. (2007). *Plant Anatomy and Embryology*. New Delhi: UBS publishers and distributors Pvt. Ltd.
- Razdan, M.K. (2018). *Introduction to Plant Tissue Culture*. New Delhi: CBS Publishers and Distributors Pvt. Ltd.
- Tayal, M.S. (2004). *Plant Anatomy*. Meerut: Rastogi Publication.

#### **Suggested e-Resources:**

- **Plant tissues types, structure and functions**  
[http://edudel.nic.in/PAHAL/biology\\_260309/biology\\_dt\\_270309.pdf](http://edudel.nic.in/PAHAL/biology_260309/biology_dt_270309.pdf)  
<http://lib.du.ac.ir/documents/10157/60298/Anatomy+of+Flowering+Plants.pdf>
- **Secondary anomalous structures**  
<http://www.biologydiscussion.com/anatomy/anatomy-of-anomalous-dicot-stems-botany/56969>
- **General account of angiosperms**  
<http://www.nhptv.org/natureworks/nwep14f.htm>
- **Secondary growth**  
<http://egyankosh.ac.in/bitstream/123456789/16401/1/Unit-10.pdf>
- **Embryology of angiosperms**  
[krishikosh.egranth.ac.in/bitstream/1/2023583/1/BPT10611.pdf](http://krishikosh.egranth.ac.in/bitstream/1/2023583/1/BPT10611.pdf)
- **Plant tissue culture techniques**  
<https://nptel.ac.in/courses/102103016/4>
- **Introduction to plant tissue culture**  
[http://shodhganga.inflibnet.ac.in/bitstream/10603/110292/12/12\\_chapter%202.pdf](http://shodhganga.inflibnet.ac.in/bitstream/10603/110292/12/12_chapter%202.pdf)

## BOT 102L Angiosperm Anatomy, Embryology and Tissue Culture Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### Learning Outcomes:

On completion of the course, students will be able to:

- Detailed knowledge of angiosperm families and plant adaptations in different environment.
  - Understanding plant tissue culture and preparation of MS medium for in vitro culture of plants.
1. Vegetative structure of hydro - and xerophytes (ecological anatomy of *Calotropis*, *Capparis*, *Nerium*, *Hydrilla* and *Nymphaea*).
  2. Anamolous secondary growth in stem/root of angiosperms (*Boerhaavia*, *Bignonia*, *Salvadora*, *Aristolochia*, *Nyctanthes* and *Dracaena*).
  3. Slides and models on embryology.
  4. MS media preparation
  5. Embryo culture.

### Suggested Books:

- Bendre, A., & Kumar, A. (2010). *A Textbook of Practical Botany- II*. Meerut: Rastogi Publications.

## Third Semester

### BOT 201 Angiosperms Taxonomy and Economic Botany

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

### Learning Outcomes:

On completion of the course, students will be able to:

- Identify characteristic features of angiosperm families and their interdisciplinary approaches Understand plant morphology terminologies and distinguishing features with morphological peculiarities.
- Know the economic importance of angiosperms and its use in various industries.

**Unit-I**

- International code of nomenclature for algae, fungi and plants- history, rules, principles. Concept of family, genus and species, citation of author's name.
- Numerical taxonomy and chemical taxonomy (brief ideas only).
- A brief account of national herbaria and botanical gardens of India.

**Unit 2**

- Classification: System of Bentham and Hooker, a brief account of classification by Engler and Prantl, Hutchinson and Takhtajan, merits and demerits.
- Study of following families with emphasis on their diagnostic features:
  - Ranunculaceae
  - Papaveraceae
  - Capparidaceae
  - Caryophyllaceae
  - Rutaceae
  - Myrtaceae
  - Malvaceae

**Unit 3**

- Study of following families with emphasis on their diagnostic features:
  - Cucurbitaceae
  - Rubiaceae
  - Asclepiadaceae
  - Apocynaceae
  - Asteraceae
  - Amaranthaceae
  - Acanthaceae
  - Solanaceae
  - Apiaceae
  - Lamiaceae
  - Euphorbiaceae
  - Brassicaceae
  - Fabaceae
  - Caesalpinaceae
  - Mimosaceae
  - Poaceae
  - Arecaceae
  - Liliaceae

#### Unit 4

- Food plants: Maize, bajra, wheat, legumes, potato, sugarcane.
- Spices: General account (coriander, turmeric, chillies, *Cumin*, fennel, *Asafoetida*).
- Beverages: Tea and coffee.
- Fatty oils: Mustard, groundnut, sesame, coconut.

#### Unit 5

- Fibre plants: *Gossypium*, *Corchorus*, *Saccharaum munja*.
- Drug plants: *Cinchona*, *Rauwolfia*, *Papaver*, *Digitalis*.
- Timber plants: *Tectona*, *Dalbergia*, *Pinus*. Rubber: *Hevea brasiliensis*.

#### Suggested Books:

- Alam, A., & Sharma, V. (2012). *Economic Botany*. Jaipur: Pointer Publishers.
- Dutta, S. (2009). *A Hand Book of Systematic Botany*. New Delhi: New Age International (P) Limited.
- Khetrapal, Y.T. *An Introduction to the Taxonomy of Angiosperms*. Jaipur: Ramesh Book Depot.
- Kochhar, S.L. (2016). *Economic Botany of the Tropics*. London: Macmillan India Limited
- Kumar, A., & Bendra, A. (1983). *Economic Botany: for university students*. Meerut: Rastogi Publications.
- Lawrence, G.H.M. (2017). *Taxonomy of vascular plants*. Jodhpur: Scientific publisher
- Radford, A.R., & Caddell, G.M. (1986). *Fundamentals of Plant systematics*. USA: Harper & Row Publishers.
- Sharma, O.P. (2011). *Taxonomy of Angiosperm*. New Delhi: TATA McGraw-Hill.
- Singh, V., & Jain, D.K. (2010). *Taxonomy of Angiosperm*. Meerut: Rastogi Publication.
- Verma, V. (2010). *A text book of economic botany*. New Delhi: Emkay publications.

#### Suggested e-Resources:

- **Angiosperms: APG system of classification**  
<https://academic.oup.com/botlinnean/article/181/1/1/2416499>
- **Angiosperms: Classification and reproduction**  
<https://www.toppr.com/guides/biology/plant-kingdom/angiosperms/>
- **Economic botany**  
<http://nsdl.niscair.res.in/jspui/bitstream/123456789/130/1/beverages.pdf>

## **BOT 201L Angiosperms Taxonomy and Economic Botany Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### **Learning Outcomes:**

On completion of the course, students will be able to:

- Develop skills for plant identification, with reference to systematic position, morphological characters, floral formula and floral diagram.
  - Diagnose the structural features of plant organs and differentiate microscopically their tissue elements.
  - Study fiber, gum, resin, timber, spices and medicinal plants and its applications.
1. Study of locally available plants of the families mentioned in the syllabus.
  2. Study of economically important plant products as mentioned in the syllabus.
  3. Preparation of herbarium.

### **Suggested Books:**

- Sahu, A.C. (2015). *Text book of Practical Botany*. New Delhi: Kalyani Publishers.

## **Fourth Semester**

### **BOT 203 Microbiology and Plant Pathology**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

### **Learning Outcomes:**

On completion of the course, students will be able to:

- Understand the structure and life process of prokaryotes and virus.
- Know about sources of plant pathogens, identify symptoms & methods of studying plant diseases
- Identify the role of various microbes in food and beverage industries.

**Unit-1**

- Microbiology- Brief history.
- General account of bacteria- Brief classification and structure; nutrition-types, media; bacterial growth- brief idea, factors affecting growth.
- Recombination in bacteria- conjugation, transformation and transduction.
- Pure culture techniques, staining techniques- a brief idea.

**Unit-2**

- Techniques for sterilization.
- Preservation of microorganisms.
- General account of viruses: introduction, structure and composition.
- Replication of viruses: lytic and lysogenic cycles.
- Cultivation of viruses.

**Unit-3**

- Microbiology of foods and beverages: Bread making, alcoholic beverages (beer and whisky), cheese, fermented milk products, sauerkraut.
- Microbes in spoilage of food.

**Unit 4**

- Bacterial diseases: General symptoms and types of bacterial diseases.
  - (i) Soft rot of carrot
  - (ii) Bacterial wilt of maize
  - (iii) Brown rot of potato
  - (iv) *Citrus* canker
- Viral diseases: General symptoms, survival and transmission of plant viruses.
  - (i) Tomato leaf curl
  - (ii) Cucumber mosaic
  - (iii) Potato mosaic
  - (iv) Tobacco mosaic

**Unit 5**

- Fungal diseases: General symptoms and disease cycle.
  - (i) Wart disease of potato
  - (ii) Damping off



- (iii) Green ear of bajra
- (iv) Powdery mildew on wheat
- (v) Black rust
- (vi) Smut - Wheat and bajra
- (vii) White rust
- (viii) Early blight of potato.

### **Suggested Books:**

- Agrios, G.N. (2005). *Plant Pathology* (5<sup>th</sup> ed.). Elsevier Science.
- Alexopoulos, C.J., Mims, C.W., & Blackwell, M. (2007). *Introductory Mycology*. New York: John Wiley & Sons.
- Ananthanarayan, R., & Paniker, C.K.J. (2009). *Ananthanarayan and Paniker's Textbook of Microbiology* (9<sup>th</sup> ed). Universities Press (India) Private Limited.
- Biswas, S.B. (2009). *An Introduction to Viruses*. New Delhi: Vani Education.
- Butler, E.J. *Plant Pathology- Fungi & Diseases in Plants*. Kolkata: Tanker Spink & Co.
- Dubey, H.C. (2013). *Introduction to Fungi*. Jodhpur: Scientific Publishers.
- Dubey, R.C., & Maheshwari, D.K. (2008). *A Text book of Microbiology*. New Delhi: S. Chand and Company.
- Kumar, H.D., & Kumar S. (2001). *Modern Concepts of Microbiology*. New Delhi: Vikas Publishing House.
- Madigan, M., Martinko, J., Stahl, D., & Clark, D. (2010). *Brock Biology of Microorganisms* (13<sup>th</sup> ed.). Pearson.
- Mehrotra R.S. (2006). *Plant Pathology*. New Delhi: Tata McGraw-Hill.
- Pelczar, M.J., Chan, E.C.S., & Kreig N.R. (2008). *Microbiology*: New Delhi: Tata McGraw Hill.
- Purohit, S.S. (2009). *Microbiology - Fundamentals and Applications*. Bikaner: Agro Botanical Publishers.
- Ross, F.C. (1983). *Introductory Microbiology*. Columbus: Charles E. Merrill.

- Sharma, P.D. (2016). *Microbiology & Plant Pathology*. Meerut: Rastogi Publications
- Sharma, P.D. (2017). *Plant Pathology*. Meerut: Rastogi Publications
- Singh, R.S. (2013). *Plant Disease*. New Delhi: Oxford & IBH.
- Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2014). *Prescott's Microbiology* (9<sup>th</sup> ed). McGraw-Hill Education.

#### **Suggested e- Resources:**

- **Plant diseases: Identification and control**  
<https://www.planetnatural.com/pest-problem-solver/plant-disease/>

### **BOT 203L Microbiology and Plant Pathology Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Learn techniques for microbial isolation, purification, handling and maintenance.
  - Gain knowledge of different methods for the isolation of microbial organisms.
  - Identify the plant diseases based upon symptoms & its causal organism.
1. Knowledge of instruments and equipments used in microbiology and plant pathology.
  2. Preparation of media: PDA, NA, EMB.
  3. Isolation of soil microorganisms by Warcup method.
  4. Isolation of microorganisms from air, water and soil.
  5. Measurement of thermal death time and thermal death point of bacterial culture.
  6. Streaking techniques: Continuous and discontinuous.
  7. Bacterial staining: Simple staining, negative staining, differential staining, endospore staining.
  8. Preservation of cultures by making glycerol stock and revival of culture.

9. Study of bacterial and viral diseases of plants mentioned in the syllabus with help of specimens (Cucumber mosaic, tobacco mosaic, brown rot of potatoes, *Citrus canker*).
10. Study of fungal diseases in plants mentioned in the syllabus by: a) Museum specimens; b) temporary and prepared slides (Smut-wheat and bajra, early blight of potato).

#### **Suggested Books:**

- Aneja, K.R. (2003). *Experiments in microbiology, plant pathology and biotechnology*. New Age International Publishers.
- Mitra, A. (2013). *Practical manual of modern microbiology*. Mumbai: Himalaya Pub. House.

## **Fifth Semester & Sixth Semester Discipline Elective Courses-I & II**

### **BOT 302 Introduction to Genetics and Genetic Engineering**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Acquire knowledge of the structure and arrangement of the genome in living organisms.
- Understand the biochemical nature of nucleic acids, their role in living systems.
- Impart basic genetic manipulation techniques and their application for human welfare.
- Translate concepts in genetic engineering to their own research.

#### **Unit 1**

- Organization of eukaryotic chromosomes.
- Bacterial genetics.
- Cell cycle, mitosis and meiosis.
- Eugenics and genetic counseling.

**Unit 2**

- Genetic terminology, Mendel's experiments: Laws of inheritance, interaction of factors (Modified dihybrid ratios).
- Quantitative inheritance, linkage, crossing over, multiple alleles.
- Sex determination and sex linked inheritance.
- Extra chromosomal inheritance.

**Unit 3**

- Chromosomal aberrations- structural and numerical.
- Mutations.
- Gene: Basic concept.
- Isolation of eukaryotic mRNA, cDNA synthesis and library.
- Genomic library.

**Unit 4**

- Restriction enzymes.
- Vectors- plasmids, phages, cosmids.
- Construction of recombinant DNA.
- Screening and selection of recombinant clones.

**Unit 5**

- Isolation of DNA- plasmid, plant genomic DNA, phage DNA.
- General idea of patents and bio safety guidelines.
- Biotechnology: Definition, application of biotechnology, basic concept of biotechnological processes.
- Edible vaccines.

**Suggested Books:**

- Borem, A., Santos, F.R., & Bowen, D.E. (2003). *Understanding Biotechnology* (1<sup>st</sup> d.). USA: Prentice Hall.
- Brown, T. (2011). *Introduction to Genetics –A molecular approach* (1<sup>st</sup> ed.). USA: Garland Science.
- Brown, T.A. (2010). *Gene Cloning and DNA Analysis: An Introduction* (6<sup>th</sup> ed.). USA: Wiley-Blackwell.
- Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2005). *Principles of Genetics* (8<sup>th</sup> ed.). New Jersey, USA: John Wiley & Sons Ltd.
- Glick, B.R., & Patten, C.L. (2017). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (5<sup>th</sup> ed.). USA: American Society for Microbiology Press.

- Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewonith, R.C. & Gelbert, W.M. (2000). *An Introduction to Genetic Ananlysis* (7<sup>th</sup> ed.). New York, U.S.: W. H. Freeman.
- Gupta, P.K. (2009). *Genetics*. Meerut: Rastogi Publications.
- Gupta, P.K. (2010). *Plant biotechnology*. Meerut: Rastogi Publications.
- Hartl, D.L. & Jones, E.W. (1997). *Genetics: Analysis of Genes and Genome* (9<sup>th</sup> ed.). Canada: Jones and Barlett Publishers.
- Hartwell, L., Hood., Goldberg, M., Reynolds, A.E., & Silver, L. (2010). *Genetics: From Genes to Genomes* (4<sup>th</sup> ed.). New York: McGraw-Hill Education.
- Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A., Killian, D. (2018). *Concepts of Genetics* (12<sup>th</sup> ed.). USA: Pearson Education.
- Krebs, J.E., Goldstein, E.S., & Kilpatrick, S.T. (2012). *Lewin's Genes XI* (11<sup>th</sup> ed.). USA: Jones and Bartlett Publishers.
- Maloy, S.R., Cronan, J.E., & Friefelder, D. (1994). *Microbial Genetics* (2<sup>nd</sup> ed.). USA: Jones and Bartlett.
- Primrose, S.B., & Twyman, R. (2006). *Principles of Gene Manipulation and Genomics* (7<sup>th</sup> ed.) UK: Oxford University Press.
- Singh, B.D. (2015). *Biotechnology*. New Delhi: Kalyani Publishers.
- Strickberger, M.W. (1995). *Genetics* (3<sup>rd</sup> ed.). New Delhi: Prentice Hall India Learning Private Limited.
- Tamarin, R.H. (2004). *Principles of Genetics* (7<sup>th</sup> ed.). USA: McGraw-Hill Higher Education.
- Watson, J.D., Tania, A.B., & Stephen, P.B. (2017). *Molecular Biology of the Gene* (7<sup>th</sup> ed.). USA: Pearson Education.
- Winnacker, E.L. (1987). *From Genes to Clones: Introduction to Gene Technology*. Germany: Wiley VCH.

#### **Suggested e- Resources:**

- **Genetics**  
<https://www.britannica.com/science/genetics>
- **Recombinant-DNA-technology**  
<https://www.britannica.com/science/recombinant-DNA-technology>  
<https://nptel.ac.in/courses/102103013/4>  
<http://www.agbioworld.org/biotech-info/topics/dev-world/policies4.html>
- **Principles & processes of recombinant-DNA-technology**  
<https://www.toppr.com/guides/biology/biotechnology-principles-and-process/processes-of-recombinant-dna-technology/>

➤ **Vectors used in genetic engineering**

<http://www.biologydiscussion.com/genetic-engineering/vectors-used-in-genetic-engineering-biotechnology/61382>

➤ **Patent rights in India**

<https://www.hg.org/legal-articles/patent-rights-in-india-4995>

## **BOT 302L Introduction to Genetics and Genetic Engineering Lab**

**Max. Marks : 100**

**L T P C**

**(CA: 40 + ESA: 60)**

**0 0 4 2**

**Learning Outcomes:**

On completion of the course, students will be able to:

- Develop skills and understanding about different techniques used in genetics and genetic engineering
- Critically analyze and interpret data generated from each practical
- Develop knowledge about genetic problems such as genetic mapping, test cross etc.

1. Problems of genetics.
2. Models based on Mendel's law.
3. Human genetics: Tongue rolling, widow's peak, ear lobes, little finger.
4. Estimation of standard DNA by DPA method.
5. Determination of purity of standard DNA.
6. Determination of  $\lambda_{\max}$  of standard DNA.
7. Isolation of DNA from plant cells.
8. Restriction digestion of DNA.
9. Agarose gel electrophoresis of DNA.
10. Basic biosafety guidelines in the laboratory.

**Suggested Books:**

- Purohit, S.D. (2007). *Molecular Biology and Biotechnology: A Practical Manual*. Udaipur: Apex Publishing House.
- Vats, S. (2015). *A Laboratory Textbook of Biochemistry, Molecular biology and Microbiology*. GRIN Verlag.

## BOT 303 Plant Physiology and Ecology

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### Learning Outcomes:

On completion of the course, students will be able to:

- Comprehend about life processes happening inside plants and how they cope with varied biotic and abiotic factors.
- Understand maintenance of ecological balance and role of man in the degradation of the environment and to suggest remedies.
- Highlight the potential of these studies to become an entrepreneur.

### Unit 1

- Plant water relations: Importance of water to plant life; movement of water across the membranes, ascent of sap; transpiration.
- Mineral nutrition: Methods to study the availability of macro and micro elements, uptake and roles of mineral elements.
- Translocation of organic substances: General principle and mechanism.

### Unit 2

- Photosynthesis: Photosynthetic pigments, factors affecting photosynthesis, mechanism of photosynthesis, role of light, carbon fixation in plants, Photophosphorylation.
- Respiration: Significance and mechanism, factors affecting respiration, release and utilization of biochemical energy, ATP synthesis.

### Unit 3

- Fat Metabolism: Mechanism of synthesis and break down of fats.
- Nitrogen metabolism: Nitrate assimilation, nitrogen fixation, amino acid synthesis and nitrogen cycle.
- Growth and development: Physiology of dormancy and seed germination, vegetative and reproductive growth, vernalization and photoperiodism.
- Growth regulators: Auxins, gibberellins, cytokinins, ethylene and abscisic acid, their physiological importance.

### Unit 4 Ecology

- Plant environment: Climatic, edaphic, topographic and biotic factors.
- Ecosystem: Brief concept, food chains, ecological pyramids (pyramids of number, mass and energy), energetics, biochemical cycling.

## Unit 5

- Plant communities: Structure, classification, diversity, dynamics.
- Applied ecology: Introduction to restoration ecology.
- Environmental pollution (air, water, noise and radioactive), Conservation, plant indicators.

### Suggested Books:

- Ambhast, R.S. (2008). *Plant Ecology*. New Delhi: CBS.
- Dutta, S.C. (2012). *Plant Physiology*. New Delhi: New age International Publishers.
- Hopkins, W.G., & Huner, N.P.A. (2008). *Introduction to Plant Physiology*. New Jersey: John Wiley and Sons Inc.
- Narst, V., Devlin & Witham. (1974) *Plant Physiology*. New Delhi: East West Press.
- Noggle, G.R., & Fritz, G.J. (1992). *Introductory Plant Physiology*. New Delhi: Prentice Hall of India.
- Odum, E.P. (2004). *Fundamentals of Ecology*. Dehradun: Natraj Publishers.
- Pandey, S.N., & Sinha, B.K. (2015). *Plant Physiology*. New Delhi: Vikas Publishing House.
- Salisbury & Ross. (2012). *Plant Physiology*. New Delhi: Prentice Hall of India.
- Sharma, P.D. (2003). *Ecology & Environment*. Meerut: Rastogi Publications.
- Srivastava, H.S. (2005). *Plant Physiology*: Meerut: Rastogi Publications.
- Taiz, L., & Zeiger, E. (2010). *Plant Physiology*. London: Sinauer Associates.

### Suggested e- Resources:

- **Plant Physiology**  
[https://www.udemy.com/plant-physiology/?siteID=zOCYiUhWwNM-1RExiYvhsJfnMd\\_rZR\\_ivg&LSNPUBID=zOCYiUhWwNM](https://www.udemy.com/plant-physiology/?siteID=zOCYiUhWwNM-1RExiYvhsJfnMd_rZR_ivg&LSNPUBID=zOCYiUhWwNM)
- **Ecological communities**  
<http://www-plb.ucdavis.edu/courses/bis/1c/text/Chapter27nf.pdf>



## BOT 303L Plant Physiology and Ecology Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### **Learning Outcomes:**

On completion of the course, students will be able to:

- Understand the physiological details of photosynthesis and respiration.
- Design experiments, collect and analyze data, critically evaluate and present the data produced in physiology or ecology.
- Demonstrate skills related to laboratory as well as field based studies.

### **A. List of Physiology experiments**

1. Osmosis
  - a. Grapes and dried raisins.
  - b. Potato osmoscope and semi permeable membrane.
  - c. Plasmolysis and deplasmolysis.
2. Root pressure
  - a. An experiment on root pressure.
3. Transpiration
  - a. Ganong's potometer and Farmer's photometer.
  - b. Unequal transpiration from two surfaces of a leaf
    - i. Cobalt chloride paper method.
    - ii. Four leaf method with greased surface.
  - c. Demonstration of water lifting power of transpiration (suction force).
  - d. Ringing experiment.
  - e. Study of stomata
4. Photosynthesis
  - a. Oxygen is given off during photosynthesis (Wilmott's bubbler apparatus).
  - b. Light is necessary for photosynthesis.
  - c. Chlorophyll is necessary for photosynthesis.

- d.  $\text{CO}_2$  is necessary for photosynthesis.
- e. RQ by Ganong's respirometer (Demonstration).

5. Respiration

- a.  $\text{CO}_2$  is produced during respiration.
- b. Loss of dry weight in respiration.
- c. Anaerobic respiration.

**B. List of Ecological experiments**

1. To determine the soil temperature by soil thermometer.
2. To measure relative humidity of the atmosphere by wet and dry-bulb thermometer or psychrometer.
3. To determine soil texture.
4. To test the presence of carbonate, nitrate, pH value and base deficiency in soil.
5. To measure the light intensity.
6. To study the structure of the plant community of an area by quadrat method and to determine the plant density, abundance and frequency.
7. To determine the water holding capacity of different soils.

**Suggested Books:**

- Bendre, A., & Kumar, A. (2010). *A Textbook of Practical Botany- II*. Meerut: Rastogi Publications.

## BOT 304 Ethnobotany

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

**Learning outcomes:**

On completion of the course, students will be able to:

- Understand the science of ethnobotany, its concept, scope and objectives.
- Know the types, distribution and life style of ethnic groups in India.
- Know the importance of tribals in present era.
- Know the various uses of plants by the ethnic people in their daily life.
- Know the miscellaneous uses of plants.

- Understand the methodology of ethnobotanical work.
- Know the medicinal uses of plants in crude ways.
- Aware about the legal aspects associated with ethnobotany.

### **Unit 1: Ethnobotany**

- Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science.
- The relevance of ethnobotany in the present context.
- Major and minor ethnic groups or Tribals of India, and their life styles.

### **Unit 2: Ethnobotanical Uses**

- Plants used by the tribals: a) Food plants b) Fodder c) intoxicants and beverages d) Resins and oils and miscellaneous uses.
- Plants of mythological and religious.
- Plants mentioned in Folklore and Folk songs.
- Plants as totems, taboos and superstition.

### **Unit 3: Methodology of Ethnobotanical studies**

- Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.
- Major centers of Ethnobotany in India.

### **Unit 4: Role of ethnobotany in modern Medicine**

- Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology): (a) *Azadiractha indica* (b) *Ocimum sanctum* (c) *Vitex negundo* (d) *Gloriosa superba* (e) *Tribulus terrestris* (f) *Pongamia pinnata* (g) *Cassia auriculata* (h) *Indigofera tinctoria*.
- Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Trichopus zeylanicus*, *Artemisia*, *Withania*.
- Role of ethnic groups in conservation of plant genetic resources.
- Endangered taxa and forest management (participatory forest management).

### **Unit 5: Ethnobotany and legal aspects**

- Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India.
- Biopiracy, Intellectual Property Rights and Traditional Knowledge.

### Suggested Readings

- Colton C.M. 1997. *Ethnobotany – Principles and applications*. John Wiley and sons, Chichester
- Sharma, V. & Alam, A. *Ethnobotany*: Rastogi Publishing House, Meerut
- Faulks, P.J. 1958. *An introduction to Ethnobotany*, Moredale pub. Ltd.
- Jain S.K. (1990). *Contributions of Indian ethnobotany*. Scientific publishers, Jodhpur.
- Jain S.K. (1995). *Glimpses of Indian. Ethnobotny*, Oxford and I B H, New Delhi – 1981
- Jain S.K. (1995). *Manual of Ethnobotany*, Scientific Publishers, Jodhpur, 1995.
- Jain S.K. (ed.) (1989). *Methods and approaches in ethnobotany*. Society of ethnobotanists, Lucknow, India.
- Lone et al. (1980). *Palaeoethnobotany*, Oxford and I B H, New Delhi – 1981
- Rajiv K. Sinha (1996). *Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur*
- Rama Ro, N and Henry A.N. (1996). *The Ethnobotany of Eastern Ghats in Andhra Pradesh*, India. Botanical Survey of India. Howrah.

### Suggested e- Resources:

<http://botanicaldimensions.org/what-is-ethnobotany/>

<https://www.plantsnap.com/blog/casual-ethnobotany/>

<https://trove.nla.gov.au/work/36470887?selectedversion=NBD44743330>

## BOT 304L Ethnobotany Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning outcomes:

On completion of the course, students will be able to:

- Understand the methodology of ethnobotanical work.
- Know the miscellaneous uses of plants.
- Learn the preparation of herbarium.
- Understand the details of ethnic groups through the photographs and other available scientific literatures.

1. Study of wild plants of different families at taxonomical level.
2. Collection of locally growing plants of ethnic importance.
3. Herbarium preparation.
4. Study of ethnic groups through photographs and available literature.
5. Preparation of plants extract.
6. Analysis of phytochemicals.

## **BOT 305 Horticulture**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### **Learning outcomes:**

On completion of the course, students will be able to:

- Understand the basic technique of plant propagation.
- Perform cutting, grafting, budding, layering etc.
- Grow plants in the absence of soil medium.
- Start bonsai creation.
- Know various aspects of Green House Technology.
- Start commercial cultivation of fruits and vegetables.

### **Unit 1**

- Basic horticultural techniques (soil preparation, bed preparation, transplantation & pruning).
- Vegetative propagation of plants (a) cutting (b) grafting (c) budding (d) layering (e) other special structures.

### **Unit 2**

- Soil less culture (hydroponic, Aeroponics).
- Application of Coco peat, Perlite, Vermiculite and Peat moss in horticultural practices.
- Indoor and outdoor plants.
- Bonsai: Types, forms, structure and styles.

### **Unit 3**

- Greenhouse Technology: Importance, types and operation techniques.
- Commercial uses of Green House Technology.
- Benefits and Risks associated with Green House Technology.

## Unit 4

- Commercial cultivation of cut flowers (Roses, Gerberas & Carnations).
- Study of foliage plants (*Ficus*, *Croton* & *Coleus*).
- Study of one locally available vegetables (root, leafy, cole crops).

## Unit 5

- Study of tropical fruits (Mango, Amla, Date palm).
- Study of temperate fruits (Apple).
- Commercial cultivation of exotic fruits.

## Suggested Books

- Ankur: (Magazine).
- Bajaj, Y.P.S. & Narosa. *Biotechnology in agriculture and forestry*.
- Chalam, Venkateshwarlu, G.V.I. *Introduction to Agricultural Botany in India*. Asia Publishing House, New Delhi.
- Hartmann and Kester. *Plant Propagation*.
- Jain, S.K. & Rao, R.R. *A Hand book of Field & Herbarium Methods*. Today & Tomorrow's Printers & Publications, New Delhi.
- Sandhu, M.K. *Plant Propagation*.

## Suggested e- Resources:

[https://icar.org.in/content/horticultural\\_division](https://icar.org.in/content/horticultural_division)

<http://tnhorticulture.tn.gov.in/horti/>

[https://www.onionseek.com/in/search/web/?pk=nQMhNzQd8g9IZLslSBEH6g&q=Online%20Horticulture%20Degree%20Program&id\\_event=5cc7d0693778ea7e85ea4bc6](https://www.onionseek.com/in/search/web/?pk=nQMhNzQd8g9IZLslSBEH6g&q=Online%20Horticulture%20Degree%20Program&id_event=5cc7d0693778ea7e85ea4bc6)

<https://www.longdom.org/horticulture.html>

## BOT 305L Horticulture Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

## Learning outcomes:

On completion of the course, students will be able to:

- Understand the methodology of plant propagation.
- Demonstrate cutting, grafting, budding, layering etc.

- Grow plants in the absence of soil medium.
  - Know various aspects of Green House Technology.
  - Learn the cultivation of fruits and vegetables.
  - Demonstrate the technique of compost production.
1. Layout of kitchen garden.
  2. Vegetative propagation by cutting and grafting.
  3. Herbarium preparation.
  4. Vegetative propagation by budding and layering (Gootee).
  5. To perform emasculation & hybridization.
  6. Preparation of compost.

## CHEMISTRY

### First Semester

#### CHEM 102 Inorganic Chemistry-I

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### Learning Outcomes

On completion of course, the students will be able to:

- derive Schrodinger wave equation and quantum numbers, predict shapes of orbital from probability curves and apply Slater's rule for calculating  $Z_{\text{eff}}$ .
- explain periodic properties like atomic and ionic radii, ionization energy, electron affinity and electronegativity.
- demonstrate bonding theories including valence bond theory, valence shell electron pair repulsion and molecular orbital theory and its applications.
- determine ionic structure of solids with the help of radius ratio values for coordination numbers 3, 4 and 6 and have brief knowledge of metallic bond.
- acquire knowledge of characteristic properties of 3d series elements and its comparison with 4d and 5d series.

- apply the Werner's coordination theory and its experimental verification; to solve numerical problems based on effective atomic number concept.

### **Unit 1 Atomic Structure:**

Schrodinger wave equation, significance of  $\Psi$  and  $\Psi^2$ , quantum numbers, radial and angular wave function and probability distribution curves, shapes of *s*, *p*, *d* orbitals. Aufbau and Pauli principles, Hund's multiplicity rule, exchange energy, pairing energy, symmetrical distribution of charge, extra stability of half-filled and fully-filled orbitals, electronic configuration of elements up to atomic No. 71, effective nuclear charge, shielding effect, Slater's rules for evaluation of shielding constant.

### **Periodic Properties:**

Atomic and ionic radii, ionization energy, electron affinity and electronegativity-definition, methods of determination or evaluation, trends in periodic table, application in predicting and explaining the chemical behavior

### **Unit 2 Chemical Bonding:**

Covalent bond: resonance, valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, valence shell electron pair repulsion (VSEPR) theory with reference to  $\text{BF}_3$ ,  $\text{BF}_4^-$ ,  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{H}_3\text{O}^+$ ,  $\text{PCl}_5$ ,  $\text{SF}_4$ ,  $\text{ClF}_3$ ,  $\text{I}_3^-$ ,  $\text{SF}_6$ ,  $\text{IF}_7$ ,  $\text{ICl}_2^-$ , and  $\text{POCl}_3$ ; MO theory, simple LCAO theory; sigma, pi and delta molecular orbitals; homonuclear and heteronuclear (CO and NO) diatomic molecules and their ions, multicenter bonding in electron deficient molecules, bond strength and bond energy, percentage ionic character from dipole moment and electronegativity difference.

### **Ionic Solids:**

Ionic structure, radius ratio effect and coordination number, calculation of limiting radius ratio values for CN 3, 4 and 6; limitations of radius ratio rule, lattice defects, semi-conductors, lattice energy (excluding mathematical derivation), Born-Haber cycle, solvation energy and solubility of ionic solids, polarizing power and polarisability of ions, Fajan's rule, metallic bond: free electron, valence bond and band theories; weak interactions: hydrogen bonding, Van der Waals interactions.



**Unit 3 s-Block Elements:**

Comparative study, diagonal relationship, salient features of hydrides, solvation and complexation tendencies and an introduction to alkali and alkaline earth metals, alkyl and aryl of *s*-block elements

**p-Block Elements:**

Comparative study (including diagonal relationship) of groups 13 to 17 elements, compounds like hydrides, oxides, oxyacids and halides of groups 13 to 16, hydrides of boron-diboranes and higher boranes, borazine, borohydride; fullerenes, carbides, fluorocarbons, silicates (structural principle), tetrasulphur tetranitride, basic properties of halogens, interhalogens and polyhalides

**Chemistry of Noble Gases:**

Chemical properties of noble gases, chemistry of xenon, structure and bonding in xenon compounds.

**Unit 4 Chemistry of Elements of First Transition Series:**

Characteristic properties of *d*-block elements, properties of elements of the first transition series, their binary compounds and complexes illustrating relative stability of their oxidation states, coordination number and geometry.

**Chemistry of Elements of Second and Third Transition Series:**

General characteristics, comparative treatment with their *3d*-analogues with respect to ionic radii, oxidation states, magnetic behaviour, spectral properties and stereochemistry.

**Unit 5 Valence Bond Theory:**

Introduction, Werner's coordination theory and its experimental verification, effective atomic number concept, chelates, nomenclature of coordination compounds, isomerism in coordination compounds, valence bond theory of transition metal complexes, limitations of VBT.

**Oxidation and Reduction:**

Use of redox potential data, analysis of redox cycle, redox stability in water, Frost, Latimer and Pourbaix diagrams, principles involved in the extraction of the elements.

**Acids and Bases:**

Arrhenius, Lewis, Bronsted-Lowry, Lux-Flood and solvent system concepts of acids and bases.

### Recommended Books

1. Lee, J. D. (1998). *Concise Inorganic Chemistry* (5th ed.). United Kingdom: Wiley/Oxford Publications.
2. Puri, B.R., Sharma, L.R. & Kalia, K.C. (2017). *Principles of Inorganic Chemistry* (33rd ed.). India: Vishal Publications.
3. Cotton, F. A., & Wilkinson, G. (1994). *Basic Inorganic Chemistry* (3rd ed.). United Kingdom: John Wiley Publications.
4. Bhagchandani, P. (2017). *Inorganic Chemistry*. India: Sahitya Bhawan Publications.
5. Malik, W. U., Tuli, G.D., & Madan, R. D.(2010). *Selected Topics in Inorganic Chemistry*. (Revised ed.).India: S. Chand Publications.

### Suggested e-Sources

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

## CHEM 102L Inorganic Chemistry-I Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes

On completion of course, the students will be able to:

- understand the principles of working with laboratory equipments and ability to properly use them during chemistry experiments.
  - prepare standard solution of various secondary standard salts.
  - process purification of impure compounds by crystallization.
  - calibrate lab equipments like pipettes and burettes.
  - analyze, separate and identify inorganic ions from various groups.
1. **Semi-micro Analysis:** Anion and cation analysis, separation and identification of ions from groups Zero, I, II, III, IV, V and VI.
  2. **Calibration:** fractional weights, pipettes and burettes, preparation of standard solutions (0.1 M to 0.001 M).

### 3. Volumetric Analysis

- Determination of acetic acid in commercial vinegar using NaOH.
- Determination of alkali content in antacid tablet using HCl.
- Estimation of calcium content in chalk as calcium oxalate by permanganometry.
- Estimation of copper using thiosulphate.

### Recommended Books

- Gurdeep, R (2016), Advanced Practical Inorganic Chemistry, revised Ed., Krishna Prakashan publication.
- Svehla, G. (2010), Vogel's Qualitative Inorganic Analysis, 7th Edition, Prentice Hall.
- Gurtu, J. N. and Gurtu, A (2011), Physical Chemistry Vol – I, Pragati Prakashan publication.

### Suggested e-Sources

- National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
- Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
- Free Online Education SWAYAM  
<https://swayam.gov.in>

## Second Semester

### CHEM 103 Organic Chemistry-I

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### Learning Outcomes

On completion of course, the students will be able to:

- explain the organic reactions and their mechanisms.
- explain the stereochemistry of the organic compounds including their optical activity, conformations and configurations.

- explain physical and chemical properties of the hydrocarbons, alcohols, carbonyl compounds and carboxylic acids.
- understand the basics of chemistry of aromatic compounds.

### Unit 1 Organic Reactions and their Mechanisms:

Nature of fission of covalent bonds, notations of bond fission, types of reagents, types of organic reactions and energy considerations.

#### Reactive intermediates:

Carbocation, carbanion, free radical, carbene and nitrene.

#### Organometallic Compound:

Structure, synthesis and applications of Grignard reagent.

### Unit 2 Stereochemistry of Organic Compounds:

Concept of isomerism, types of isomerism.

**Geometrical isomerism:** - *cis*- and *trans*- isomerism, E & Z system of nomenclature, determination of configuration of geometrical isomers, geometrical isomerism in oximes and alicyclic compounds.

**Optical isomerism:** - elements of symmetry, molecular chirality, stereogenic centre, optical activity, chiral and achiral molecules with two stereogenic centres- enantiomers, diastereoisomers, threo and erythro diastereoisomers, meso compounds; relative and absolute configuration, sequence rules, D & L and R & S systems of nomenclature; inversion, retention and racemization; resolution of enantiomers.

**Conformational isomerism:** -projection formulae (Fischer, sawhorse, Newman and flying wedge formulae), interconversion of projection formulae, difference between configuration and conformation, conformational analysis of ethane and n-butane, conformations of cyclohexane, axial and equatorial bonds, conformation of monosubstituted cyclohexane derivatives.

### Unit 3 Alkanes and Cycloalkanes:

(a) **Alkanes:** Nomenclature, isomerism, methods of preparation (with special reference to Wurtz reaction, Corey-House reaction, Kolbe reaction and decarboxylation of carboxylic acids), physical properties, mechanism of free radical halogenation of alkanes, reactivity and selectivity.

- (b) **Cycloalkanes:** Ring strain in cyclopropane and cyclobutane, Baeyer's strain theory and its limitation, theory of strainless rings with special reference to cyclopropane ring.

#### **Alkenes:**

Nomenclature, isomerism, relative stabilities, methods of preparation: dehydration of alcohols, dehydrohalogenation of alkyl halides, dehalogenation of vic-dihalides, pyrolysis of quaternary ammonium hydroxides; physical properties, chemical reactions: - catalytic hydrogenation, addition of hydrogen halides, hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis, hydration, hydroxylation with  $\text{KMnO}_4$ , substitution reactions at the allylic and vinylic positions, polymerization; regioselectivity in alcohol dehydration, Saytzeff and Hofmann rules for elimination; industrial applications of ethylene and propene.

#### **Dienes:**

Classification, structure of allene and butadiene, chemical reactions:- electrophilic and free radical addition, polymerization, Diels-Alder reaction.

#### **Alkynes:**

Nomenclature, isomerism, structure and bonding in alkynes, methods of preparation, physical properties, chemical reactions-addition of hydrogen, mechanism of electrophilic and nucleophilic addition, acidity of alkynes, hydroboration-oxidation, metal-ammonia reductions, oxidation and polymerization.

### **Unit 4 Aromaticity:**

Nomenclature of benzene derivatives, aromatic nucleus, side chain, aryl group, structure of benzene: Kekule structure, MO diagram; aromaticity: Huckel rule, aromatic, anti-aromatic and non-aromatic compounds.

**Aromatic Electrophilic Substitution Reactions:** General mechanism, role of  $\sigma$ - and  $\pi$ -complexes, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts reaction; activating and deactivating substituents, *ortho/para* ratio, orientation and methods of determination of the orientation.

**Alky Halides and Aryl Halides:**

**Alkyl Halides:** Nomenclature, classification and methods of preparation, chemical reactions: nucleophilic substitution and elimination reactions.

**Aryl Halides:** Nomenclature, classification, methods of preparation, chemical reactions: nucleophilic aromatic substitution reactions, low reactivity of vinyl and aryl halides, and high reactivity of allyl and benzyl halides; DDT and BHC.

**Alcohols and Phenols:**

**Alcohols:** Nomenclature and classification, dihydric alcohols: methods of preparation, physical properties, chemical reactions of vicinal glycols: acidic nature, reaction with phosphorous halides, reaction with HCl, esterification, oxidative cleavage [ $\text{Pb}(\text{OAc})_4$  and  $\text{HIO}_4$ ] and pinacol-pinacolone rearrangement; trihydric alcohols: methods of preparation, physical properties, chemical reactions of glycerol.

**Phenols:** Nomenclature, classification, structure and bonding, preparation of phenols, physical properties, chemical reactions: acidic character, comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion, electrophilic aromatic substitution, acylation and carboxylation, Fries rearrangement, Claisen rearrangement, Gatterman synthesis, Lederer-Manasse reaction and Reimer-Tiemann reaction.

**Unit 5 Aldehydes and Ketones:****Aldehydes and Ketones:**

Nomenclature, structure of the carbonyl group, synthesis of aldehydes and ketones with particular reference to synthesis of aldehydes and ketones using acid chlorides and 1, 3-dithianes, synthesis of ketones from nitrile and carboxylic acids; physical properties; mechanism of nucleophilic additions to carbonyl group with particular emphasis on aldol, Perkin, Cannizzaro and Knoevenagel condensations; reactions with ammonia and its derivatives; Wittig reaction, Mannich reaction, Clemmenson reduction and Wolf-Kishner reduction; oxidation of aldehydes (reactions with Tollen's reagents, Fehling's solution and Benedict's solution) and ketones (Baeyer-Villiger oxidation).

**Carboxylic Acids:**

Nomenclature, structure and bonding, preparation, physical properties, effects of substituents on acid strength, chemical reactions of carboxylic acids: salt formation, formation of acid derivatives, reduction, reaction with Grignard reagent, decarboxylation and halogenation (Hell-Volhard-Zelinsky reaction).

### Recommended Books

1. Clayden, J., Greeves, N., Warren, S., & Wothers, P., (2001). *Organic Chemistry*. (2<sup>nd</sup> ed.). Oxford University Press.
2. Sykes, P. (1986). *A guide book to mechanism in organic chemistry* (6<sup>th</sup> ed.). Pearson.
3. Ingold, C. K. (1970). *Structure and mechanism in organic chemistry*. Cornell University Press.
4. Morrison, R.T., Boyd, R.N. (2002). *Organic chemistry* (6<sup>th</sup> ed.). PrenticeHall: Englewood Cliffs, NJ.
5. Nasipuri, D. (1994). *Stereochemistry of organic compounds*. (2<sup>nd</sup> ed.). New Age International
6. Singh, M.S. (2005). *Advanced organic chemistry-reactions and mechanisms*. Pearson Education (Singapore) Pvt. Ltd.
7. Wade, L.G., Singh, M.S. (2008). *Organic chemistry*. Pearson Education, Dorling Kindersley Pvt. Ltd.
8. Singh, M.S. (2014). *Reactive intermediates in organic chemistry-structure, mechanism and reactions*. Wiley, VCH, & Weinheim.
9. Eliel E. L., Wilen S. H., Manden L. N. (2005). *Stereochemistry of Carbon compounds*. Wiley & sons.

### Suggested e-Sources

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

## CHEM 103L Organic Chemistry-I Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Laboratory Techniques:

- To calibrate the thermometer using naphthalene (80-82°C), acetanilide (113.5-114°C), urea (132.5-133°C), water (100°C) as reference materials.
- To Determine the boiling point of ethanol, cyclohexane, toluene, benzene.
- To determine the mixed melting point of Urea-cinnamic acid mixture of various compositions (1:4, 1:1, 4:1).

**Distillation**

- Simple distillation of ethanol-water mixture using water condenser.
- Distillation of nitrobenzene and aniline using air condenser.

**Crystallization**

- Concept of introduction of crystallization
- Phthalic acid from hot water (using fluted filter paper and steamless funnel)
- Acetanilide from boiling water
- Naphthalene from ethanol
- Benzoic acid from water

**Decolorisation and Crystallization using Charcoal**

- Decolorisation of brown sugar (sucrose) with animal charcoal using gravity filtration.
- Crystallization and decolorisation of impure naphthalene

**Sublimation (Simple and Vacuum)****Qualitative Analysis:**

- **Part-I** Detection of extra elements (N, S and halogens) and functional groups (carboxylic, alcoholic, phenolic, carbonyl, ester, carbohydrate, amine, amide and nitro) in simple organic compounds
- **Part-II** Identification of an organic compound through the functional group analysis, determination of melting points and preparation of suitable derivatives.

**Stereochemical Study of Organic Compounds via Models:**

- R and S configuration of optical isomers.
- E and Z configuration of geometrical isomers.
- Conformational analysis of cyclohexanes and substituted cyclohexanes.

**Paper Chromatography: Ascending and Circular:**

- Determination of  $R_f$  values and identification of organic compounds.
- Separation of monosaccharides (a mixture of D-galactose and D-fructose) using n-butanol, acetone and water in 4:5:1 ratio, and spray reagent (aniline hydrogen phthalate).



### Recommended Books

1. Leonard, J., Lygo, B., Procter, G. (2013). *Advanced Practical Organic Chemistry* (3rd ed.). CRC Press, Taylor & Francis Group.
2. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.). New York, John Wiley & Sons, Inc.

### Suggested e-Sources

1. National Programme on Technology Enhanced Learning  
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2. Online Chemistry Courses  
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3. Free Online Education SWAYAM  
<https://swayam.gov.in>

## Third Semester

### CHEM 202 Physical Chemistry-I

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### Learning Outcomes

On completion of course, the students will be able to:

- explain the basic principles of thermodynamics and thermochemistry.
- describe the states of matter.
- explain the concepts of chemical kinetics and catalysis.
- apply the concept of thermodynamics to determine the heat of neutralization of chemical reaction.
- explain the concept of colloids.

### Unit 1 Chemical kinetics and Catalysis:

Introduction, measurement of reaction rate, integration and determination of rate laws, rate constant, unit of rate constant for zero order, first order and second order reactions, order of reaction, molecularity of reaction, difference between order and molecularity of reaction, chemical kinetics and its scope, factors influencing the rate of a reaction-concentration, temperature, pressure, solvent, light, catalyst; concentration dependence of

rates, mathematical characteristics of simple chemical reactions-zero order, first order, second order, pseudo order; half-life and mean life; determination of the order of reaction-differential method, graphical method, method of integration, method of half-life period and isolation method, radioactive decay as a first order phenomenon.

### **Theories of chemical kinetics:**

Effect of temperature on rate of reaction, temperature co-efficient, Arrhenius equation, concept of activation energy, transition state theory (equilibrium hypothesis), expression for the rate constant based on equilibrium constant and thermodynamic aspects.

### **Unit 2 Thermodynamics-I:**

Definition, significance and limitations, classical versus statistical thermodynamics, different thermodynamic terms: system, surroundings, types of systems, intensive and extensive properties, state and path functions, and their differentials, Euler reciprocity relation and cyclic rule, thermodynamic process, concept of heat and work.

First law of Thermodynamics: statement, definition of internal energy and enthalpy, heat capacity: heat capacities at constant volume and pressure and their relationship, Joule's law, Joule-Thomson coefficient and inversion temperature, calculation of  $w$ ,  $q$ ,  $dU$  and  $\Delta H$  for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process, application of first law of thermodynamics, zeroth law of thermodynamics and the absolute temperature scale.

### **Thermo-Chemistry:**

Standard state, standard enthalpy of formation: Hess's law of heat summation and its applications, heat of reaction at constant pressure and at constant volume, various types of enthalpies of reaction: enthalpy of formation, enthalpy of combustion, enthalpy of solution, enthalpy of dilution, enthalpy of hydration and enthalpy of neutralization, bond dissociation energy and its calculation from thermochemical data, calculation of lattice energy from Born-Haber's cycle, temperature dependence of enthalpy, Kirchhoff's equation, adiabatic flame temperature.

### **Unit 3 Thermodynamics-II:**

Second law of thermodynamics: need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorem, thermodynamic scale of temperature and its identity with ideal gas temperature scale.

Concept of entropy: entropy as a state function, characteristics of entropy function and Maxwell relations, entropy as a function of V and T, entropy as a function of P and T, entropy change in physical change, Clausius inequality and its application to an isolated system, entropy as a criteria of spontaneity and equilibrium, entropy change in ideal gases: temperature and volume, temperature and pressure variations, standard entropy and entropy of mixing of ideal gases.

### **Chemical Equilibrium:**

Free energy of spontaneous reactions and the role of temperature, equilibrium constant and free energy, thermodynamic derivation of law of mass action, Van't Hoff reaction isotherm, factors affecting the state of equilibrium, Le-Chatelier's principle and its applications to physical and chemical equilibrium, reaction isotherm and reaction isochore, Clapeyron and Clausius-Clapeyron equations and its applications for liquid-vapor, solid-vapor and solid-liquid equilibrium.

### **Unit 4 Gaseous State:**

Postulates of kinetic theory of gases, deviation from ideal behavior, Van der waals equation of state, critical phenomena, PV isotherms of real gases, continuity of states, the isotherms of Van der waals constants, the law of corresponding states and reduced equation of state.

Molecular velocities: root mean square, average and most probable velocities, qualitative discussion of the Maxwell's distribution of molecular velocities, collision number, mean free path and collision diameter, liquification of gases (based on Joule-Thomson effect).

### **Liquid State:**

Intermolecular forces, structure of liquids (a qualitative description), structural differences between solids, liquids and gases; liquid crystals: difference between solid crystals and liquid crystals; classification, structure of nematic and cholestric phases, thermography and seven-segment cell.

## Unit 5 Colloidal State:

Definition and classification of colloids, solid in liquid (sol): properties-kinetic, optical and electrical; stability of colloids, protective action, Hardy-Schulze law, gold number, liquid in liquid (emulsion): types and preparation of emulsions, emulsifier, liquid in solid (gel): classification, preparation and properties, inhibition and general applications of colloids.

### Solid State:

Solids-classification, properties:-electrical and magnetic; crystals-external features, symmetry, lattice point, unit cell, classification; ionic crystals - packing of constituents in crystals, relationship between edge length and ionic radii, packing efficiency, coordination number, interstitial voids-trigonal voids, tetrahedral voids, octahedral voids and cubic voids, radius ratio of voids.

### Defects in Solids:

Definition, classification, stoichiometric and non-stoichiometric defects, consequences of defects.

### Recommended Books

1. Atkins, P., Julio, P. D. (2014). *Physical Chemistry* (10th Ed.), United Kingdom: Oxford University Press.
2. Castellan, G.W. (1983). *Physical Chemistry* (3rd Ed.), United State of America: Addison-Wesley Publishing Company.
3. West, A. R. (2014). *Solid State Chemistry and its Applications* (2nd Ed.), John Wiley & Sons Ltd.
4. Puri, B.R., Sharma, L.R., Pathania, M.S.(2016). *Principle of Physical Chemistry* (47th Ed.), India: Vishal Publishing Company.
5. Laider, K.J.(1965). *Chemical Kinetics* (2nd Ed.), New York: McGraw Hill Book Company.

### Suggested e-Sources

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
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3. Free Online Education SWAYAM  
<https://swayam.gov.in>

## CHEM 202L Physical Chemistry-I Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### Learning Outcomes

On completion of course, the students will be able to:

- determine the percentage composition of unknown mixture by viscosity and surface tension methods.
- measure kinetics parameters of chemical reaction.
- evaluate the enthalpy of neutralization.
- calculate the lattice energy of  $\text{CaCl}_2$  and solubility of benzoic acid at different temperatures.

### Surface Tension and Viscosity:

1. To find the relative and absolute viscosity of the given liquid at room temperature.
2. To determine the percentage composition of given mixture (non-interacting systems) by viscosity method.
3. To find the surface tension of given liquid by drop number method at room temperature.
4. To determine the percentage composition of given binary mixture by surface tension method (acetone and ethyl/methyl ketone).

### Chemical Kinetics:

1. To determine the specific reaction rate of the hydrolysis of methyl acetate/ethyl acetate catalyzed by hydrogen ions at room temperature.
2. To study the effect of acid strength on the hydrolysis of an ester.
3. To compare the strengths of  $\text{HCl}$  and  $\text{H}_2\text{SO}_4$  by studying the kinetics of ethyl acetate.
4. To study the reaction rate of decomposition of iodide by  $\text{H}_2\text{O}_2$  kinetically.

### Colloids:

1. To prepare arsenious sulfide sol and compare the precipitating power of mono-, bi- and trivalent anions.

### Transition Temperature:

1. Determination of the transition temperature of given substance by thermometric method (e.g.  $\text{MnCl}_2 \cdot 4\text{H}_2\text{O}$  /  $\text{SrBr}_2 \cdot 2\text{H}_2\text{O}$ ).

**Thermo-Chemistry:**

1. To determine the solubility and heat of reaction of benzoic acid at different temperatures.
2. To determine the enthalpy of neutralization of strong acid and strong base.
3. To determine the enthalpy of neutralization of weak acid and strong base.
4. To determine the enthalpy of solution of solid calcium chloride and calculate its lattice energy using Born-Haber cycle.
5. Determination of heat of reaction and verification of Hess's law.

**Partition Coefficient:**

1. To find the partition coefficient of  $I_2$  between  $CCl_4$  and  $H_2O$ .

**Recommended Books**

1. Gurtu, G.N., Gurtu, A. (2014). *Advanced Physical Chemistry*, India: Pragati Prakashan .
2. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan Publishers.

**Suggested e-Sources**

1. National Programme on Technology Enhanced Learning  
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<https://swayam.gov.in>

**Fourth Semester****CHEM 201 Inorganic Chemistry-II****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

**Learning Outcomes**

On completion of course, the students will be able to:

- apply crystal field theory on different geometries and correlate it with stability.
- elucidate the nomenclature, structures, magnetic properties and reactivity of transition metal complexes.

- apply the concept of L-S coupling for the determination of term symbols of different spectroscopic states and appreciate its utility.
- elaborate the thermodynamic and kinetic stability of metal complexes.
- demonstrate the structure, bonding and reactivity of organometallic compounds.
- discuss a concise treatment of the important inorganic non-aqueous solvents and its application in various known reactions.
- apply HSAB principle on stability of molecules.

### **Unit 1 Crystal Field Theory:**

Introduction, crystal field splitting in octahedral, tetrahedral, square planar, and trigonal bipyramidal complexes, factors affecting the crystal-field parameters, Jahn-Teller distortions, applications and limitations of crystal field theory.

#### **Magnetic Properties of Transition Metal Complexes:**

Types of magnetic behavior, methods of determining magnetic susceptibility, spin-only formula, L-S coupling, correlation of  $\mu_s$  and  $\mu_{eff}$  values, orbital contribution to magnetic moments, applications of magnetic data for 3d-metal complexes.

### **Unit 2 Electronic Spectra of Transition Metal Complexes:**

Types of electronic transitions, selection rules for d-d transitions, spectroscopic ground states, spectrochemical series, Orgel energy level diagram for  $d^1$  and  $d^9$  states, discussion of the electronic spectrum of  $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$  complex ion.

#### **Thermodynamic and Kinetic Aspects of Metal Complexes:**

Lability and inertness of complexes, brief outline of thermodynamic and kinetic stability of metal complexes and factors affecting the stability, substitution reactions of square planar complexes.

### **Unit 3 Chemistry of Lanthanides:**

Electronic structure, oxidation states, ionic radii, lanthanide contraction, complex formation, occurrence and isolation, lanthanide compounds, spectral and magnetic properties.

#### **Chemistry of Actinides:**

General features and chemistry of actinides, chemistry of separation of Np, Pu and Am from U, similarities between the post actinides and the post lanthanides.

**Unit 4 Non-aqueous Solvent:**

Classification of solvents, physical properties of solvents, reactions in non-aqueous solvents with reference to liquid  $\text{NH}_3$  liquid HF and liquid  $\text{SO}_2$ .

**Hard and Soft Acid and Base (HSAB):**

Classification of acids and bases as hard and soft, Pearson's HSAB concept, acid-base strength and hardness and softness, symbiosis, theoretical basis of hardness and softness.

**Unit 5 Bio-Inorganic Chemistry:**

Essential and trace elements in biological processes, metalloporphyrins: hemoglobin, myoglobin, hemocyanin and hemerythrin; biological role of alkali and alkaline earth metal ions with special reference to  $\text{Ca}^{2+}$  in muscle contraction, nitrogen fixation.

**Organometallic Chemistry:**

Definition, nomenclature and classification of organometallic compounds, preparation, properties, bonding and applications of alkyls and aryls of Li, Al, Hg, Sn and Ti, a brief account of metal-ethylenic complexes, mononuclear carbonyls and the nature of bonding in metal carbonyls.

**Recommended Books**

1. Lee, J.D (1998). *Concise Inorganic Chemistry*, (5th ed.). Oxford Publications.
2. Puri, B.R, Sharma, L.R., Kalia, K.C. (2017). *Principles of Inorganic Chemistry*, (3rd ed.). Vishal Publications.
3. Cotton, F.A., Wilkinson, G. (1994). *Basic Inorganic Chemistry*, (3rd ed.). John Wiley Publications
4. Huheey, J.E., Keiter, J.A. & Keiter, R.L. (1997), *Inorganic Chemistry: Principles of Structure and Reactivity*, 4th (ed.) Pearson Publications.
5. Bhagchandani, P. (2017), *Inorganic Chemistry*, Sahitya Bhawan Publications.
6. Malik, W.U., Tuli, G.D. & Madan, R.D. (2010), *Selected Topics in Inorganic Chemistry*, Revised Ed., S. Chand Publications.

**Suggested e-Sources**

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>



- Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
- Free Online Education SWAYAM  
<https://swayam.gov.in>

## CHEM 201L Inorganic Chemistry - II Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes

On completion of course, the students will be able to:

- perform the proper procedures and have the knowledge of regulations for safe handling and use of chemicals.
- predict chemical bonding or molecular geometry of various complexes based on accepted models.
- synthesize various transition metal complexes.
- Handle instruments like calorimeter and potentiometer.

### Analysis of the following by Volumetrically/Gravimetrically:

- Estimation of Barium (as sulphate)
- Estimation of Lead (as sulphate)
- Estimation of Zinc (as ammonium sulphate)
- Estimation of Magnesium (as magnesium hydrogen phosphate)
- Estimation of Copper (as thiocynate)
- Estimation of Nickel (as nickel dimethyl glyoximate)

### Complexometric Titrations using Disodium Salt of EDTA:

- Estimation of  $Mg^{2+}$  and  $Zn^{2+}$
- Estimation of  $Ca^{2+}$  by substitution method

### Preparation and Purification of following Complexes:

- Sodium trioxalatoferrate (III)
- Tetraamminecopper (II) sulphate
- Sodium trioxalatochromate (III)
- cis- and trans-diaquadioxalatochromate (III) ion

### Colorimetric Estimation:

- Job's method
- Mole-ratio method

**Adulteration Analysis (any one of the following):**

1. Food stuffs
2. Effluents

**Solvent Extraction:**

1. Separation and estimation of Mg (II) and Fe (II)

**Recommended Books**

1. Gurdeep, R. (2016). *Advanced Practical Inorganic Chemistry*, Krishna Prakashan publication.
2. Svehla, G. (2010). *Vogel's Qualitative Inorganic Analysis*, (7th ed.). Prentice Hall.
3. Gurtu, J. N. and Gurtu, A (2011), *Physical Chemistry Vol – I*, Pragati Prakashan publication.

**Suggested e-Sources**

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

**Fifth Semester & Sixth Semester****Discipline Electives (Theory)****CHEM 302 Organic Chemistry-II****Max. Marks : 100****(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

**Learning Outcomes:**

On completion of course, the students will be able to:

- explain the structures and properties of biomolecules: carbohydrates, amino acids, proteins and nucleic acids.
- explain the structures, synthesis and properties of different class of organic compounds: nitro compounds, amines, diazonium salts, enolates, pyrrole, thiophene, furan, pyridine, indole, quinoline and isoquinoline.

- discuss the basic principles of UV-visible, IR and NMR spectroscopy.
- elucidate the structure of organic compounds using UV-visible, IR and NMR spectral data.

### Unit 1 Carbohydrates:

Classification and nomenclature, monosaccharides: chain lengthening and chain shortening of aldoses, configuration, mechanism of osazone formation, mechanism of mutarotation, interconversion of glucose and fructose, epimerization (conversion of glucose into mannose), determination of ring size of D (+)-glucose and fructose; disaccharides: -sucrose, lactose and maltose (without involving structure determination); polysaccharides: starch and cellulose (without involving structure determination).

### Biomolecules:

- Amino acids:** Classification, structure, acid-base behaviour, isoelectric point; preparation, physical properties and chemical reactions of  $\alpha$ -amino acids.
- Peptides and Proteins:** Classification, structure determination, and end group analysis, selective hydrolysis of peptides, solid-phase peptide synthesis.
- Nucleic acids:** Introduction, constituents of nucleic acids, ribonucleosides and ribonucleotides, double helical structure of DNA.

### Unit 2 UV-visible Spectroscopy:

Introduction to electromagnetic spectrum, basic principle, types of electronic transitions, factors affecting the position of absorption bands: conjugation and solvent; concept of chromophore and auxochrome; bathochromic, hypsochromic, hyperchromic and hypochromic shifts; UV-visible spectra of conjugated enes and enones: Woodward and Fieser rules, calculation of  $\lambda_{\text{max}}$  of simple molecules; applications: strength of hydrogen bond, geometrical isomerism, keto-enol tautomerism.

### Infrared Spectroscopy:

Basic principle, molecular vibrations, Hooke's law, selection rule, intensity and position of IR bands, factors affecting vibrational frequencies: coupled vibrations, Fermi resonance, electronic effects, hydrogen bonding and angle strain; fingerprint region,

characteristic absorptions of various functional groups, interpretation of IR spectra of simple organic compounds, applications of IR spectroscopy.

### Unit 3 Organic Compounds of Nitrogen:

- (a) **Nitro Compounds:** Nomenclature, preparation of nitroalkanes and nitroarenes, physical properties, chemical reactions of nitroalkanes: acidic character, mechanism of nucleophilic and electrophilic substitution, reduction; chemical reactions of nitroarenes: mechanism of nucleophilic and electrophilic substitution, reduction in acidic, neutral and alkaline media, picric acid: methods of preparation, physical and chemical properties, halonitroarenes: methods of preparation and reactivity.
- (b) **Amines:** Nomenclature and structure, stereochemistry, separation of mixture of amines, preparation of amines: reduction of nitro compounds, Gabriel-phthalimide reaction, Hofmann bromamide reaction, Curtius, Schmidt and Lossen rearrangements, physical properties, chemical reactions: structural features affecting basicity of amines, amine salts as phase-transfer catalysts, electrophilic aromatic substitution, diazotization.
- (c) **Diazonium Salts:** Nomenclature and structure, preparation, physical properties, chemical reactions: replacement of diazo group by H, OH, F, Cl, Br, I, NO<sub>2</sub>, CN and aryl group; synthetic applications.

### Unit 4 Heterocyclic Compounds:

Introduction, classification, nomenclature of five and six-membered rings, molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine; methods of synthesis and chemical reactions with particular emphasis on the mechanism of electrophilic substitution; mechanism of nucleophilic substitution reactions in pyridine derivatives; comparison of basicity of pyridine, piperidine and pyrrole.

Introduction of condensed five and six membered heterocycles; preparation and reactions of indole, quinoline and isoquinoline with special reference to Fischer-indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis; mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

## Unit 5 Organic Synthesis via Enolates:

Introduction, acidity of  $\alpha$ -hydrogens, reactive methylene group-alkylation of diethyl malonate and ethyl acetoacetate, synthesis and reaction of ethyl acetoacetate, Keto-enol tautomerism of ethyl acetoacetate, alkylation of 1,3-dithianes, alkylation and acylation of enamines.

### Nuclear Magnetic Resonance Spectroscopy:

Introduction, basic principle, chemical shift, chemical shift parameters, factors affecting the chemical shift, equivalence and non-equivalence protons, spin-spin coupling, coupling constant, interpretation of PMR spectra of simple organic molecules such as ethyl bromide, n-propyl bromide, isopropyl bromide, 1,1-dibromoethene, 1,1,2-tribromoethene, ethyl alcohol, ethyl acetate, acetaldehyde, benzaldehyde, toluene and acetophenone.

### Recommended Books

1. Clayden, J., Greeves, N., Warren, S., & Wothers, P. (2001). *Organic chemistry*. (2<sup>nd</sup> ed.). Oxford University Press.
2. Sykes, P. (1986). *A guide book to mechanism in organic chemistry* (6<sup>th</sup> ed.). Pearson.
3. Ingold, C. K. (1970). *Structure and mechanism in organic chemistry*. Cornell University Press.
4. Morrison, R.T., & Boyd, R.N. (2002). *Organic chemistry* (6<sup>th</sup> ed.). Prentice Hall.
5. Nasipuri, D. (1994). *Stereochemistry of organic compounds*. (2<sup>nd</sup> ed.). New Age International
6. Singh, M.S. (2005). *Advanced organic chemistry-reactions and mechanisms*. Pearson Education, Singapore.
7. Wade, L.G., & Singh, M. S. (2008). *Organic chemistry*. Pearson Education.
8. Singh, M.S. (2014). *Reactive intermediates in organic chemistry-structure, mechanism and reactions*. Wiley, VCH & Weinheim
9. Kemp, W. (1991). *Organic Spectroscopy*. (3<sup>rd</sup> ed.). Palgrave Houndmills. New York.
10. Mohan, J. (2001). *Organic Spectroscopy: Principles and Applications*. Narosa Publication, New Delhi.
11. Kalsi, P. S., (2016). *Organic Spectroscopy*. (7<sup>th</sup> ed.). New Age International Publishers, New Delhi
12. Silverstein, R. M., Webster, F. X. & Kiemle, D., (2005). *Spectrometric Identification of Organic Compounds*. (7<sup>th</sup> ed.). John Wiley & Sons.

**Suggested e-Sources**

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

**CHEM 305 Molecular Modeling and Drug Design****Max. Marks : 100****(CA: 40 + ESA: 60)****L T P C****6 0 0 6****Learning Outcomes:**

On completion of course, the students will be able to:

- describe and comprehend the fundamental concepts of molecular modeling and computational-driven drug discovery.
- understand the physicochemical properties of drugs including solubility, distribution, adsorption, and stability.
- understand the Molecular modeling and computer graphics
- develop the theoretical and practical aspects of molecular modeling

**Unit 1 Introduction to Molecular Modeling:** Useful Concepts in molecular modeling: Coordinate Systems, Potential Energy Surfaces, Molecular Graphics, Computer Hardware and Software.

**Force Fields:** Fields, Bond Stretching, Angle Bending, Introduction to nonbonded interactions, Electrostatic interactions, van der Waals Interactions, Hydrogen bonding in Molecular Mechanics, Force Field Models for the Simulation of Liquid Water.

**Unit 2 Energy Minimization and Computer Simulation:** Minimization and related methods for exploring the energy surface, Non-derivative method, First and second order minimization methods, Computer simulation methods, Simple thermodynamic properties and Phase Space, Boundaries, Analyzing the results of a simulation and estimating Errors.

**Unit 3 Molecular Dynamics and Monte Carlo Simulation:** Molecular Dynamics Simulation Methods, Molecular Dynamics using simple models, Molecular Dynamics with continuous potentials, Molecular Dynamics at constant temperature and pressure, Metropolis method, Monte Carlo simulation of molecules, Models used in Monte Carlo simulations of polymers.

**Unit 4 Structure Prediction and Drug Design:** Structure prediction - Introduction to comparative Modeling, Sequence alignment, Constructing and evaluating a comparative model, Predicting protein structures by 'Threading', Molecular docking, Structure based de novo ligand design, Drug Discovery - Chemoinformatics -QSAR.

**Unit 5 Pharmaceutical Compounds:** Structure and Importance Classification, structure and therapeutic uses of antipyretics: Paracetamol (with synthesis), Analgesics: Ibuprofen (with synthesis), Antimalarials: Chloroquine (with synthesis), artemisinin, An elementary treatment of Antibiotics and detailed study of chloramphenicol, Medicinal values of curcumin (haldi), azadirachtin (neem), vitamin C and antacid (ranitidine).

### **Recommended Books**

1. Leach, A.R. (2001). *Molecular Modelling Principles and Application*, Longman.
2. Haile, J.M. (1997). *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons.
3. Gupta, S.P. (2008). *QSAR and Molecular Modeling*, Springer - Anamaya Publishers.

### **Suggested e-Sources**

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

## CHEM 303 Physical Chemistry-II

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### Learning Outcomes

On completion of course, the students will be able to:

- explain the basic principles of nuclear chemistry.
- discuss the surface phenomenon, surface properties of solid and calculate the surface area of the adsorbent.
- discuss conductance, Arrhenius theory, Debye-Huckel-Onseger's equation and Nernst equation.
- explain the concept of corrosion and factors affecting corrosion.
- explain the colligative properties of solution.
- Understand the congruent and non-congruent melting points, and azeotropic mixtures.

### Unit 1 Nuclear Chemistry:

Nuclear particles, nuclear size, nuclear spin, nuclear magnetic moment, of a nucleus, discovery of radioactivity, decay processes-average life, half life; Rutherford and Soddy transformation, nuclear forces, packing fraction, binding energy, nuclear shell model, liquid drop model, applications of radioisotopes, hot atom chemistry-Szilard-Chalmers reaction.

#### Surface Chemistry:

General terms used in adsorption, adsorption of gases by solids, factors effecting adsorption, mono and multi layer adsorption, heat of adsorption Freundlich adsorption isotherm, Langmuirs adsorption isotherm and its limitations, determination of surface area of adsorbents, change in enthalpy, entropy and free energy of adsorption, competitive adsorption, mechanism of surface reaction and activation energy.

### Unit 2 Solutions, Dilute Solutions and Colligative Properties:

Ideal and non-ideal solutions, deviation from ideal behaviour, method of expressing concentrations of solutions: - normality, molarity, molality, formality, mole fraction, percentage by mass, parts per million (ppm), activity and activity coefficient, dilute solution, Rault's law, colligative properties: relative lowering of vapour pressure, measurement of vapour pressure lowering, molecular weight determination, osmosis, law of osmotic pressure



and its measurement, determination of molecular weight from osmotic pressure, relationship between osmotic pressure and vapor pressure, lowering of an ideal solution, measurement of osmotic pressure (The Morse-Frazer method, the Berkeley-Hartley method), elevation in boiling point, depression in freezing point, thermodynamic derivation of relation between molecular weight and elevation in boiling point and depression in freezing point, experimental methods for determining various colligative properties, abnormal molar mass and Van't Hoff factor, degree of dissociation and association of solutes.

### **Unit 3 Electrochemistry-I:**

Electric transport in electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution, migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation, its uses and limitations, weak and strong electrolytes, Ostwald's dilution law and its uses and limitations, Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only), transport number, definition and determination by Hittorf method and moving boundary method, applications of conductivity measurement: determination of degree of dissociation, determination of  $K_a$  of acids, determination of solubility product of sparingly soluble salt, conductometric titrations.

### **Unit 4 Electrochemistry-II:**

Types of reversible electrodes:-gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrode reactions, relationship between EMF and equilibrium constant, Nernst equation, effect of electrolytic concentration on electrode potential, standard hydrogen electrode, reference electrode, standard electrode potential, derivation of cell EMF and single electrode potential, sign conventions, electrochemical series and its significance.

**Electrolytic and Galvanic Cells:** reversible and irreversible cells, conventional representation of electrochemical cells, EMF of a cell and its measurements, calculation of thermodynamic quantities of cell reactions ( $\Delta G$ ,  $\Delta H$  and  $K$ ), irreversible electrode potentials-polarization, over potential and its applications, hydrogen over voltage, concentration cell with and without transport, liquid junction potential, applications of concentration

cells, valency of ions in doubtful cases, solubility, solubility product and activity coefficient; potentiometric, acid-base, precipitation and redox titrations; brief introduction of redox indicators, definition of pH and  $pK_a$ , determination of pH potentiometric methods.

**Corrosion:** types, theory, factors affecting corrosion and methods of combating of iron against corrosion.

## Unit 5 Phase Equilibrium:

Introduction, terminology: phase, component, degree of freedom or variance, criteria of phase equilibrium, dynamic equilibrium, metastable equilibrium, statement of phase rule; solid solutions: compound formation with congruent melting point (Benzophenone-Diphenylamine) and incongruent melting point (Benzene-Picric acid); liquid-liquid mixtures: ideal liquid mixtures, Raoult's and Henry's laws, non-ideal system; azeotropes: - HCl-H<sub>2</sub>O and ethanol-water systems; partially miscible liquids: -phenol-water, trimethylamine-water, nicotine-water systems; lower and upper consolute temperature, effect of impurity on consolute temperature.

**Distribution Law:** thermodynamic derivation, association, dissociation and chemical combination of solute, applications.

## Recommended Books

1. Atkins, P., Julio, P. D. (2014). *Physical Chemistry* (10<sup>th</sup> Ed), United Kingdom: Oxford University Press.
2. Castellan, G.W. (1983). *Physical Chemistry* (3<sup>rd</sup> Ed), United State of America: Addison-Wesley Publishing Company.
3. West, A. R. (2014). *Solid State Chemistry and its Applications* (2<sup>nd</sup> Ed), John Wiley & Sons .Ltd
4. Puri, B.R., Sharma, L.R., Pathania, M.S. (2016). *Principle of Physical Chemistry* (47<sup>th</sup> Ed). India: Vishal Publishing Company.
5. Arniker, H. J. (2005). *Essentials of Nuclear Chemistry* (4<sup>th</sup> Ed), India: New Age International Ltd. Publisher.

## Suggested e-Sources:

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

## CHEM 304 Analytical Methods in Chemistry

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L    T    P    C**

**6    0    0    6**

### Learning Outcomes

On completion of course, the students will be able to:

- apply knowledge of basic statistics to validate the results of analysis.
- understand various chromatographic techniques and its applications in separation of mixtures, purification of samples, and qualitative and quantitative analysis.
- understand the basic principles of optical, thermal and electro analytical methods and apply its concepts to interpretation of compounds.
- explain the principle and applications of thermal methods of analysis and atomic spectroscopy

**Unit 1 Qualitative and Quantitative aspects of analysis:** Sampling, evaluation of analytical data, errors, accuracy and precision:, methods of their expression, normal law of distribution if indeterminate errors, statistical test of data; F, Q, and T test, rejection of data, and confidence intervals. Steps involved in chemical analysis, Principles of volumetric analysis: Theories of acid-base, redox, complexometric, iodometric and precipitation titrations - choice of indicators for these titrations, Principles of gravimetric analysis: precipitation, coagulation, peptization, coprecipitation, post precipitation, digestion, filtration and washing of precipitate, drying and ignition.

**Unit 2 Optical methods of analysis:** Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation (choice of source, monochromator and detector) for single and double beam instrument; Basic principle of quantitative analysis: estimation of metal ions from aqueous solution. Determination of composition of metal complexes using Job's method of continuous variation and mole ratio method. Infrared Spectrometry: Basic principles of instrumentation (choice of source, monochromator & detector) for single and double beam instrument; sampling techniques. Effect and importance of isotopic substitution

**Unit 3 Thermal and Atomic Absorption methods of analysis:** Theory of thermogravimetry (TG), basic principle of instrumentation. Techniques for quantitative estimation of Ca and Mg from their mixture. Atomic Absorption Spectrometry: Introduction, Principal of AAS. Classification of atomic spectroscopic methods, Advantages and disadvantages of AAS. Measurement of atomic absorption, Instrumentation for atomic absorption spectrometer and application of AAS.

**Unit 4 Electro analytical methods:** Classification of electroanalytical methods, Types of reversible electrodes:-gas-metal ion, metal-metal ion, metal-insoluble salt-anion and redox electrode reactions, basic principle of pH metric: determination of strength of unknown acids (Strong, Weak and mixture), potentiometric: principle, instrumentation and application (determination of transport number. Determination of valency of an ions in doubtful cases, solubility, solubility product and activity coefficient, acid-base, precipitation and redox titrations), definition of pH and  $pK_a$ , determination of pH by potentiometric methods and conductometric titrations. Electrophoreses: principle, instrumentation and types of electrophoreses methods. Electro osmosis: principle and instrumentation.

**Unit 5 Separation Techniques:** Chromatography: Classification of chromatography methods, principles of differential migration adsorption phenomenon, Nature of adsorbents, solvent systems,  $R_f$  values, factors effecting  $R_f$  values. Paper Chromatography: Principles,  $R_f$  values, experimental procedures, choice of paper and solvent systems, developments of chromatogram - ascending, descending and radial. Two dimensional chromatography, applications. Thin layer Chromatography (TLC): Advantages. Principles, factors effecting  $R_f$  values. Experimental procedures. Adsorbents and solvents. Preparation of plates. Development of the chromatogram. Detection of the spots. Applications. Column Chromatography: Principles, experimental procedures, Stationary and mobile Phases, Separation technique and Applications.

### **Recommended Books:**

1. Christian, G. D., *Analytical Chemistry*, John wiley; 6th edition.
2. Skoog, D. A., West, D. M., Hollar, F. J. and Crouch S. R.; *Fundamentals of Analytical Chemistry*, Cengage Learning; 9 ed.

- Willard, H. L., Merritt, Dean, J. A. and Settle, F. A. (2004) *Instrumental Methods of Analysis*; HCBS publishing New Delhi: 7th ed.
- Ewing, G. W. Ewing, *Instrumental Methods of Chemical Analysis*, Mcgraw-Hill Int 5th ed.
- Holler, F. J., Skoog, D. A. and Crouch, S. R. *Principles of Instrumental Analysis*, Thomson Books/Cole , 6<sup>th</sup> ed..
- Willard, H. H., Merritt, J. A., Dean, I. I. and Settle, F. A. *Instrumental methods of Analysis*, CBS Publishing New Delhi, 7<sup>th</sup> ed.
- Kaur, H., (2010). *Spectroscopy*, Pragati Prakashan, India.

#### **Suggested e-Sources:**

- National programme on technology enhanced learning  
<https://nptel.ac.in>
- Online chemistry courses  
<https://www.edx.org/learn/chemistry>
- Free online education swayam  
<https://swayam.gov.in>

## **Discipline Electives (Lab)**

### **CHEM 302L Organic Chemistry-II Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **Learning Outcomes**

On completion of course, the students will be able to:

- separate compounds by steam distillation.
- understand concept of chromatography (TLC) by separation of green leaf pigment, mixture of dyes and organic compounds.
- separate organic mixture containing two solid components and their qualitative analysis.
- synthesize organic compounds by synthetic methods: acetylation, benzylation, diazotization or coupling reaction and electrophilic substitution.

#### **Steam Distillation (any one of the following)**

- Naphthalene from its suspension in water.

2. Clove oil from clove.
3. Separation of o and p-nitrophenols.

#### Thin Layer Chromatography

Determination of  $R_f$  values and identification of organic compounds:

1. Separation of green leaf pigment (spinach leaves may be used).
2. Preparation and separation of 2,4-dinitrophenyl hydrazones of acetone, 2-butanone, hexan-2 and 3-one using toluene and light petroleum (40:60).
3. Separation of a mixture of dyes using cyclohexane and ethyl acetate (8.5:1.5).

#### Qualitative Analysis

Analysis of an organic mixture containing two solid components using water,  $\text{NaHCO}_3$ ,  $\text{NaOH}$  for separation and preparation of suitable derivatives.

**Synthesis of Organic Compounds** (any two of the following)

##### (i) Acetylation

- Salicylic acid
- Aniline
- Glucose
- Hydroquinone

##### (ii) Aliphatic Electrophilic Substitution

- Preparation of iodoform from ethanol and acetone

##### (iii) Aromatic Electrophilic Substitution

- Nitration:  
Preparation of m-dinitrobenzene  
Preparation of p-nitroacetanilide
- Halogenation:  
Preparation of p-bromoacetanilide  
Preparation of 2, 4, 6-tribromophenol

##### (iv) Diazoitization / Coupling

- Preparation of methyl orange and methyl red

##### (v) Oxidation

- Preparation of benzoic acid from toluene

**(viii) Reduction**

- Preparation of aniline from nitrobenzene
- Preparation of m-nitroaniline from m-dinitrobenzene

**Recommended Books**

1. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.), John Wiley & Sons, Inc., New York.

**Suggested e-Sources:**

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

**CHEM 305L Molecular Modeling and Drug Design Lab****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Learning Outcomes**

On completion of course, the students will be able to:

- describe and comprehend the fundamental concepts of molecular modeling and computational-driven drug discovery.
  - understand the physicochemical properties of drugs including solubility, distribution, adsorption, and stability.
  - understand the Molecular modeling and computer graphics
  - develop the theoretical and practical aspects of molecular modeling
1. Compare the optimized C-C bond lengths in ethane, ethene, ethyne and benzene. Visualize the molecular orbitals of the ethane  $\sigma$  bonds and ethene, ethyne, benzene and pyridine  $\pi$  bonds.
  2. (a) Perform a conformational analysis of butane. (b) Determine the enthalpy of isomerization of cis and trans 2-butene.

3. Visualize the electron density and electrostatic potential maps for LiH, HF, N<sub>2</sub>, NO and CO and comment. Relate to the dipole moments. Animate the vibrations of these molecules.
4. (a) Relate the charge on the hydrogen atom in hydrogen halides with their acid character. (b) Compare the basicities of the nitrogen atoms in ammonia, methylamine, dimethylamine and trimethylamine.
5. (a) Compare the shapes of the molecules: 1-butanol, 2-butanol, 2-methyl-1-propanol, and 2-methyl-2-propanol. Note the dipole moment of each molecule. (b) Show how the shapes affect the trend in boiling points: (118 °C, 100 °C, 108 °C, 82 °C, respectively).
6. Build and minimize organic compounds of your choice containing the following functional groups. Note the dipole moment of each compound: (a) alkyl halide (b) aldehyde (c) ketone (d) amine (e) ether (f) nitrile (g) thiol (h) carboxylic acid (i) ester (j) amide.
7. (a) Determine the heat of hydration of ethylene. (b) Compute the resonance energy of benzene by comparison of its enthalpy of hydrogenation with that of cyclohexene.
8. Arrange 1-hexene, 2-methyl-2-pentene, (E)-3-methyl-2-pentene, (Z)-3-methyl-2-pentene, and 2,3-dimethyl-2-butene in order of increasing stability.
9. (a) Compare the optimized bond angles H<sub>2</sub>O, H<sub>2</sub>S, H<sub>2</sub>Se. (b) Compare the HAH bond angles for the second row dihydrides and compare with the results from qualitative MO theory.
10. Titrimetric estimation of drugs: Paracetamol, Ascorbic acid, Aspirin, etc.

**Note:** Software: ChemSketch, ArgusLab ([www.planaria-software.com](http://www.planaria-software.com)), TINKER 6.2 ([dasher.wustl.edu/ffe](http://dasher.wustl.edu/ffe)), WebLab Viewer, Hyperchem, or any similar software.

### Recommended Books

1. Leach, A.R. (2001). *Molecular Modelling Principles and Application*, Longman.
2. Haile, J.M. (1997). *Molecular Dynamics Simulation Elementary Methods*, John Wiley and Sons.
3. Gupta, S.P. (2008). *QSAR and Molecular Modeling*, Springer - Anamaya Publishers.



**Suggested e-Sources**

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

**CHEM 303L Physical Chemistry-II Lab****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Learning Outcomes:**

On completion of course, the students will be able to:

- handle instruments like calorimeter, conductometer and potentiometer.
- perform the proper procedures and have the knowledge of regulations for safe handling and use of chemicals.
- evaluate physical properties of analytes viz. the molecular weight, conductivity, optical rotation.

**Colorimetry**

1. To verify Beer-Lambert law for  $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$  and determine the concentration of the given solution of the substance.

**Conductometry (any two)**

1. To determine the strength of the given acid conductometrically using standard alkali solution.
2. To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.
3. To study the saponification of ethyl acetate conductometrically.
4. To determine the ionization constant of a weak acid conductometrically.

**Potentiometry**

1. To titrate potentiometrically the given ferrous ammonium sulphate solution using  $\text{KMnO}_4/\text{K}_2\text{Cr}_2\text{O}_7$  as titrant and calculate the redox-potential of  $\text{Fe}^{2+} / \text{Fe}^{3+}$  on system on the hydrogen scale.

**Molecular Weight Determination** (one of the following)

1. Determine of molecular weight of a non-volatile solute by Rast method/Beckmann freezing point method.
2. Determination of the apparent degree of dissociation of an electrolyte (e.g. NaCl) in aqueous solution at different concentrations by ebullioscopy.

**Refractometry and Polarimetry** (one of the following)

1. To verify the law of refraction of mixtures (e.g. of glycerol and water) using Abb's refractometer.
2. To determine the specific rotation of a given optically active compound.

**Recommended Books**

1. Gurtu, G.N., Gurtu, A. (2014). *Avanced Physical Chemistry*, India: Pragati Prakashan .
2. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan Publishers.

**Suggested e-Sources**

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

**CHEM 304L Analytical Methods in Chemistry Lab****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Learning Outcomes**

On completion of course, the students will be able to:

- develop their skills for qualitative and quantitative research in different fields.
- perform various analytical operations to qualify and quantify different analytes.
- outline synthetic strategies for important chemicals.

- check the purity of synthesized compounds through TLC, UV, FT-IR spectral data
- analysis of soil through determination pH, estimation of ions and by total dissolve salts.
- able to determine the Chemical and biological oxygen demand by spectroscopic techniques.

## **Separation Techniques**

### **1. Chromatography:**

- (a) Separation of mixtures
  - (i). Paper chromatographic separation of  $\text{Fe}^{3+}$ ,  $\text{Al}^{3+}$ , and  $\text{Cr}^{3+}$ .
  - (ii). Separation and identification of the monosaccharides present in the given mixture (glucose & fructose) by paper chromatography. Reporting the  $R_f$  values.
- (b) Separate a mixture of Sudan yellow and Sudan Red by TLC technique and identify them on the basis of their  $R_f$  values.
- (c) Chromatographic separation of the active ingredients of plants, flowers and juices by TLC.

### **2. Solvent Extractions:**

- (a) To separate a mixture of  $\text{Ni}^{2+}$  &  $\text{Fe}^{2+}$  by complexation with DMG and extracting the  $\text{Ni}^{2+}$ - DMG complex in chloroform, and determine its concentration by spectrophotometry.
- (b) Solvent extraction of zirconium with amberliti LA-1, separation from a mixture of irons and gallium.
- (c) Determine the pH of the given aerated drinks fruit juices, shampoos and soaps.
- (d) Determination of Na, Ca, Li in cola drinks and fruit juices using flame photometric techniques.
- (e) Analysis of soil:
  - (i). Determination of pH of soil.
  - (ii). Total soluble salt
  - (iii). Estimation of calcium, magnesium, phosphate, nitrate
- (f) Ion exchange:
  - (i). Determination of exchange capacity of cation exchange resins and anion exchange resins.
  - (ii). Separation of metal ions from their binary mixture.
  - (iii). Separation of amino acids from organic acids by ion exchange chromatography.

### Spectrophotometry

1. Determination of pK<sub>a</sub> values of indicator using spectrophotometry.
2. Structural characterization of compounds by infrared spectroscopy.
3. Determination of dissolved oxygen in water.
4. Determination of chemical oxygen demand (COD).
5. Determination of Biological oxygen demand (BOD).
6. Determine the composition of the Ferric-salicylate/ ferric-thiocyanate complex by Job's method.

### Recommended Books

1. Gurdeep, R (2016), *Advanced Practical Inorganic Chemistry*, revised Ed., Krishna Prakashan publication.
2. Svehla, G. (2010), *Vogel's Qualitative Inorganic Analysis*, 7th Edition, Prentice Hall.
3. Gurtu, J. N. and Gurtu, A(2011), *Physical Chemistry Vol – I*, Pragati Prakashan publication.
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G. & Tatchell, A.R. (1989). *Practical Organic Chemistry* (5th ed.). New York, John Wiley & Sons, Inc.
5. Christian, Gary D. (2004), *Analytical Chemistry*, New York, 6th Ed. John Wiley & Sons.
6. Khopkar, S.M. (2009), *Basic Concepts of Analytical Chemistry*, New Age, International Publisher.
7. Christian, Gary D. (2004), *Analytical Chemistry*, New York , 6th Ed. John Wiley & Sons.

### Suggested e-Sources

1. National Programme on Technology Enhanced Learning  
<https://nptel.ac.in>
2. Online Chemistry Courses  
<https://www.edx.org/learn/chemistry>
3. Free Online Education SWAYAM  
<https://swayam.gov.in>

# COMPUTER SCIENCE

## First Semester

### CS 107 Computer Fundamentals and Programming

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### Learning Outcomes

On successful completion of the course students will be able to

- make a conceptual understanding of input and output devices of computers and how it works and recognize the basic terminology used in computer programming
- develop the ability to write, compile and debug programs in C language and use different data types for writing the programs.
- formulate the programs based on structures, loops and functions.
- conceptualize the understating of differentiating between call by value and call by reference.
- develop the conceptual understanding of the dynamic behavior of memory by the use of pointers.

#### Syllabus

**Unit-I** Introduction to Computer System and functions of its components. Evolution of Computers and its classification. Hardware and Software.

Introduction to Number System: Decimal, Binary, Octal and Hexadecimal and their inter conversions.

Integer and real number representation, Character and codes (BCD, ASCII, and EBCDIC), Logic Gates (AND, OR, NOT, NAND, NOR, XOR and XNOR), Binary and Floating Point Arithmetic (addition and subtraction).

Introduction to Operating system (Windows, DOS), DOS commands (Internal and External).

**Unit-II** Basic concepts of Boolean algebra and their electronic implementation through various logic gates. Simplification of Boolean Expressions (Boolean Algebra and Karnaugh map method).

Characteristics of Memory Devices, Memory types - Primary and Secondary, Random Access and Sequential Access, Memory Hierarchy, Storage location and addresses, RAM, ROM, PROM, EPROM, EEPROM, Core memory, Magnetic Bubble memory, Cache Memory, Virtual memory (definition and block diagram), Secondary Memory devices and their characteristics, Interleaving memory.

**Unit-III** Introduction to computer programming, Problem analysis, stepwise refining, Problem definition, algorithm, flowcharts, Programming languages (high level, low level), Compiler, Interpreter.

Computer Programming (in C): Overview of C language- History, Character set, Identifiers, Various Data types (Simple and Structured ) and their representation, Constants and Variables, Operators (arithmetic, logical, relational), Program structure, Data assignment, Input-Output statements, Arithmetic and Logic expressions, Control statements (sequencing, conditional & un conditional branching and looping),

**Unit-IV** Single & Multi-dimensional Arrays, Matrix manipulations, functions, parameter passing (call by value, call by reference), recursion, storage classes.

**Unit-V** Concept of pointers, pointer expression, pointer v/s arrays, structure, union and enumerated data types, file handling, command line arguments, concept of structured programming.

(Unit III, IV & Unit V to be done using C Programming).

### **Suggested Books:**

1. Sinha, P. K., & Sinha, P. BPB Publication. Computer Fundamental, Third Edition-2005, 12..
2. Mano, M. M. (2003). Computer system architecture. Prentice-Hall of India.
3. Norton, P. (1989). Peter Norton's DOS guide. Brady.
4. Balagurusamy, E. (2012). programming in ANSI C. Tata McGraw-Hill Education.
5. Venugopal K.R., Programming with C, Tata McGraw-Hill Publishing Company Limited.
6. Hayes John P., Computer Architecture and Organization, Tata McGraw Hill, New Delhi, 1998.

7. RAM B., Computer Fundamentals, Architecture & Organization, New Age International, New Delhi.
8. Kernighan Brian W., Ritchie Dennis M., The C Programming Language, Pearson Education, 2nd Edition, New Delhi Prentice Hall.
9. Kanetkar, Y. P. (2016). Let us C. BPB publications..
10. Gottfried, B. (1996). Programming with C, Schaum's Outlines

### **Suggested E-Resources:**

1. Introduction to Programming in C  
<https://nptel.ac.in/courses/106104128/>
2. Introduction to Programming in C Specialization  
<https://www.coursera.org/specializations/c-programming>
3. Sinha, P. K. (2003). Computer fundamentals: concepts, systems & applications. BPB publications.  
<https://www.edutechlearners.com/computer-fundamentals-p-k-sinha-free-pdf/>

## **CS 108L Computer Fundamentals and Programing Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### **Lab no. Problems**

- L 1 -L2 Simple hands on DOS Commands e.g. CD, MD, RD. COPY, TYPE/TREE etc.
- L4-L7 Simple problems using scanf and printf functions. Formula based problems using constants, variables and use of operators.
- L8-L10 Condition checking using if statement, nested if statement, switch and goto constructs. Programs like:
- i. Check odd-even, positive-negative
  - ii. Calculation of Division, Rank of student
  - iii. Solution of Quadratic Equations
  - iv. Menu Driven Programs
- LI 1-L19 Loop Statement using for, while, do-while. Problems like:
- i. Sum of digits of number, reverse of number, palindrome checking
  - ii. Table Generation.
  - iii. Prime number checking, generation.

- iv. Calculation of GCD, LCM.
- v. Sum of various series, Fibonacci series, sin, cos, exp etc.
- vi. Printing patterns with digits/alphabet/symbols.

L20-L27 Problems on arrays (one and two dimensional arrays) like:

- i. Maximum, minimum & average calculation
- ii. Linear Search
- iii. Binary Search
- iv. Bubble Sort
- v. Selection Sort
- vi. Insertion Sort
- vii. Merging
- viii. Matrix Manipulation
- ix. Sum of row, column & diagonal elements
- x. Display and sum of upper triangular, lower triangular matrix elements
- xi. Matrix Arithmetic (Addition, Subtraction, Multiplication)
- xii. String Manipulation.

L28-L36 Using Pointers and Functions

- i. Implementation of previous programs using user defined functions.
- ii. Use of pointers and function in array and string processing.  
Recursion
- i. Calculation of factorial and power of a given number, GCD, etc.
- ii. Programs on Fibonacci series.

L37-L39 Declaration, reading, writing and manipulation on struct and union.

- i. Operations on Complex numbers
- ii. Reading, writing, searching records of student/teacher/employee etc.
- iii. Use of Union

L40-L43 File handling

- i. Reading and writing from and to a file.
- ii. Copy/ move the contents of one file to another.
- iii. Searching a string/number in a file etc.

L44-L45 Command Line Arguments.



## Second Semester

### CS 103 Computer Architecture and Object Oriented Programming

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### Learning Outcome

On successful completion of this course, Student will be able to

- Equip the students to meet the requirement of corporate world and Industry standard.
- Engage in professional development and to pursue graduate education in the fields of Information Technology and Computer Applications
- Apply C++ features to program design and implementation.
- Explain object-oriented concepts and describe how C++ including identifying the features and Peculiarities of the C++ programming language support them.
- Use C++ to demonstrate practical experience in developing object-oriented solutions

#### Syllabus

**Unit I** Introduction to Computer Architecture. Instruction Formats- instruction execution cycles, Machine Instruction types. Concept of Microprogramming, Addressing Modes- (Direct, Indirect, Register direct, Register indirect, Auto increment, Auto decrement, Base, Index, Absolute and Relative addressing). Instruction formats-(zero address, one address, two address and three address machines).

I/O Organization-Simple I/O devices and their properties, device interfacing, DMA interface, program & interrupt control transfer.

**Unit II** Combinational Circuits: Binary Adder (Half and Full), Binary Subtractor, Decoder, Encoder, Multiplexer, Demultiplexer, Parallel adder and subtractor.

Introduction to Sequential circuits. Flip Flops (RS, JK). Introduction to Shift Registers and Counters (synchronous and asynchronous).

**Unit III** Basic Concept of Object Oriented Programming: Need of OOP, advantage over other programming paradigms, Tokens, Keywords, Identifiers and Constants, Basic Data Types, Control Structures.

Functions: Call by Value, Call by Reference.

Classes & Objects: Concepts of Objects & Classes, declaring multiple objects, array of objects.

**Unit IV** Constructors and Destructors: Introduction, Default, Parameterized and Copy Constructor, Concept and use of destructors.

Operator Overloading: Overloading Unary Operators and Binary Operators.

Static and friend functions. Inheritance, Function Overriding.

**Unit V** Pointers to Objects, this Pointer, Virtual Functions, polymorphism.

Console I/O: Concept of Streams, Hierarchy of Console stream Classes, Unformatted and formatted I/O Operations, Manipulators.

Templates: Class and function templates.

Introduction to file handling.

### **Suggested Books:**

1. Mano, M. M. (2002). Digital design. EBSCO Publishing, Inc...
2. Mano, M. M. (2003). *Computer system architecture*. Prentice-Hall of India.
3. Balagurusamy, E. (2001). *Object Oriented Programming with C++, 6e*. Tata McGraw-Hill Education.
4. Schildt, H. (2003). *C++: The complete reference*. McGraw-Hill..
5. Hafez, A. A. (1988). Computer architecture and organization
6. Venugopal, K. R. (2013). *Mastering C++*. Tata McGraw-Hill Education.
7. Lafore, R. (2001). *Object-oriented programming in Turbo C++*. Galgotia publications.
8. Stroustrup, B. (2000). *The C++ programming language*. Pearson Education India..
9. Kumar K., Programming with C++ Made Simple.

### **Suggested E-Resources:**

1. Programming in C++  
<https://nptel.ac.in/courses/106105151/>

2. Computer Organizations and Architecture  
<https://nptel.ac.in/courses/106103068/>
3. Stallings, W. (2003). *Computer organization and architecture: designing for performance*. Pearson Education India.  
<http://williamstallings.com/ComputerOrganization/>

## **CS 104L Computer Architecture and Object Oriented Programming Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### **Lab Number Problems**

- L1-L4      Implementation of simple problems with the objects and classes.  
 (Involving if- else, switch, for, while do-while loops and arrays)
- i. Sum of digits of number, palindrome checking etc.
  - ii. Calculation of GCD, prime numbers etc.
  - iii. Menu driven programs.
  - iv. Searching/sorting arrays.
- L5-L8      Programs based on use of constructors & destructors and access specifiers (public, private, protected)
- L9-L10     Implementation of static variable & static member functions.  
 Problems using friend function.
- LI 1-LI 4   Programs related to function overloading.
- L15-L19    Implementation of inheritance and its type.
- L20-L26    Programs involving operator overloading (using member functions and friend functions)
- i. Unary operators (+, -, \*, % etc)
  - ii. Binary operators: +, \*, [ ], >> and << operators.
- L27-L33    Problem related with dynamic binding and function overriding.  
 Problems using this pointer.
- L34-L37    Problems related with the templates function and template classes-
- L38-L45    File handling and 10 manipulators
- i. Reading and writing from and to a file.
  - ii. Copy/ move the contents of one file to another.
  - iii. Searching a string/number in a file etc.

## III Semester

### CS 210 Data Structures

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### Learning Outcomes

On successful completion of the course students will be able to

- Choose appropriate data structure as applied to specified problem definition.
- Handle operations like searching, insertion, deletion, traversing mechanism etc. on various data structures.
- Use linear and non-linear data structures like stacks, queues, linked list etc.
- Understand Internal representation of Linear and nonlinear data structures.

**Unit 1** Concept of Data types, Abstract data type and data structure, Running time of program, Complexity of algorithm, Asymptotic notations: Big- $\Omega$ , Big-O, Big- $\theta$  notation ) Searching and Sorting: Linear search and Binary Search, Bubble sort, Selection sort, Insertion sort, Quick sort, Radix sort.

**Unit 2** Linear Data structures : Stacks, Queues and their types, their array and linked list implementations, applications of stacks & queues, recursion stacks and recursive procedures

**Unit 3** Linear Linked structures: Single Linked Lists, Doubly & Circular Linked Lists, simple applications. Representation of polynomial using linked list, addition and subtraction of polynomials.

**Unit 4** Nonlinear structures: Tree concepts, General Tree, binary tree and types and their applications. Binary Search Tree: implementation of various operations on Binary Search Tree (tree traversal, searching, insertion and deletion, counting leaf and non-leaf nodes, height).

**Unit 5** Heap and heap sort, Balanced tree: Introduction and concepts. Graph: Introduction, Graph Theory terminology, Sequential representation of graphs: Adjacency Matrix, Path Matrix, Linked Representation of graph, Graph traversal: DFS, BFS.

**Note :** Data structures to be implemented using C/C++.

**Suggested Books:**

1. Aho, A., Hopcroft, J., & Ullman, J. (1974). *The Design and Analysis of Algorithms*. Addison and Wesley. Reading, MA.
2. Tremblay, J. P., & Sorenson, P. G. (1976). *An introduction to data structures with applications*. McGraw-Hill Computer Science Series, New York: McGraw-Hill, 1976.
3. Knuth, D. E., & Knuth, D. E. (1973). *Fundamental algorithms* (Vol. 1). Reading, MA: Addison-Wesley.
4. Horowitz, E. (2006). *Fundamentals of data structures in C++*. Galgotia Publications.
5. Tenenbaum, A. M. (1990). *Data structures using C*. Pearson Education India.
6. Kruse, R., & Tondo, C. L. (2007). *Data structures and program design in C*. Pearson Education India.
7. Lipschutz, S. (1987). *Schaum's Outline of Data Structure*. McGraw-Hill, Inc..

**Suggested E-Resources:**

1. Programming and Data Structures  
<https://swayam.gov.in/course/1407-programming-and-data-structures>
2. Data Structures and Program Methodology  
<https://nptel.ac.in/courses/106103069/>

**CS 210L Data Structures Lab****Max. Marks : 100****(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**Lab no. Problems**

- L1-L4 Programs on Searching and Sorting: Linear search and Binary Search, Bubble sort, Selection sort, Insertion sort, Quick sort, Radix sort.
- L5-L6 Programs based on static implementation of stacks.
- L7-L8 Programs based on static implementation of queues.
- L9-L13 Programs based on dynamic implementation of stack and its applications.
- L14-L17 Programs based on dynamic implementation of queue and its applications.

- L18-L27 Programs based on Singly, Doubly & Circular Linked lists. Operations on linked lists like: creation, insertion, deletion, traversal, searching etc.
- L28-L40 Operations on Binary tree, binary search tree.
- L41-L45 Simple programs on representation of graphs and their traversal.

## IV SEMESTER

### CS 208 Computer Oriented Numerical and Statistical Method

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### Learning Outcomes

On successful completion of the course students will be able to

- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Using appropriate numerical methods, determine the solutions to given non-linear equations, systems of linear equations, interpolation, numerical differentiation and integration and numerical solution of ordinary differential equations.
- Analyze the errors obtained in the numerical solution of problems.
- Apply appropriate algorithms to solve selected problems, both manually and by writing computer programs.
- Compare different algorithms with respect to accuracy and efficiency of solution.
- Implement numerical methods algorithm using programming language.

**Unit 1** Computer arithmetic and errors, Floating point arithmetic and error estimates, Implication of precision, Illustrations of errors due to round-off.

Solution of non-linear equations: Zeros of polynomials, real & complex. Bisection, Fixed point iteration, Newton - Raphson method, Aitkins process, rate of convergence.

**Unit 2** Solution of Linear system of equations: Direct method - Gaussian elimination including pivoting and Jordan, iterative method: Jacobi's and Gauss-Siedel.

Interpolation: Lagrange's Polynomials, divided differences, Evenly spaced data, Newton-Gregory forward and backward interpolations, and Inverse interpolations, Error term and error of interpolation.

**Unit 3** Numerical differentiation: Differentiation formula based on interpolating polynomials, formulae for higher derivatives.

Numerical integration: Newton-Cotes integration formulae, The Trapezoidal, rule, Romberg integration Simpson's  $1/3$  &  $3/8$  rule, Gaussian quadrature formulae for integration.

**Unit 4** Solution of ordinary differential equations - Taylor's series method, Euler's and modified Euler's method. Local and global error analysis, Runge-Kutta 2nd orders and 4th orders methods, Predictor-Corrector method, multistep method- Milne's method.

Approximation: Approximation of functions by Taylor's series, Least squares approximations, Fitting linear and nonlinear curves by least squares, Chebyshev polynomials.

**Unit 5** Statistical Methods: Concept of population, sample and Variance, Correlation and regression-simple & multiple, Test of significance for large and, chi-square test for goodness of fit and Independence of Attributes, analysis of variance for one way classified data, Statistical decision making.

#### **Suggested Books:**

1. Rajaraman, V. *Computer Oriented Numerical Methods*. 2004.
2. Sastry, S. S. (2012). *Introductory methods of numerical analysis*. PHI Learning Pvt. Ltd..
3. Gupta, S. P. (1994). *Statistical Methods*, Sultan Chand & Sons, New Delhi, pp. E10, 1-61.

4. Gupta, S. C., & Kapoor, V. K. (1997). *Fundamentals of Mathematical Statistics*, Ninth Extensively Revised Edition, Sultan Chand & Sons.
5. Grewal, B. S. (2018). *Numerical Methods in Engineering and Science: (C, and C++, and MATLAB)*. Stylus Publishing, LLC.
6. Krishnamurthy, E. V., & Sen, S. K. *Numerical Algorithms: Computations in Science and Engineering. 2001. Affiliated East-West Press, New Delhi.*
7. Govil R., *Kamputer se sankhyatmak Reetiyen*, et.al. Pitamber Publications, New Delhi
8. Krishnamurthy, E. V., & Sen, S. K. (1976). *Computer-based numerical algorithms*. East-West Press.
9. Rao, K. S. (2017). *Numerical methods for scientists and engineers*. PHI Learning Pvt. Ltd..
10. Yule, G. U., & Kendall, M. G. (1987). *An Introduction to the Theory of Statistics* Universal Book Stall. New Delhi.
11. Agarwal, B. L. (2006). *Basic statistics*. New Age International.

### **Suggested E-Resources:**

1. Numerical methods and programming  
<https://nptel.ac.in/courses/122106033/>

## **CS 208L Computer Oriented Numerical and Statistical Methods Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**No of Labs**

**Problems**

- |         |   |
|---------|---|
| L1 – L2 | Perform floating point operations using normalization (addition, subtraction, multiplication, division)                                   |
| L3 – L8 | Find the roots of equation (bisection method, regula-falsi method, Newton raphson method, secant method, successive approximation method) |



- L9 – L11 Find solution of  $n$  linear equation (Gauss elimination method (with & without pivoting), Gauss Seidel method, Gauss Jordan method)
- L12 – L14 Generate following difference tables (forward, backward, divided difference)
- L15 – L17 Interpolate value of  $f(x)$  at given  $x$  (Lagrange's interpolation method, Newton forward interpolation method, Newton's backward interpolation method)
- L18 Interpolate value of  $x$  at given  $f(x)$  using Inverse interpolation method.
- L19 – L20 Fitting of different curves (straight line fit ( $x$  on  $y$ ), straight line fit ( $y$  on  $x$ ), parabola, geometric curve, exponential curve)
- L21 Find order of polynomial.
- L22– L24 Find derivative of a given tabulated function at given value (Newton's forward method, Newton's backward method)
- L25 – L27 Find Integrated value, (when tabulated function given- Trapezoidal rule (simple & modified), Simpson's  $1/3$  (simple & modified), Simpson's  $3/8$  (simple & modified))
- L28 – L30 Find Integrated value, when algebraic expression given (when algebraic expression given- Trapezoidal rule (simple & modified), Simpson's  $1/3$  (simple & modified), Simpson's  $3/8$  (simple & modified))
- L31 – L32 Solve differential equation (Euler's method, Runge-Kutta 2nd order method, Runge-kutta 4th order method, Modified Euler's method, Predictor-corrector method)

## V Semester and VI Semester

### CS 310L Project Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

The students have to design & develop a software project following SDLC approach in groups (not executing three/four)

- Problem Definition & Requirement analysis report
- Design
- Implementation
- Documentation (report)

### CS 316 Business Data Processing and Database Management System

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### Learning Outcomes

On successful completion of the course students will be able to

- Develop Business applications in Cobol.
- Identify all peripheral devices.
- Prepare of all documents developed during system development.
- Identifies key of various types, use SQL-the standard language of relational databases, normalize data base.
- Develop COBOL Programming language.

**Unit 1** Introduction to Business organization: Business system and its environments, major business functions including production, marketing, personnel & finance, information systems need and role of management services. Introduction to file processing: record, files, file organization: sequential, indexed & direct access (random) files, Data Base system architecture: Basic concepts, data structures, classical data models (relational, hierarchical and network).

**Unit 2** COBOL Language: COBOL program structure: Divisions, Sections, Paragraphs, Input Output verbs, Data transfer verbs, conditional verbs including condition-name-condition, Table handling in COBOL.

- Unit 3** File handling in COBOL (Sequential, Relative, Indexed files): SORTING, MERGING, UPDATION, SORT & MERGE statements, Character handling, subroutine, Report writing facility in COBOL, Segmentation, Library facility.
- Unit 4** Data modeling using E-R Model, mapping constraint, super key, Candidate key, primary key, Relational data model, Integrity and security of DBMS, SQL, Query handling.
- Unit 5** Database Design, Functional dependencies, Normal Forms: 1 NF, 2 NF, 3 NF, 4 NF, BCNF, 5NF, steps in database design, Introduction to Transaction Processing & Concurrency control

### **Suggested Books :**

1. Orilla, *An Introduction to Business Data Processing*, Tata Mc Graw Hill
2. Roy, M. K., & Dastidar, D. G. (1989). *COBOL programming*. Tata McGraw-Hill Education.
3. Elmasri, R., & Navathe, S. (2010). *Fundamentals of database systems*. Addison-Wesley Publishing Company.
4. Bayross I, *Structured Query Language*, BPB
5. Stern, N. B., & Stern, R. A. (1985). *Structured COBOL programming*. John Wiley & Sons.
6. Martin, J. (1977). *Computer database organization*. Prentice Hall PTR
7. Date, C. J. (1990). *An introduction to database systems. Volume 1*
8. Silberschatz, A., Korth, H. F., & Sudarshan, S. (1997). *Database system concepts* (Vol. 4). New York: McGraw-Hill
9. Leon, A., & Leon, M. (2010). *Database management systems*. Vikas Publishing House Pvt. Limited

### **Suggested E-Resources:**

1. COBOL Programming  
<http://www.csis.ul.ie/cobol/course/Default.htm>
2. Norton, P. (2002). *Introduction to computers*. McGraw Hill.  
<https://onlinestudy4u.files.wordpress.com/2012/10/introduction-to-computers-by-peter-norton-6th-ed.pdf>
3. Data Base Management System  
<https://nptel.ac.in/courses/106105175/>
4. Database Management Essentials  
<https://www.coursera.org/learn/database-management>

## CS 316L Business Data Processing and Database Management System Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### Lab Number Problems

- L1            Familiarity with COBOL environment
- L2 - L3     Program based on the use of various data types, Input output verbs: ACCEPT, DISPLAY, arithmetic verb ADD, SUBTRACT, MULTIPLY, DIVISION
- L4- L5     Program for data movement verbs, COMPUTE verb with various options.
- L6 - L7     Program for various conditions: relational, sign, class, condition-name-condition, negated, compound
- L8 - L9     Program for GO TO with depending phrase, ALTER, EXIT, PERFORM
- L10 - L11 Program for various PERFORM verbs: TIMES , UNTIL, VARYING, VARYING-AFTER
- L12 - L14 Program for Table handling : - Implementation of single and multi dimensional tables, INDEX table. - Implementation of SEARCH, SEARCH-ALL, SET, OCCURS DEPENDING-Implementation of various sorting algorithm ( bubble, insertion, selection, shuttle
- L15 - L17 Program for performing following operations on Sequential file- Creation-Insertion-Deletion-Modification
- L18           Program for SORT, MERGE
- L19 - L23 Program for performing following operations on Relative file, INDEXED File-Creation-Insertion-eletion-Modification
- L24 - L25 Program for character handling verb: EXAMINE, INSPECT, STRING, UNSTRING
- L26           Program for use of subroutines, segmentation and library facility: COPY statement  
DBMS  
(ORACLE/MSACCESS)
- L1-L2       Basic DDL commands(Create, Drop, Alter) with integrity constraints

L3	DML & DCL commands (Insert, Update, Delete, Select, Commit, Rollback)
L4-L5	Operators (Arithmetic, Logical, Relational etc.)
L6-L8	Joins(Self join, inner join, outer join, equi join)

## **CS 301 Communication and Networking**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### **Learning Outcomes**

On successful completion of the course students will be able to:

- Demonstrate knowledge of the network and its application areas.
- Ability to use various networks protocols.
- Understanding of the proper contents of a data communication and networking

### **Syllabus**

- Unit 1** Data Communication today, Components of a data communication system, Equipment at user's end, Equipment at the computer end, Data Transmission Concepts (Time domain and Frequency domain concepts), Digital and analog, transmission, Serial/parallel data transmission, Signal encoding techniques, Modulation and modems.
- Unit 2** Transmission channels (twisted pair, coaxial cable, microwave, optical fiber, satellite), Transmission Impairments, Channel Capacity and its numerical, Baud rate, Bandwidth, Multiplexing (frequency division, time division, wave division), Synchronous and asynchronous transmission, Simplex, half duplex and duplex transmission.
- Unit 3** Computer Network, Advantage of Networking, Local Area Networks. Types of LAN (Star, Ethernet, Bus, EPABX), LAN Technology (IEEE 802.3, 802.4, 802.5), Network Switching: Circuit, Packet (Datagram & Virtual Circuit), Wide Area Networks (WAN): Requirements, Advantages. Network Operating Systems, Introduction to Novell Netware.
- Unit 4** ISO-OSI model of Networking, Different layers and their functions, Definition of protocol, Networking & Internetworking Services gateway and bridges, E-mail, Teleconferencing, Electronic banking, Videotext, Network Security & Privacy.

**Unit 5** TCP/IP protocol suite, Introduction to Internet, Intranet, Extranet, Internet applications like DNS, TFTP, FTP, SMTP, SNMP, www, HTTP, URL), Introduction to ISDN, B-ISDN. Distributed databases, Social implications of telemetric society, Awareness of Indian Networks-NICNET, ERNET etc.), An introduction to mobile computing.

**Suggested Books:**

1. Stallings, W. (2007). *Data and computer communications*. Pearson Education India.
2. Forouzan, A. B. (2007). *Data communications & networking*. Tata McGraw-Hill Education.
3. Tanenbaum, A. S., & Wetherall, D. (2014). *Computer networks*. Harlow, Essex: Pearson,.
4. Martin, J. (1978). *Computer networks and distributed processing*.

**Suggested E-Resources:**

1. Kurose, J. F., & Ross, K. W. (2009). *Computer networking: a top-down approach*. Boston: Addison Wesley.  
[https://www.bau.edu.jo/UserPortal/UserProfile/PostsAttach/10617\\_1870\\_1.pdf](https://www.bau.edu.jo/UserPortal/UserProfile/PostsAttach/10617_1870_1.pdf)
2. Data Communication  
<https://nptel.ac.in/courses/106105082/>

## CS 215 Systems Programming

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

**Learning Outcomes:**

On successful completion of the course students will be able to:

- Define the basics of system programs like editors, compiler, assembler, linker, loader, interpreter and debugger.
- Define how computer and operating system handles the memory.
- Describe the various concepts of assemblers and microprocessors.
- Analysis the various phases of compiler and compare its working with assembler.
- Examine how linker and loader create an executable program from an object module created by assembler and compiler.
- Identify various editors and debugging techniques

## Syllabus

- Unit I** Components of system software. Evolution of system software, General machine structure (memory, register, data, instructions). Structured Programming, Applications of structured programming techniques to construction of system software.
- Unit II** Assembler - Design of one pass and two pass assembler. Introduction to preprocessor and Macro processor. Interpreter and brief description of different phases of a compiler.
- Unit III** Loaders: loading concepts, various loading schemes: Compile & go, absolute, relocating, direct linking & subroutine linkage loader schemes, binders, linking loaders. Design of two pass direct linking loader.
- Introduction to System Software tools for program entry and testing, editors, debug monitors.
- Unit IV** Operating System: Types and basic functions of an operating system. Single User and multiuser operating system.
- UNIX: Introduction, history, kernel and shell, file system, user management in Unix, Unix commands, security, background processing, editors on Unix.
- Unit V** Access to system services: ROM, BIOS, DOS, Mouse and EMS function, keyboard and screen management, introduction to Interrupts and its processing. Device drivers: types, structure and processing.

## Suggested Books:

1. Donovan, J.J., & International Student edition. (1972). *Systems programming* (Vol. 3, No. 5). New York: McGraw-Hill.
2. Das, S. (2005). *Your UNIX: The ultimate guide*. McGraw-Hill, Inc..
3. Duncan, R. (1988). *Advanced MS-DOS Programming* (p. 309). Redmond, WA: Microsoft Press.
4. Ellzee, *System Software*, Science Research Association.
5. Bose, S. K. (1996). *Hardware and Software of Personal Computers*. New Age International..
6. Biggerstaff T.J., *System Software Tools*, Pentrice - Hall..
7. Aho, A. V., & Ullman, J. D. (1977). *Principles of Compiler Design* (Addison-Wesley series in computer science and information processing). Addison-Wesley Longman Publishing Co., Inc.,.
8. Kanetkar, Y. P. (1996). *Unix shell programming*. BPB Publ...
9. Dhamdhere, D. M. (1999). *Systems Programming and Operating Systems*. Tata McGraw-Hill.

10. Beck, L. L. (1997). *System software: an introduction to systems programming*. Addison-Wesley.

### **Suggested E-Resources:**

1. System Programming

<http://solomon.ipv6.club.tw/Course/SP.941/>

## **CS 320 Programming in Java**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

### **Learning Outcomes:**

On successful completion of the course students will be able to:

- Apply Object oriented features to program design and implementation.
- Explain object-oriented concepts and describe how Java including identifying the features and peculiarities of the Java programming language supports them.
- Use Java to demonstrate practical experience in developing object-oriented solutions using graphical components.

### **Syllabus**

**Unit 1** Object Oriented Paradigm, Concepts of Object Oriented Programming (Objects and Classes, Data Abstraction and Encapsulation, Inheritance, Polymorphism, Dynamic Binding, Message Communication), Benefits of Object Oriented Programming, Applications of Object Oriented Programming, Procedural v/s Object Oriented Programming, Java History, Java Features, Comparison between Java and C++, Java Virtual Machine (JVM), Java Runtime Environment (JRE), Java Development Kit (JDK), Structure of Java Program, Java Tokens (Java Character Set, Keywords, Identifiers, Literals, Operators, Separators), Constants, Variables, Data Types, Scope of Variables, Type Conversion & Casting, Automatic Type Promotion, Operators (Arithmetic, Relational, Logical, Assignment, Increment and Decrement, Conditional, Bitwise, Special), Operator Precedence, Expressions, Branching (if, if...else, Nested if...else, else if ladder, switch, ? : operator), Looping (while, do...while, for), Jumps in Loops (break, continue), Labeled Loops

**Unit 2** Classes, Objects and Methods, Constructors, this Keyword, Garbage Collection, finalize( ) Method, Overloading Methods, Objects as Parameters, Returning Objects, Recursion, Access



Specifiers (default, private, protected, public), static Keyword, final Keyword, Nesting of Methods, Nested and Inner Classes, Command-Line Arguments, Arrays, One-Dimensional Arrays, Two-Dimensional Arrays

**Unit 3** Inheritance, Super Class, Sub Class, Visibility Controls, super Keyword, Types of Inheritance (Single, Multilevel, Hierarchical), Method Overriding, Dynamic Method Dispatch, final with Inheritance, Abstract Methods and Abstract Classes, Object Class, Interfaces (Defining, Extending, Implementing), Packages, Standard Java Packages, Programmer-Defined Java Packages (Creating, Accessing), CLASSPATH, Access Protection

**Unit 4** String and StringBuffer Classes and their Methods, Wrapper Classes, Vector Class, Types of Errors (Compile Time Errors, Run Time Errors), Exceptions, Checked and Unchecked Exceptions, Handling Exceptions (try, catch, finally, throw, throws), Programmer-Defined Exceptions, Multithreading, Creating Threads (Extending Thread Class, Implementing Runnable Interface), Life Cycle of a Thread, Thread Exceptions, Thread Priority, Synchronization

**Unit 5** World Wide Web, Web Browser, HTML, Basic Features of HTML, HTML Tags, Applets v/s Stand Alone Applications, Creating and Executing Small Applets, GUI Components, Graphics Class, Lines and Rectangles, Circles and Ellipses, Arcs, Polygons, Delegation Event Model, AWT and its Basic Controls, Layout Managers (FlowLayout, BorderLayout, GridLayout, CardLayout)

### **Suggested Books:**

1. Bhave, M. P., & Patekar, S. A. (2009). *Programming with Java*. Pearson Education.
2. Kahate, *Java Programming*. Oxford
3. Balagurusamy, E., & Hirshfield, S. (2000). *Programming with java*. Tata McGraw-Hill.
4. Mughal, K. A., & Rasmussen, R. W. (2016). *A Programmer's Guide to Java SE 8 Oracle Certified Associate (OCA)*. Addison-Wesley Professional.
5. Arnold, K., Gosling, J., & Holmes, D. (2005). *The Java programming language*. Addison Wesley Professional.
6. Zukowski, J. (1998). *Mastering Java 2*. SYBEX Inc..
7. Deitel, P., & Deitel, H. (2011). *Java How to program*. Prentice Hall Press.

8. Horstmann, C. S., & Cornell, G. (2002). *Core Java 2: Volume 1, Fundamentals*. Pearson Education.
9. Schildt, H. (2007). *Java: the complete reference*. McGraw-Hill.

### **Suggested E-Resources:**

1. Java Lectures  
[https://www.cse.iitb.ac.in/~nlp-ai/javalect\\_august2004.html](https://www.cse.iitb.ac.in/~nlp-ai/javalect_august2004.html)
2. Object Oriented Programming in Java Specialization  
<https://www.coursera.org/specializations/object-oriented-programming>

## **CS 320L Programming in Java Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

<b>Lab Number</b>	<b>Problems</b>
L1	Display the given information in a given format using Sequential statements
L2-L3	Problems based on arithmetic, logical, relational and bitwise operators such as the following programs
L4-L6	Problems based on Conditional Statements (if, if.. else, switch, goto, labeled continue, labeled break )
L7-L10	Problems based on conditional and unconditional loop (For, While, Do...While)
L11-L13	Problems based on single and multidimensional Arrays
L14-L19	Problems based on object oriented concepts (class)
L20-L23	Problems based on Inheritance
L24-L29	Problems based on Package and Interface
L30-L32	Problems based on Wrapper Class
L33-L35	Problems based on Exception handling
L36-L41	Problems based on I/O Stream
L42-L47	Problems based on String class and its methods
L48-L50	Problems based on Applet
L51-L54	Problems based on Graphics(GUI component)
L55-L60	Problems based on Event Handling

## CS 323 Web Development and .NET Framework

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

### Learning Outcomes:

On successful completion of the course students will be able to:

- Develop working knowledge of C# programming constructs and the .NET Framework architecture.
- Develop, implement and create Applications with C#.
- Build and debug well-formed Web Forms with ASP. NET Controls
- Use of XML in ADO.NET and SQL server.

**Unit - I** Introduction to .NET Framework, CLR, MSIL, Metadata, Namespaces, Console Applications using .NET Framework, C# Programming: Introduction, Tokens, Data Types, Variables, Operators, Control Statements, Methods, Arrays, String, Structures, Enumerations.

**Unit II** Object Oriented Programming in C#, Classes and Objects, Encapsulation, Polymorphism, Inheritance, Interfaces and Collections, Properties, Exceptions Handling, Garbage Collector, Operator Overload Conversions Operators.

Advance C#: Delegates, Events. Advance C# type Construction, Indexers, Generics, Threading, File Handling.

**Unit III** Web Development: Basic Concept of Client-Server Architecture, Elements of Web, Website Design Phases, Characteristics of good Website, HTML, CSS, Client Side and Server Side Coding, Introduction to Scripting Languages (JavaScript, VBScript), Client-Side Validations.

**Unit IV** Web Application Development using ASP.NET with C#: Web Application in ASP.NET, IIS and Development Server, Migrating ASP Web Application to ASP.NET, Working with HTML Controls, Server Controls, Validation Controls, Working with Classes and Dynamic Link Library (DLL), Master Page, State Management in ASP.NET, Data Binding.

**Unit V** Data Management with ADO.NET, Creating & Consuming XML Web Services, Navigation, Localization, Security, Packaging and Deploying ASP.NET Web Application. Introduction to AJAX.

**Suggested Books:**

1. Schildt, H. (2008). *C# 4.0: The Complete Reference*. Tata McGraw-Hill.
2. Sklar, J. (2010). *Textbook of Web Design*. Publisher Course Technology.
3. Evjen, B., Hanselman, S., & Rader, D. (2008). *Professional ASP. NET 3.5 in C# and VB*. Wrox Publication.
4. *C# 2008 Programming: Covers .NET 3.5 (Black Book)*, Dreamtech Press.
5. Troelsen, A. (2007). *Pro C# With. Net 3.0*. Aprèss Publication, 2007

**Suggested E-Resources:**

1. W3Schools website  
<https://www.w3schools.com/xml/>
2. HTML, CSS, and Javascript for Web Developers by Johns Hopkins University  
<https://www.coursera.org/learn/html-css-javascript-for-web-developers>
3. Internet Technology  
<https://nptel.ac.in/courses/106105084/>

## **CS 323L Web Development and .Net Framework Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Lab Number Problems**

- |         |   |
|---------|---|
| L1-L2   | Introduction to Visual Studio.NET             |
| L3-L4   | Create, Debug & Run Console Application in C# |
| L5      | Programs based on Control Statements          |
| L6-L8   | Programs based on Classes & Inheritance       |
| L9-L10  | Programs based on Arrays                      |
| L11-L12 | Programs based on Enumerations & structures   |

L13-L14	Programs based on Interfaces & Collection
L15	Programs based on Exception Handling
L16-L17	Programs based on Strings
L18-L19	Programs based on Event Handling
L20-L21	Programs based on Indexers, Operator Overloading, Conversions, Generics
L22-L23	Programs based on ADO.NET
L24	Problems based on HTML forms (GET & POST )
L25-L26	Problem based on ASP
L27	Migrating ASP Web application to ASP.NET
L28-L29	Problem based on HTML Controls
L30-L32	Problem based on Server Controls
L33-L35	Problem based on Validation Server Control
L36-L37	Problem based on Master Page
L38-L39	Problem based on state management in ASP.NET
L40-L41	Problem based on Data Management Using ADO.NET
L42-L44	Problem based on LINQ
L45-L46	Problem based on AJAX
L47-L48	Problem based on packaging & deployment
L49-L50	Introduction to Windows Application & VB.NET
L51	Simple Problems based on Windows Form

## ELECTRONICS

### First Semester

#### ELE 102 Circuits and Signals

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### **Learning Outcomes:**

After completion of the course, students will be able to:

- Predict the behaviour of any electrical and magnetic circuits.
- Formulate and solve complex AC, DC circuits.
- Explain response of RL, RC and RLC networks.

- Realize the requirement of transformers in transmission and distribution of electric power and other applications.

- Unit 1** Passive components and transient response: Resistance, Temperature Effect, Types of Resistors, Capacitance, Dielectric Strength, Leakage current, Types of capacitors, Inductors, Electromagnetic Induction, Self-inductance, Types of Inductors. Transient response of R-L, R-C & R-L-C circuits (D.C.)
- Unit 2** Network Theorems and Two-Port Parameters: Series and Parallel combination of Resistors and Capacitors, Kirchhoff's Laws, Maxwell Loop current method, Superposition theorem, Thevenin's, Norton's, Miller's and Maximum Power Transfer Theorem. Z, Y, ABCD and h-parameters, Inter-relation between different parameters.
- Unit 3** AC Fundamentals: Equation of the Alternating Voltage and Current, R.M.S. and Average Value of sinusoidal and non-sinusoidal periodic waves, Numerical problems based on AC Fundamentals, A.C. through Inductance, Resistance and Capacitance. Series A.C. Circuits: A.C. through Resistance and Inductance, Active, Reactive, Apparent power, Q-factor of coil.
- Unit 4** A.C. through resistance and capacitance, R-L-C in series, Resonance in R-L-C circuits and graphic representation of resonance, Bandwidth and Q-factor of a series circuit. Resonance in Parallel circuits, graphic representation of parallel resonance and Q-factor of a parallel circuit.
- Unit 5** Introduction, principle and construction; E.M.F. equation of a transformer, different losses in Transformer tests, (Open circuit and Short-circuit tests); Regulation of Transformer, Auto transformer, Application of instrument transformers.

### **Recommended Books:**

1. Thareja, B.L. (2005). *A Text Book of Electrical Technology*. New Delhi: S Chand Publication.
2. Chakrabarti, A. (2018). *Circuit Theory Analysis and Synthesis*. New Delhi: Dhanpat Rai & Co.
3. Mehta, V.K. (2005). *Principles of Electrical Engineering*. New Delhi: S Chand Publication.

### **Suggested e-resources:**

1. **Basic Electrical Circuits** by Dr Nagendra Krishnapura, Indian Institute of Technology, Madras.  
<https://nptel.ac.in/courses/117106108/>

2. **Basic Electrical Technology** by Prof. T. K. Bhattacharya, Indian Institute of Technology, Kharagpur.  
<https://nptel.ac.in/courses/108105053/>
3. **Fundamentals of Electrical Engineering** by Prof. Debapriya Das, Indian Institute of Technology, Kharagpur.  
<https://nptel.ac.in/courses/108105112/1>

## **ELE 102L Circuits and Signals Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### **Learning Outcomes:**

After completion of this laboratory course, students will be able to:

- Test Various Active and Passive components using Multimeter and CRO.
- Understand frequency response of resonance.
- Verify different Network Theorems.

### **List of experiments:**

1. Testing of active and passive components with Q meter.
2. Testing of active and passive components with CRO.
3. To study frequency response of R,L,C series resonance.
4. To study frequency response of R,L,C parallel resonance.
5. To verify Kirchoff's current law.
6. To verify Kirchoff's voltage law.
7. To verify Thevenin's Theorem.
8. To verify Norton's Theorem.
9. Conversion of Norton's model to Thevenin's model.
10. To verify Superposition Theorem.
11. To verify maximum power transform's Theorem.

## Second Semester

### ELE 103 Principles of Electronics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

**Learning Outcomes:** After completion of the course, the students will able to:

- Design various diodes circuits for various applications.
- Differentiate various biasing methods used in BJTs and FET's
- Analyse different kinds of oscillators and feedback circuits.

**Unit 1** Recapitulation of semiconductor Intrinsic and Extrinsic Semiconductor Physics including P-N diode, Diode Equation and Load Line Concept, Break down diodes, Zener Diode, Tunnel Diode, Light Emitting Diode, Varactor Diode, Photo Diode. Diode Applications: Clipping circuits, Comparators, Rectifiers, Capacitor Filters and Clamper circuit, Constant Voltage and Constant current Adjustable Regulated Power Supplies.

**Unit 2** BJT: Transistor current components, The Transistor as an Amplifier, CB configuration, Early Effect, I/O Characteristics, including ICBO & Circuit Considerations, Saturation region in detail, Typical Transistor Junction Voltage Values, CC Configuration, Photo transistor and Maximum Voltage Testing. Transistor Biasing and Bias Stabilization. Small signal low frequency Transistor model-Two Port devices & Hybrid Model, Analysis of Transistor Amplifier circuits using h-parameters & simple numerical, Cascading of the stages.

**Unit 3** FET-Operation and Characteristics of JFET, Enhancement & Depletion Mode MOSFET, Introduction to UJT and its applications

**Unit 4** Feedback in Amplifiers: General theory of feedback, Effect of Negative Feed-back on Gain, Stability, Bandwidth, Noise, I/P & O/P Resistance, Different Feedback Schemes (Voltage series feedback in detail).

**Unit 5** Oscillators: Basic principles of Feedback Oscillators; Barkhausen criteria, RC & LC Oscillators (Hartley, Colpitt, Wein bridge, R-C phase shift oscillator) Derivation for frequency of Practical oscillators



**Recommended Books:**

1. Parikh, Millman & Halkias. (2017). *Integrated Electronics: Analog & Digital Circuits and Systems*. New Delhi: McGraw Hill Education.
2. Boylestad, Robert L., & Nashelsky Louis. (2015). *Electronic Devices & Circuit Theory*. New Delhi: Pearson Publication.
3. Malvino, Albert. & Bates, David J. (2017) *Electronic Principles*. New Delhi: McGraw Hill Education.

**Suggested E-resources:**

1. **Basic Electronics** by Dr. Pramod Agarwal, Indian Institute of Technology, Roorkee. <https://nptel.ac.in/courses/117107095/>

**ELE 103L Principles of Electronics Lab****Max. Marks : 100****(CA: 40 + ESA: 60)****L T P C****0 0 4 2****Learning Outcomes:**

After completion of this laboratory course, students will be able to:

- Identify and Test various electronics components.
- Understand I-V characteristics of various Electronic devices.
- Draw frequency response of amplifiers.

**List of experiments:**

1. Familiarization to Electronics components and apparatus.
2. To study VI Characteristics of p-n junction.
3. To study VI Characteristics of Zener diode
4. To study VI Characteristics of LED.
5. To study of various types of Clippers circuits.
6. To study of various types of Clampers circuits.
7. To study VI Characteristics BJT CB mode.
8. To study VI Characteristics BJT CE mode.
9. To study VI Characteristics of FET.
10. To study frequency response of single stage amplifier.
11. To study Colpitts & Hartley oscillator.
12. To study Wein bridge & crystal oscillator

## Third Semester

### ELE 204 Fundamentals of Digital Electronics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

**Learning Outcomes:**

After completion of the course, the students will able to:

- Develop a skill to build digital logic circuits, troubleshoot them and apply it to solve real life problems.
- Analyse, design and implementation of various combinational and sequential circuits.
- Differentiate various logic families.
- Understand the operation and application of multi-vibrators.

**UNIT 1** logic gates, number system: number system (binary, octal, decimal, hexadecimal) bits & bytes, representation of integers, real, positive and negative numbers. Bcd code. boolean algebra : use of basic theorems of boolean algebra, karnaugh map-use of karnaugh map in simplification of logic circuits. Combinational logic circuits: binary adder, subtractors, comparators, multiplexer, demultiplexer, encoder, decoder.

**UNIT 2** arithmetic logic unit : full adder designs, binary coded decimal adder, addition and subtraction in the 2's complement system, shift operation, binary and decimal multiplication, division logical operations, high speed arithmetic parallel multipliers, floating point number system. Arithmetic operations with floating points number system.

**UNIT 3** (i) Sequential circuits: flip-flops-r-s type, j-k, j-k (master slave), d-type and t-type.

(ii) Counters -asynchronous, synchronous and divide-by n counters. Shift registers, ring counter and twisted ring counter.

**UNIT 4** Elements of logic families:

- (i) Bipolar families:
- (a) DTL
  - (b) TTL
  - (c) ECL

(ii) MOS families:

- (a) PMOS
- (b) NMOS
- (c) CMOS

- UNIT 5**
- (i) Bistable Multivibrators: fixed-bias and self-biased transistorized collector-coupled. Triggering methods, schmitt trigger & its applications.
  - (ii) Collector-Coupled Monostable Multivibrator.
  - (iii) Astable Multivibrator (collector-coupled).

### Recommended Books:

1. Morris Mano, M., & ciletti, Michael d. (2018). *Digital Design*. New Delhi: Pearson Publication.
2. Singhal, Rajul. (2003). *Pulse & Linear Integrated Circuits*. New Delhi: Standard Publisher distributor.
3. Floyd, Thomas L. (2014). *Digital Fundamentals*. New Delhi: Pearson Publication.

### Suggested E-resources:

1. **Digital Circuits and Systems** by Prof. Srinivasan Department of Electrical Engineering Indian Institute of Technology Madras. <https://nptel.ac.in/courses/117106086/>
2. **Digital System Design** by Prof. D. Roy Choudhury Department of Computer Science and Engineering Indian Institute of Technology, Kharagpur. <https://nptel.ac.in/courses/117105080/3>.

## ELE 204L Fundamentals of Digital Electronics Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes:

After completion of this laboratory course, students will be able to:

- Understand the functioning of bread board.
- Implement and verify logic gates and theorems.
- Design combinational and sequential circuits.

**List of experiments:**

1. To verify the truth table of various Logic gates.
2. To implement the functions of various Logic gates with the help of Universal Gates.
3. Verification of theorems of Boolean algebra
4. Study of Binary Adder (Half and Full)
5. Study of Binary Subtractor (Half and Full)
6. Study of Multiplexer and Demultiplexer circuits
7. Study of BCD to Decimal Decoder and Encoder.
8. Study and designing with the help of gates of flip-flops (SR, D, JK, T).
9. Study and designing with the help of gates modulo  $-N$  Synchronous counter for a given value of  $N$ .
10. Study and designing with the help of gates of circuit of given Binary Up and Down synchronous counter.
11. Study and designing with the help of gates of circuit of an asynchronous counter.
12. Study and designing with the help of gates of circuit of Ring and Johnson counter.

**Fourth Semester****ELE 203 Electronic Instrumentation and Measurements****Max. Marks : 100****(CA: 40 + ESA: 60)****L T P C****6 0 0 6****Learning Outcomes:**

After completion of the course, the students will able to:

- Understand and estimate various types of errors in measurements.
- Explain the operating principle of various measuring instruments used to detect physical quantities.
- Design op-amp circuits and understand SCR operation.

**Unit 1** Transducers : Classification of Transducers, Selection of Transducers, Strain Gauge, Displacement Transducers, capacitive Transducers, Linearly variable differential Transformer (LVDT).

Piezo-electric transducers, Temperature transducers-Resistance thermometer, Thermocouples and thermister, Photo-sensitive Devices: Phototubes, photo conductive cells and photo voltaic cells.

**Unit 2** Operational Amplifiers: Basic principle, characteristics and applications as linear op-amp circuits (summer, Voltage-to current converters differential amplifier:BIBO, DC & AC Amplifier, integrator and differentiator) and non-linear op-amp circuits (comparators and schmitt-triggers.)

**Unit 3** Thermistors: SCR characteristics, principle of operation, transistor analogy, methods of Turning On and Turning Off, improvement of device characteristics, Gate characteristics, Applications of SCR in the following areas: Static circuits breaker, Over voltage protection. Zero voltage switch, Logic and Digital Circuits, Pulse circuits.

**Unit 4** (i) LCR Bridges-Measurement of Lumped circuit constants using bridges such as Wheatstone, Wein, Maxwell, Schering and Hay's Bridge.

(ii) Operation of universal counter and measurement errors.

**Unit 5** (i) Digital instruments: A/D and D/A techniques, digital voltmeter.

(ii) Wave analyzer, spectrum analyzer, harmonic distortion analyzer.

(iii) Electronic voltmeters and Q-meter.

### **Recommended Books:**

1. Ramamoorthy, M. (1991). *An Introduction to Thyristors & their Applications*. New Delhi: Affiliated East-West Press (Pvt.) Ltd.
2. Sawheny, A.K.(2015). *A Course in Electrical & Electronic Measurements and Instrumentation*. New Delhi: Dhanpat Rai & Co
3. Helfrick Albert D. & Cooper W.D. (2016). *Modern Electronic Instrumentation and Measurement Techniques (1/e)*. New Delhi: Pearson Publication.

### **Suggested E-resources:**

1. **Industrial Instrumentation** by Prof. Alok Barua, Department of Electrical Engineering Indian Institute of Technology, Kharagpur.  
<https://nptel.ac.in/courses/108105064/7>

2. **Analog Circuits** by Prof. Pramod Agarwal, Department of Electrical Engineering Indian Institute of Technology, Roorkee.  
<https://nptel.ac.in/courses/117107094/1>
3. **Basic Electronics** by Prof. T.S. Natarajan, Department of Physics Indian Institute of Technology, Madras.  
<https://nptel.ac.in/courses/122106025/39>
4. **Electrical and Electronic Measurements** by Prof. V. Jagdeesh Kumar, Department of Electrical Engineering Indian Institute of Technology, Madras. <https://nptel.ac.in/syllabus/108106070/>

## **ELE 203L Electronic Instrumentation and Measurements Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### **Learning Outcomes:**

After completion of this laboratory course, students will be able to:

- Understand principle of different transducers.
- Design various circuits Using Op-Amp IC.
- Understand and draw V-I characteristics of SCR, DIAC and TRIAC.

### **List of experiments:**

1. To study principle of Thermocouple.
2. To study principle of Load cell.
3. To study principle of Thermistor.
4. To study principle of strain gauge.
5. To study Principle of LVDT
6. To study Wein AC bridges and wheat stone AC bridge.
7. To study CRO circuitry in details
8. To calculate the frequency and phase with lissajous figure pattern.
9. To design an adder and subtractor using op-amp 741.
10. To design an integrator using op-amp 741.
11. To design differentiator using op-amp 741.
12. To study the V-I characteristics of a DIAC.
13. To study the V-I characteristics of a TRIAC.
14. To study the V-I characteristics of a SCR.

## Fifth Semester/Sixth Semester

### Discipline Electives

#### ELE 305 Microprocessors

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

After completion of the course, the students will able to:

- Describe the general architecture of a microcomputer system and architecture & organization of 8085 & 8086 Microprocessor and understand the difference between 8085 and advanced microprocessor.
- Distinguish the use of different instructions and apply them in assembly language programming.
- Explain and realize the interfacing of memory & various I/O devices with 8085 microprocessor.

**Unit 1** Evolution of microprocessors, microprocessor(8085) architecture, concept of address, data & control bus, Internal operation, addressing modes, instruction formats & execution timings.

**Unit 2** Microprocessor instructions & programming: 8085 instruction set - data transfer, arithmetic, logical, rotate, compare, jump operations. Programming techniques, stack, subroutine, conditional call and return instructions.

**Unit 3** Interfacing input keyboards, interfacing output displays, memory interfacing, memory mapped I/O. Interrupts - type & masking, 8257 DMA controller chip, 8255 programmable peripheral interface.

**Unit 4** Internal organization of 8086, generating memory addresses, addressing modes, maximum and minimum modes.

**Unit 5** 8086 Instruction set: Data transfer, arithmetic, logical, shift, rotate, flag control instructions, compare, jump, string instructions, subroutine & subroutine handling, loop instructions.

#### **Recommended Books:**

1. Gaonker, R.S. (2013) *Microprocessor Architecture, Programming & Applications with the 8085*. Mumbai, Maharashtra: Penram International Publishing (India) Pvt. Ltd.

2. Douglas V. Hal., SSSP, Rao.(2012) *Microprocessor and Interfacing*. New Delhi: Mc-Graw Hill Publication
3. Ram B. (2018). *Fundamentals of Microprocessors and Microcomputers*. New Delhi: Dhanpat Rai & Co

#### **Suggested E-resources:**

1. **Microprocessor** by Dr. Pramod Agarwal, Department of Electrical Engineering, IIT Roorkee <https://nptel.ac.in/courses/108107029/>
2. **Microprocessors and Microcontrollers** by Prof. Krishna Kumar, IISC Bangalore <https://nptel.ac.in/courses/106108100/>

### **ELE 305L Microprocessors Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **Learning Outcomes:**

After completion of this laboratory course, students will be able to:

- Understand the different instructions of 8085 microprocessor assembly language.
- Coding in assembly language.
- Solve different real time problems.

#### **List of experiments:**

##### **8085 Programming:**

1. To add two 8-bit numbers.
2. To add two 16-bit numbers.
3. To add 'N' 8-bit numbers.
4. To multiply two 8-bit numbers.
5. To divide two 8-bit numbers.
6. To subtract two 8-bit numbers.
7. To subtract two 16-bit numbers.
8. To find the factorial of a given numbers.
9. To find the sum of the integers of a given numbers.
10. To search a given number from a set of numbers.
11. To transfer a block of data from one memory location to another.
12. To exchange a block of data between two memory locations.
13. To find the largest number from a given set of numbers.
14. To find the smallest number from a given set of numbers.
15. To arrange the list of numbers in ascending & descending order.



## ELE 302 Communication Systems

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

### Learning Outcomes:

After completion of the course, the students will able to:

- Explain the working of communication system, Analog Modulation Techniques and their comparative analysis and applications suitability.
- To analyze various methods of baseband/band pass Analogue transmission and detection.
- To evaluate the performance of analogue communications in the presence of noise.
- Explain the working of AM, FM transmitter and receiver.

**Unit 1** (a) Principle of Modulation: Definition of modulation, Need for modulation.

(b) Amplitude modulation: Theory, frequency spectrum of A.M. Wave, Representation of AM wave, Power relation in AM wave, Generation of AM Wave, Single Side Band Generation Techniques in Filter, Phase & Third method.

**Unit 2** (a) Frequency Modulation: Theory of frequency Modulation, Frequency Spectrum of FM wave, advantages of FM, comparison between AM and FM, Generation of FM wave

(b) Phase modulation: Theory of phase modulation, noise in FM, Noise triangle, pre-emphasis & de-emphasis, Adjacent Channel Interference, Co-channel Interference, Stereophonic FM Multiplex system.

### Unit 3 Radio Receivers:

(a) Classification of Radio receivers and their salient features.

(b) AM receivers, super heterodyne receivers, frequency mixer for radio receivers, Intermediate Frequency Amplifier, Detection & Automatic gain control, Tone Control & tuning control.

(c) FM receivers: stages of FM radio receivers - Amplitude Limiting, basic FM demodulators: Foster seeley, balanced slope & ratio detectors.

**Unit 4 TV Transmitter:**

- (a) Block diagrammatic description of transmitter (Black & White T.V.)
- (b) T.V. receiver: block diagrammatic description of T.V. receiver (Black & White) composite video signal, scanning, blanking etc.
- (c) Elementary idea of color T.V., Luminance & chrominance signal.

**Unit 5 Pulse modulation:** Introduction & types, pulse amplitude modulation, pulse time modulation (PPM & PWM), Pulse Code modulation: Principle, noise performance of PCM (Quantization & transmission noise), Compounding, advantages & applications of PCM, Application of pulse communication - Telegraphy & telemetry.

**Recommended Books:**

1. Kennedy, George. (2017) *Electronics communication System*. New Delhi:Mc-Graw Hill Publication.
2. Gulati, R. R. (2011) *Monochrome and colour Television*. New Delhi: New Age International Publication.
3. Shilling, Taub. (2013) *Principles of Communication Systems*. New Delhi: Mc-Graw Hill Publication.
4. Lathi,B.P., Ding, Zhi., & Gupta, Hari Mohan. (2017) *Modern Digital and Analog Communication Systems*. New Delhi: Oxford University Press.
5. Sharma S.P. (2012). *Basic Radio & Television*. New Delhi: Mc-Graw Hill Publication.

**Suggested E-resources:**

1. **Analog Communication** by Prof. Goutam Das, G S Sanyal School of Telecommunications, IIT Kharagpur. <https://nptel.ac.in/courses/117105143/>
2. **Communication Engineering** by Prof. Surendra Prasad, Dept. of Electrical Engineering, IIT, Delhi. <https://nptel.ac.in/courses/117102059/>

## ELE 302L Communication Systems Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes:

After completion of this laboratory course, students will be able to:

- Understand modulation, demodulation waveform and measure modulation index.
- Understand the operation of Pulse modulation and demodulation.
- Familiarized with radio and TV receiver.

### List of experiments:

1. To study the Amplitude Modulation & Demodulation and measure modulation Index.
2. To study the Single sideband AM using Balanced Modulator.
3. To study the PAM and its Demodulation.
4. To study the PWM and its Demodulation.
5. To study the PCM and its Demodulation.
6. To study the PPM and its Demodulation.
7. Familiarization with Radio Receiver - Block Diagram.
8. Familiarization with TV Receiver - Block Diagram.
9. **Project:** Project related to the electronics course contents.

## ELE 312 Antenna Theory and Wave Propagation

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### Learning Outcomes:

After completion of the course, the students will able to:

- Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems.
- Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering.
- Recall electromagnetic plane waves. Apply principles of electromagnetic to explain antenna radiation. Explain various antenna parameters.

- Explain dipole antennas. Establish mathematical equations for various parameters of thin linear antenna.

**Unit I** Review of Electromagnetic theory: Cartesian coordinate system, Circular coordinate system, Spherical coordinate system (dot product, cross product, divergence & curl). Maxwell's equations in differential and integral form, Boundary Conditions for Electrostatics and magnetostatics.

**Unit II** Wave equation and its solution, Poynting vector, General Transmission line equation, input impedance, characteristic impedance, Reflection coefficient, standing wave ratio, Practical problems in transmission lines.

**Unit III** Introduction to antennas, network theorems, Antenna characteristics (Radiation pattern, Directivity, Gain, Polarization, Effective aperture, Friis transmission formula), Vector potentials for electric and magnetic current sources

**Unit IV** Wire antennas: Hetzian and Marconi antenna, Half wave dipole, monopole and loop antenna, Antenna arrays: Linear array, Two element array, Uniform array, Binomial array

**Unit V** Practical antennas: Slot antenna, Horn antenna, Yagi-uda antenna, folded dipole antenna, Helical antenna.

### **Recommended Books:**

1. Hyat, W. H. & Jr. John A. Buck. (2018). *Engineering Electromagnetics, Student edition*. McGraw Hill Education.
2. Liao, S. Y. (1989). *Microwave devices and circuits*. Pearson Education India.
3. Balanis, C. A. (2016). *Antenna theory: analysis and design*. John Wiley & sons.
4. Sadiku, M. N., & Kulkarni, S. V. (2015). *Principles of electromagnetics*. Oxford University Press.
5. Kraus, J. D., Marhefka, R. J., & Khan, A. S. (2006). *Antennas and wave propagation*. Tata McGraw-Hill Education.
6. Collin, R. E. (2007). *Foundations for microwave engineering*. John Wiley & Sons.

## ELE 312L Antenna Theory and Wave Propagation Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### Learning Outcomes:

After completion of this laboratory course, students will be able to:

- Use HFSS tool to design and analysis of antennas.
- Design various type of antennas
- Measure and analyse radiation pattern of antennas.

### List of experiments:

1. To design dipole antenna in HFSS
2. Design monopole antenna in HFSS
3. Design horn antenna in HFSS
4. To measure radiation pattern of Horn Antenna
5. To measure radiation pattern of log periodic Antenna
6. To measure radiation pattern of micro strip patch Antenna
7. To measure radiation pattern of YAGI-UDA Antenna.

## ELE 313 Introduction to Photonics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

### Learning Outcomes:

After completion of the course, the students will able to:

- Explain the light propagation through optical fibers.
- Explain the various light sources and optical detectors.
- Design fiber optic transmitter and receiver system.

**Unit 1** Introduction, Ray theory, Optical fibers: multimode, single mode, step index, graded index, plastic & glass fibers.

Transmission Characteristics of Optical Fibers: Attenuation, Material absorption loss, refractive index profile, Dispersion (intermodal & intramodal), Dispersion Shifted Fibers, Dispersion Compensating Fiber.

**Unit 2** Emission and absorption of radiation, Einstein relation, Absorption of radiation, Population inversion, Optical feedback, Threshold

condition. Population inversion and threshold, Basic idea of solid state, semiconductors, gas & liquid laser. Basic concept of Q-switching and mode locking.

**Unit 3** Fiber Structure, Material, Characteristics, Power & Efficiency of Light Emitting Diode.

Optical detection principles, quantum efficiency, Responsivity, p-n and p-i-n photo diode, Avalanche photo diodes.

**Unit 4** Measurements of Fiber Attenuation, Dispersion, Refractive Index Profile, Cut off Wave Length, Numerical Aperture & Diameter.

Optical Time Domain Reflectometry (OTDR) Field measurement through optical time domain reflectometry, Laser

**Unit 5** Laser based systems for measurement of distance, velocity, liquid level. Fibre optic gyroscope, Holography: basic principle and applications.

#### **Recommended Books:**

1. Senior, John.M. (2009). *Optical Fiber Communication Principles & Practice*. New Delhi: PHI Publication.
2. Keiser, Gerd. (1991). *Optical Fiber Communication*. New Delhi: McGraw Hill Publication.
3. Ghatak, A.K. & Thyagarajan, K. (1981). *Laser Theory and Applications*, 1 edition. Springer

### **ELE 313L Introduction to Photonics Lab**

**Max. Marks : 100**

**L T P C**

**(CA: 40 + ESA: 60)**

**0 0 4 2**

#### **Learning Outcomes:**

After completion of this laboratory course, students will be able to:

- Understand the characteristics of an optical fiber and LED.
- Understand and measure the basic properties of propagation of light in dielectric Optical fibre including losses, attenuation and coupling.
- Explain the working of optical power meter and various sensors.

#### **List of experiments:**

1. To study Analog Link.
2. To study Digital link.

3. To measure Numerical aperture.
4. To study Propagation Loss.
5. To study Bending Loss.
6. To study EYE Pattern.
7. To calculate BER.
8. To study the characteristics of optical source.
9. To study the characteristics of Optical detector.

## **GEOGRAPHY**

### **First Semester**

#### **GEOG 103 Physical Geography**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Describe origin of earth, continents and ocean basin, Isostasy, diastrophism, drainage pattern and several landforms
- Describe the wind movements, pressure, composition and structure of the earth, jet streams
- Classify world in terms of climate, air masses and fronts and describe cyclones and their types
- Describe ocean bottom reliefs of Indian ocean, distribution of temperature and salinity, tides, currents and coral reefs

#### **Course Content:**

**Unit I** Definition and Scope of Physical Geography; Origin of the Earth: - Gaseous Hypothesis of Kant, Nebular Hypothesis of Laplace, Tidal Hypothesis of James Jeans and Big Bang Theory; Interior of the Earth; Origin of the Continent and Oceans: - Wegner's Theory of Continental Drift and Plate Tectonic Theory; Theories of Mountain Building: - Geosyncline Orogen Theory of Kober and Plate Tectonic Theory.

**Unit II** Isostasy: - Concept and Views of Airy and Pratt; Diastrophism: - Faults & Folds; Weathering: - Physical, Chemical and Biological; Drainage pattern and Cycle of Erosion: - Davis & Penck; Landforms: - Fluvial, Coastal and Arid.

**Unit III** Composition and Structure of the Atmosphere; Atmospheric Temperature: – Insolation and Heat Budget; Atmospheric Pressure: - Vertical and Horizontal; Distribution of Air pressure; Winds: - Planetary, Periodic and Local winds; Jet stream:- Definition, Characteristics & its Significance.

**Unit IV** Air masses: - Source region and Classification of Air masses; Fronts: - Frontogenesis and Frontolysis, Type of Fronts; Cyclones: - Tropical and Temperate Cyclones; Anti Cyclones; Climatic classification by Koppen.

**Unit V** Reliefs of the ocean basins – Bottom reliefs of the Indian Ocean; Distribution of Temperature and Salinity of Oceans; Ocean currents: - Atlantic Ocean and Pacific Ocean currents; Tides: - Type and Theory of Origin (Progressive wave and Stationary Wave theory); Coral reefs: - Conditions of growth, Types and Origin according to Darwin and Murray.

Stencils are to be permitted during the examination.

#### Recommended Books:

1. Barry, R.G. & Chorley, R.J. (1998). *Atmosphere: Weather and Climate* (7<sup>th</sup> ed.). London, UK: Routledge.
2. Das, P.K. (1968). *The Monsoons*. New Delhi, India: National Book Trust.
3. Dayal, P. (1996). *A Text book of Geomorphology*. (2<sup>nd</sup>ed.). Patna, India: Shukla Book Depot.
4. Garrison, T. (1998). *Oceanography*. (3<sup>rd</sup>ed.). California, CA: Wadsworth.
5. Gohchengleong (2011). *Certificate Physical and Human Geography*. New Delhi, India: Oxford University Press.
6. Khullar, D.R. (2016). *Physical Geography*. Ludhiana, India: Kalyani.
7. Siddartha, K. (2014). *The Earth's Dynamic surface: A textbook on Geomorphology*. New Delhi, India: Kisalya.
8. Singh, S. (2015). *Geomorphology*. Allahabad, India: Pravalika.
9. Smails, R.J. (1985). *The Study of Landforms*. New York, NY: McGraw Hill.
10. Strahler, A.N. & A.H. Strahler (2008). *Modern Physical Geography*. (4<sup>th</sup> ed.). New Jersey, NJ: John Wiley & Sons.
11. चौहान, वी.एस. (1996). *भौतिक भूगोल*. मेरठ, भारत: रस्तोगी.



12. शर्मा, एच. एस. (2014). *भौतिक भूगोल*. जयपुर, भारत: पंचशील.
13. सिंह, एस. (2005). *भौतिक भूगोल*. गोरखपुर भारत: वसुन्धरा.

### **Suggested e-learning materials:**

1. Interior of earth  
<https://www.nationalgeographic.com/science/earth/surface-of-the-earth/earths-interior/>
2. Plate Tectonics, Weathering, Mass Wasting and Erosion  
<http://hkss.cedd.gov.hk/hkss/eng/education/GS/eng/hkg/chapter4.htm>
3. Geomorphic Processes  
<http://ncert.nic.in/ncerts/l/kegy206.pdf>

## **GEOG 101L Fundamentals of Cartography Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Learning Outcomes:**

After the completion of this course, students should be able to:

- Describe cartography and theoretical background of scales and their types.
- Draw plain, diagonal, comparative, time and Vernier scale.
- Enlarge, reduce and combine maps.
- Describe the uses of thermometer, barometer, hair hygrometer, rain gauge and wind vane.
- Conduct a plane table survey through radiation, intersection and traversing.

### **Course Content:**

- 1) Meaning and Definition of Cartography.
- 2) Scale: - Plain, Diagonal, Comparative (Distances and Time), & Vernier (2 exercises of each scale).
- 3) Enlargement, Reduction & Combination of maps.
- 4) Weather Instruments: - Thermometer, Barometer, Hair hygrometer, Rain Gauge & Wind vane.

- 5) Plane Table Survey: - Methods of Plane tabling; Radiation, Intersection and traverse.

Non Scientific calculators are allowed during the examination.

### **Recommended Books:**

1. Mishra, R.P. (2014). *Fundamentals of Cartography* (2<sup>nd</sup> ed.). New Delhi, India: Concept.
2. Robinson, A.R. (2011). *Elements of Cartography* (6<sup>th</sup> ed.). London, UK: Chapman & Hall.
3. Saha, P. & Basu, P. (2011). *Advanced Practical Geography* (7<sup>th</sup> ed.). Kolkatta, India: Books & Allied.
4. Singh, R.L. (2011). *Elements of Practical Geography* (8<sup>th</sup> ed.). New Delhi, India: Kalyani.
5. खुल्लर, डी.आर. (2015). *प्रयोगात्मक भूगोल*. लुधियाना, भारत: कल्याणी.
6. दयाल, पी. (2006). *प्रयोगात्मक भूगोल की रूपरेखा*. नई दिल्ली, भारत: राजेश.
7. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी.
8. सिंह, आर.एल. (2013). *प्रायोगिक भूगोल के सिद्धान्त* (तृतीय सं.). इलाहाबाद, भारत: शारदा पुस्तक भवन.

### **Suggested e-learning materials:**

1. Introduction to Cartography  
<http://www.sfu.ca/~hickin/Maps/Chapter%201.pdf>
2. Scale  
[http://earthsci.org/education/fieldsk/Map\\_Scales/geo\\_scales.html](http://earthsci.org/education/fieldsk/Map_Scales/geo_scales.html)
3. Plane table surveying  
<https://nptel.ac.in/courses/105107122/33>
4. Methods of Plane table Surveying  
<https://nptel.ac.in/courses/105107122/34>
5. Weather Instruments  
<http://sites.tufts.edu/stompactivitydatabase/files/formidable/Weather-Instruments.pdf>

## Second Semester

### GEOG 102 Human Geography

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Define human geography and relate it to the other social sciences; describe man environment relationships and schools of human geography.
- Describe evolution of man, classify human races and describe migration theories.
- Map and describe the distribution of several tribes- Pigmies, Badawins, Eskimos, Khirgiz, Gujjars, Bakarwals, Toda, Bhil and Santhal and their economic activities.
- Describe population distribution of the world with maps, concepts of population growth, population theories and human development.
- Classify cities functionally; describe urbanization, settlements and their types.

#### **Course Content:**

**Unit I** Definition and Scope of Human Geography, its relation with other Social Sciences; Man – Environment relationship; Schools of Human Geography: Determinism, Possibilism and Neo – determinism; Fundamental principles of Human Geography: Principle of Activity, Principle of Areal Differentiation, Principle of Terrestrial Unity.

**Unit II** Evolution of Man: Monogenetic Theory, Multi Origin Theory and Modern Theory; Criteria of classification of Human Races; Classification and Distribution of Human Races according to G. Taylor; Factors of evolution of Human Races; Migration Zone Theory by G. Taylor.

**Unit III** Distribution of Tribes in the Equatorial and Desert Region: Habitat, Economic activities and Social organization of Pigmies and Badawins; Distribution of Tribes in the Grasslands and Tundra Region: Habitat, Economic activities and Social organization of Eskimos and Khirgiz; Distribution of Tribes in North and South India: Habitat, Economic activities and Social organization of

Gujjars & Bakarwals and Toda; Distribution of Tribes in East and West India: Habitat, Economic activities and Social organization of Santhal and Bhil; Early Economic activities of mankind:- Food gathering, Hunting & Shifting cultivation.

**Unit IV** Distribution of population: World distribution pattern Physical, Economic and Social factors influencing spatial distribution; Concept of Over population, Under population, Optimum population and Zero population growth; Demographic Transition Theory; Migration-Internal and International, General laws of migration- E.G. Ravenstein's laws, Lee's model, Zelinsky's mobility transition model; Concept of Human Development, Population Problems and Policy of India.

**Unit V** Settlement: Origin and Types of settlement; Rural settlement- Pattern of rural settlements, House types and Building materials, Rural settlement in India; Urban settlement- Origin of towns, Patterns of cities; Functional classification of cities, Zoning of cities; Urbanization and Problems: with special reference to slums.

Stencils are to be permitted during the examination.

### **Recommended Books:**

1. Huntington, E. (1959). *The Principles of Human Geography* (2<sup>nd</sup> ed.). New York, NY: John Wiley & Sons.
2. Husain, M. (2014). *Human Geography* (4<sup>th</sup> ed.). Jaipur, India: Rawat.
3. Leong, G. C. & Morgan, G. C. (2010). *Human and Economic Geography* (2<sup>nd</sup> ed.). Oxford, UK: O.U.P.
4. Maurya, S. D. (2015). *Human Geography*. Allahabad, India: Pravalika.
5. Negi, B.S. (1982). *Human Geography- An Ecological Approach*. Meerut, India: Kedarnath Ramnath.
6. Rubenstein, J. M. (2003). *An Introduction to Human Geography* (7<sup>th</sup> ed.). New Jersey, NJ: Prentice Hall.
7. Singh, L. R. (2005). *Fundamentals of Human Geography* (2<sup>nd</sup> ed.). Allahabad, India: Sharda Pustak Bhawan.
8. Verma, J. K. (2008). *Human Geography*. New Dehli, India: GNOSIS.

9. कौशिक, एस. डी. (2011). *मानव भूगोल के सरल सिद्धांत* (12 वाँ सं.). मेरठ, भारत: रस्तोगी.
10. गर्जुर, आर., एवं जाट, बी. सी. (2006). *मानव भूगोल*. जयपुर, भारत: पंचशील.
11. मौर्या, एस. डी. (2009). *मानव भूगोल* (तृतीय सं.). इलाहाबाद, भारत: शारदा पुस्तक भवन.
12. सिंह, के., एवं सिंह, जे. (2009). *मानव भूगोल*. नई दिल्ली, भारत: राधा.
13. सिंह, के. (2010). *मानव भूगोल*. जयपुर, भारत: □ इशिका.
14. हुसैन, एम. (2012). *मानव भूगोल* (चतुर्थ सं.). जयपुर, भारत: रावत.

#### **Suggested e-learning materials:**

1. Schools of Human Geography: Determinism, Possibilism and Neo – determinism  
<http://ncert.nic.in/ncerts/l/legy101.pdf>
2. factor of Evolution human race and criteria  
<http://egyankosh.ac.in/bitstream/123456789/41420/1/Unit-4.pdf>
3. Migration Zone theory by Griffith Taylor <https://booksite.elsevier.com/brochures/hugy/SampleContent/Mapping-Race-and-Ethnicity.pdf>
4. Bushmen Tribe  
<http://www.newworldencyclopedia.org/entry/Bushman>

### **GEOG 104L Statistical Techniques and Data Representation Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Describe statistical sampling and represent frequency distribution in several forms.

- Represent statistical data through diagrams- multiple bar diagram, simple pyramid diagram, rectangular diagram, wheel or pie diagram, and spherical diagram.
  - Measure mean, median mode & standard deviation.
  - Represent Statistical data through graphs-poly linear graph, climograph and triangular graph.
- calculators are allowed during the examination.

### **Recommended Books:**

1. Alvi, Z. (2005). *Statistical Geography Methods and Applications* (2<sup>nd</sup> ed.). New Delhi, India: Rawat.
2. Dadson, S. J. (2017). *Statistical Analysis of Geographical Data an Introduction*. Oxford, UK: John Wiley & Sons.
3. Gupta, S. P. (2012). *Statistical methods* (4<sup>th</sup> ed.). New Delhi, India: Sultan Chand and Sons.
4. Mahmood, A. (2017). *Statistical Methods in Geographical Studies* (6<sup>th</sup> ed.). New Delhi, India: Rajesh.
5. Saha, P. & Basu, P. (2011). *Advanced Practical Geography* (7<sup>th</sup> ed.). Kolkatta, India: Books & Allied.
6. Singh, R. L. (2011). *Elements of Practical Geography* (8<sup>th</sup> ed.). New Delhi, India: Kalyani.
7. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल*. लुधियाना, भारत: कल्याणी.
8. नागर, के. एन. (2013). *सांख्यिकीय के मूलतत्त्व* (चतुर्थ सं.). मेरठ, भारत: मीनाक्षी.
9. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी.

### **Suggested e-learning materials:**

1. Sampling  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=17 P01,M-12>
2. Frequency distribution  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=17 P01,M-12>
3. Histogram  
<https://www.liverpool.ac.uk/~cjl/lskills/WN/NumeracyDiagrams.html#histo>

4. Measures of central tendency

<https://www.mathsisfun.com/data/central-measures.html>

5. Standard deviation method

[https://www.learner.org/courses/againstallodds/pdfs/AgainstAllOdds\\_StudentGuide\\_Unit06.pdf](https://www.learner.org/courses/againstallodds/pdfs/AgainstAllOdds_StudentGuide_Unit06.pdf)

6. Diagrams

<http://egyankosh.ac.in/bitstream/123456789/20422/1/Unit-14.pdf>

## Third Semester

### GEOG 202 Introduction to Geography of India

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### Learning Outcomes:

After the completion of this course, students should be able to:

- Describe and map the location of India, its physiographic divisions.
- Describe the drainage, climate, soil and vegetation their types and distribution.
- Describe major crops, minerals, industrial regions, population of India and their distribution.
- Demarcate Rajasthan in terms of physiography, describe climate, drainage, vegetation, soils and their distribution.
- Describe agriculture, livestock, irrigation, human resources and tourism.

#### Course Content:

**Unit I** Introduction :- Location; Neighbouring countries; Frontiers; India :- A land of Diversities ; Unity within Diversities; Physiographic Division- Himalayan Region, The Great Plains of India, Peninsular Plateau, Coastal Plains and Islands.

**Unit II** Drainage systems of India; Climate: - Summer and Winter Season; Monsoon: - Mechanism of Monsoon; Soil - Type, Distribution & Characteristics; Vegetation: - Type and their Distribution.

**Unit III** Agriculture: - Major Crops and their Distribution (Wheat, Rice & Tea); Minerals: - Distribution and Production of Iron ore & coal; Industrial Regions of India and their Problems; Transport & Trade: - Ports and Foreign Trade; Population: - Distribution & Density of population, Sex Composition & Literacy Pate.

**Unit IV** Physiographic Division of Rajasthan; Climate:- Major Seasons; Drainage Systems; Natural Vegetation:- Type, Distribution & their importance; Soils of Rajasthan.

**Unit V** Agriculture:- Type and Distribution of Major Crops in Rajasthan (Bajra & Mustard) ; Livestock :- Sheep & Camel; Irrigation :- Indira Gandhi Canal Project; Human Resources of Rajasthan: - Distribution & FDensity, Sex ratio, SC, ST, Tourism in Rajasthan : Major Tourist Spots & its importance in the Economy of Rajasthan.

Stencils are to be permitted during the examination

### **Recommended Books:**

1. Bhalla, L. R. (2016). *Geography of Rajasthan* (12<sup>th</sup>ed.). Jaipur, India: Kuldeep.
2. Khullar, D. R. (2014). *India, A Comprehensive Geography* (3<sup>rd</sup>ed.). Ludhiyana, India: Kalyani.
3. Mishra, V. C. (1967). *Geography of Rajasthan*. New Delhi, India: National Book Trust.
4. Singh, G. (2010). *Geography of India* (9<sup>th</sup>ed.). Delhi, India: Atma Ram.
5. बंसल, एस. सी. (2015). *भारत का भूगोल* (तृतीय सं.). मेरठ, भारत: मीनाक्षी.
6. मामोरिया, सी. (2018). *भारत का वृहत भूगोल*. आगरा, भारत: साहित्य भवन.
7. शर्मा, एच. एस. एवं शर्मा, एम. एल. (2017). *राजस्थान का भूगोल* (13वाँ सं.). जयपुर, भारत: पंचशील.
8. शर्मा, एच. एस. एवं शर्मा, एम. एल. (2017). *भारत का नूतन भूगोल*. जयपुर, भारत: आर. बी. डी. पब्लिशिंग हाउस.
9. शर्मा, आर. (2014). *राजस्थान का वृहत भूगोल* (द्वितीय सं.). उदयपुर, भारत: हिमाशुं.



10. सक्सैना, एच. (2014). *राजस्थान का भूगोल* (12वाँ सं.). जयपुर, भारत: राजस्थान हिन्दी ग्रंथ अकादमी.
11. सक्सैना, एच. एम., सक्सैना, आर., एवं सक्सैना, पी. (2017). *भारत का भूगोल*. जयपुर, भारत: रावत.
12. सिंह, जी. (2006). *भारत का भूगोल*. दिल्ली, भारत: आत्माराम.
13. हुसैन, एम. (2018). *भारत का भूगोल* (सप्तम् सं.). नई दिल्ली, भारत: टाटा मैकग्राहिल.

#### **Suggested e-learning materials:**

1. Monsoon  
<https://www.britannica.com/science/Indian-monsoon>
2. Drainage system of India  
<https://iasscore.in/pdf/samplenotes/4.%20Drainage.pdf>
3. Indira Gandhi canal  
<https://nroer.gov.in/55ab34ff81fccb4f1d806025/file/57cff6e816b51c038dedd394>
4. Human Resources of Rajasthan  
<http://worldpopulationreview.com/countries/india-population/>

### **GEOG 203L Mapping and Prismatic Compass Survey Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Create distribution maps through chorochromatic, simple shading, choro-schematic methods.
- Create maps of isobars, isotherms and dot method.
- Conduct prismatic compass survey through radiation and intersection method.
- Correct closing error through Bowditch rule.

#### **Course Content:**

1. Distribution Map: - General Rules and Method of drawing map.

2. Qualitative Methods :- Chorochromatic Method, Dimple Dhading Method, Naming Method, Choroschematic Method- Geometrical Symbol, Pictorial Symbol and Literal Dymbol Method.
3. Quantitative Method :- Choropleth, Isopleth – Isobars and Isotherms, Dot Method.
4. Prismatic Compass Survey: Instruments required for prismatic Compass Survey.
5. Prismatic Compass Survey:- Radiation Method, Intersection Method.
6. Traverse Method.
7. Correction of closing Error with Bowditch Rule.

Non-Scientific calculators are allowed during the examination

### **Recommended Books:**

1. Mishra, R. P. & Ramesh, A. (2014). *Fundamentals of Cartography* (2<sup>nd</sup>ed.). New Delhi, India: Concept.
2. Raize, E. (1948). *General Cartography*. London, UK: McGraw Hill.
3. Sarkar, A. (2015). *Practical Geography: A Systematic Approach* (3<sup>rd</sup>ed.). Kolkatta, India: Orient Black Swan.
4. Singh, R. N. & Kanaujia, L. R. S. (1998). *Map Work & Practical Geography*. Allahabad, India: Central Book Depot.
5. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल*. लुधियाना, भारत: कल्याणी.
6. दयाल, पी. (2006). *प्रयोगात्मक भूगोल की रूपरेखा*. नई दिल्ली, भारत: राजेश.
7. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी.

### **Suggested e-Learning Materials:**

1. Distribution Maps  
<http://ncert.nic.in/ncerts/l/legy303.pdf>
2. Prismatic Compass Survey  
<https://www.svce.ac.in/departments/cve/downloads/Surveying%20I/Unit%202.pdf>

## Fourth Semester

### GEOG 201 Economic Geography

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Define economic geography, describe its scope and relate it with other social sciences
- Classify resources and describe soil mineral and energy resources
- Describe spatial distribution, production and trade of rice, wheat, cotton, tea and Classify world into agricultural regions
- Describe several industries, their location determinants, and distribution of iron- steel and cotton-textile industry.
- Describe trade, transport, their controlling factors, major law making bodies of the world and major transport routes.

#### **Course Content:**

**Unit I** Definition and Scope of Economic Geography; Development of Economic Geography. Its relation with other Subjects; Concept of the Economy; Economic Activities: Primary, Secondary and Tertiary; Impact of Economic Activities on the Environment.

**Unit II** Natural Resources: Meaning and classification of Resources; Conservation of Resources: Water & Forest; Soil Resources: Composition of Soil, Factors affecting soil formation; Soil profile, Soil Classification (NRCS); Mineral Resource: Type, Distribution & production of Iron Ore; Energy Resources: Types, Distribution and Production of Coal and Petroleum.

**Unit III** Agriculture: Physical and Socio–Cultural environment influencing crop production; Spatial Distribution, Production and International trade of Rice & Wheat; Spatial Distribution, Production and International trade of Cotton; Spatial Distribution, Production and International trade of Tea; Agricultural Classification: Whittlesey's Classification.

**Unit IV** Manufacturing Industry: Meaning & Types; Determinants of location of industry; Industrial Location Theory: A. Weber; Distribution & production of Iron & Steel Industry; Distribution & Production of Cotton Textile Industry.

**Unit V** Trade: Type of trade, Factors affecting International trade; Evolution of International trade, Barriers of International trade, Agencies: GATT, WTO, EUROPEAN UNION; Transport: Importance & Development of transport; Means of transport; Water Transport: Suez Canal, Panama Canal, North Atlantic Route.

Stencils are to be permitted during the examination.

**Recommended Books:**

1. Guha, J. L. & Chattoraj, P. R. (2009). *Economic geography – A Study of Resources* (9<sup>th</sup>ed.). Kolkata, India: The World Press.
2. Gurjar, R., & Jat, B. C. (2010). *Resources and Environment* (7<sup>th</sup>ed.). Jaipur, India: Panchsheel.
3. Hodder, B. W. & Lee, R. (2008). *Economic Geography* (Indian Reprint). Jaipur, India: Rawat.
4. Leong, G.C. & Morgan, G. C. (1982). *Human and Economic Geography* (2<sup>nd</sup> ed.). New York. NY: Oxford Press.
5. Maurya, S. D. (2018). *Economic Geography*. Allahabad, India: Pravalika.
6. Shelar, S. K. (2013). *Principles of Economic Geography*. Kanpur, India: Chandralok.
7. Siddhartha, K. (2006). *Economic Geography Theories, Processes and Patterns* (2<sup>nd</sup>ed.). Delhi, India: Kisalaya.
8. Siddhartha, K. (2016). *Economic Geography* (3<sup>rd</sup>ed.). Delhi, India: KitabMahal.
9. गौतम, ए. (2015). *आर्थिक भूगोल के मूलतत्त्व*. इलाहाबाद, भारत: शारदा पुस्तक भवन.
10. जाट, बी. सी. (2016). *आर्थिक भूगोल* (चतुर्थ सं.). जयपुर, भारत: पंचशील.
11. मामोरिया, सी. (2012). *आर्थिक भूगोल* (द्वितीय सं.). आगरा, भारत: साहित्य भवन.
12. राव. एस. (2013). *आर्थिक भूगोल*. गोरखपुर, भारत: वसुन्धरा.
13. सिंह, के. एन., एवं सिंह, जे. (2010). *आर्थिक भूगोल के मूलतत्त्व* (11<sup>वाँ</sup> सं.). गोरखपुर, भारत: ज्ञानोदय.
14. सिंह, जे. (2009). *संसाधन भूगोल*. नई दिल्ली, भारत: राधा.

**Suggested e-learning materials:**

1. Suez Canal trade route  
<https://www.britannica.com/topic/Suez-Canal>
2. Panama Canal  
<https://www.pancanal.com/eng/op/routes.html>

## GEOG 204L Relief Representation and Topographical Maps Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes:

After the completion of this course, students should be able to:

- Interpret topographical maps.
- Represent topographical features with the help of contours.
- Identify Human and natural phenomenon.
- Create Profiles using Contours in the topographical sheets.

### Course Content:

1. Methods of Relief Representation : Hachures, Contours, Layer tint, BM, Spot heights
2. Representation of Relief Features : Water fall, Ridge, Gorge, Pass, Hanging valley along with U-shaped valley, Sand dunes, Cirque, Dolines
3. Profiles: Serial, Superimposed, Projected & Composite.
4. Conventional Signs & Symbols on Topographical sheets/Open Series Map (OSM).
5. Interpretation of topographical sheets/Open Series Map (OSM).

### Recommended Books:

1. Mishra, R. P. & Ramesh, A. (2014). *Fundamentals of Cartography* (2<sup>nd</sup>ed.). New Delhi, India: Concept.
2. Raize, E. (1948). *General Cartography*. London, UK: McGraw Hill.
3. Singh, G. (2009). *Map work and Practical Geography* (4<sup>th</sup>ed.). Delhi, India: Vikas.
4. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल*. लुधियाना, भारत: कल्याणी.
5. शर्मा, जे.पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत: रस्तोगी.

### Suggested e-learning materials:

1. Method of relief representation  
<http://www.sfu.ca/~hickin/Maps/Chapter%204.pdf>
2. Representation of relief features  
<http://ncert.nic.in/ncerts/l/kegy305.pdf>

## Fifth Semester

### GEOG 303L Map Projection Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Elucidate necessity & classification of map projections.
- Compare different kind of map projections.
- Construct map projections graphically.
- Suggest projection for any area of earth surface.

#### **Course Content:**

1. Map Projection: Definition and History of Map Projection.
2. Necessity & Classification of Map Projection.
3. Graphical Construction of Map Projection.
4. Zenithal Projection: Polar zenithal equidistant projection, Polar zenithal equal area, Gnomonic polar zenithal projection, Orthographic polar zenithal projection.
5. Conical Projection: Simple conical projection with one and two standard parallel. Bonne's projection & Polyconic projection.
6. Cylindrical Projection: Perspective cylindrical projection, Cylindrical equal area projection, Mercator's projection.
7. Conventional Projection: Molleweide's projection & Globular projection.

Non Scientific calculators are allowed during the examination

#### **Recommended Books:**

1. Saha, P. & Basu, P. (2011). *Advanced Practical Geography* (7<sup>th</sup>ed.). Kolkatta, India: Books & Allied.
2. Singh, G. (2009). *Map work and Practical Geography* (4<sup>th</sup>ed.). Delhi, India: Vikas.
3. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल*. लुधियाना, भारत, कल्याणी.

4. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम सं.). मेरठ, भारत, रस्तोगी.
5. सिंह, आर. एल. (2013). *प्रायोगिक भूगोल के सिद्धान्त* (तृतीय सं.). इलाहाबाद, भारत: शारदा पुस्तक भवन.

#### **Suggested e-learning materials:**

1. Types of map projection  
<https://www.gistda.or.th/main/en/node/950>
2. Meaning and elements of map projection, construction of conical and cylindrical projection <http://ncert.nic.in/textbook/pdf/kegy304.pdf>

## **Sixth Semester**

### **GEOG 301L Fundamentals of Geoinformatics Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Explain development and types of aerial photographs.
- Identify and interpret aerial photographs.
- Elucidate different elements and development of remote sensing.
- Describe different kinds of remote sensing platforms and discuss important elements of GIS.

#### **Course Content:**

1. Aerial photographs: Introduction & Development of Aerial photographs.
2. Methods and Types of Aerial photographs.
3. Identification of Aerial photographs.
4. Stereovision, Interpretation of Aerial photographs.
5. Remote Sensing: Meaning, Process & Elements of Remote Sensing.
6. Development of Remote Sensing.
7. Advantages of Remote Sensing.
8. Remote Sensing Platforms.
9. Satellite programmes of Remote Sensing of India.

## 10. GIS: Definition, Scope & Elements of GIS.

Non Scientific calculators are allowed in the examination.

### Recommended Books:

1. American Society of Photogrammetry. (1993). *Manual of Remote Sensing* (2<sup>nd</sup> ed.). Virginia, VA: ASP, Falls Church.
2. Fazal, S. (2008). *Remote Sensing Basics*. New Delhi, India: Kalyani.
3. Hammond, R. & McCullagh, P. (1978). *Quantitative Techniques in Geography: An Introduction* (2<sup>nd</sup> ed.). Oxford, UK : Clarendon Press.
4. Nag, P. & Kudrat, M. (1998). *Digital Remote Sensing*. New Delhi, India: Concept.
5. Singh, R. L. (2011). *Elements of Practical Geography* (8<sup>th</sup> ed.). New Delhi, India: Kalyani.
6. चौनियाल, डी. (2010). *सुदूर संवेदन एवं भौगोलिक सूचना प्रणाली*. इलाहाबाद, भारत: शारदा पुस्तक भवन.
7. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल (पंचम सं.)*. मेरठ, भारत: रस्तोगी.

### Suggested e-learning materials

1. History, type and application of aerial photography  
<https://www.environmentalscience.org/principles-applications-aerial-photography>
2. Remote Sensing platform and GIS [http://ags.geography.du.ac.in/Study%20Materials\\_files/Punyatoya%20Patra\\_AM.pdf](http://ags.geography.du.ac.in/Study%20Materials_files/Punyatoya%20Patra_AM.pdf)
3. Principles of Aerial Photography  
<http://www.sfu.ca/~hickin/Maps/Chapter%208.pdf>
4. Interpretation of Aerial Photographs  
[https://www.nrem.iastate.edu/class/assets/nrem345/Week6\\_ALL.pdf](https://www.nrem.iastate.edu/class/assets/nrem345/Week6_ALL.pdf)



## Discipline Electives

### GEOG 305 Environment and Disaster Management

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Understand about the ecosystem and their functions.
- Describe disaster, its types and issues generated during different cycles of disasters.
- Describe the policies of disaster management in India.
- Assimilate role of different bodies established for the cause of disaster relief.

#### **Course Content:**

**Unit I** Ecosystem: Types, Structure and Functions, Energy Flow; Food Chains, Food Web, Ecological Succession

**Unit II** Introduction, Characteristic Features, Structure and Functions of Forest Ecosystem, Grassland Ecosystem, Desert Ecosystem, Aquatic Ecosystem (Ponds, Lakes, Streams)

**Unit III** Disaster and Types: Earthquake, Cyclone, Floods, Volcanoes, Tsunami, Famine, Draught, Epidemics.

**Unit IV** Scenario of Disaster Management in India; India's Vulnerability Profile; Disaster Management Act. 2009 and Policy Guidelines, Case studies: Bhuj Earthquake 2001, The Indian Ocean Tsunami 2004, Kashmir Floods, 2014.

**Unit V** National Institute of Disaster Management; National Disaster Response Force (NDRF); National Disaster Management Authority; State Disaster Management Authority; District Disaster Management Authority.

#### **Recommended Books:**

1. Bolt, B. A. (1988). *Earthquakes*. New York, NY: WH Freeman & Company.
2. Decker, R. W. & Decker, B. B. (2005). *Volcanoes* (4<sup>th</sup>ed.). New York, NY: WH Freeman & Company.

3. Dowrick, D. (2003). *Earthquake Risk Reduction Zone*. England, UK: John Wiley & Sons.
4. Gere, J. M., & Shah, H. C. (1984). *Terra Non Firme Understanding and Preparing for Earthquakes*. New York, NY: WH Freeman & Company.
5. IGNOU (2005). *Understanding Natural Disasters*. E GyanKosh, Noida, India: Shagun Offset Press.
6. Keller, E. A. & Devecchio, E. D. (2015). *Natural Hazards* (4<sup>th</sup>ed.). New York, NY: Pearson.
7. Keller, E.A. (1978). *Environmental Geology* (9<sup>th</sup>ed.). North Carolina, NC: Bell & Howell.
8. Montgomery, C.W. (2013). *Environmental Geology* (10<sup>th</sup>ed.). Texas, TX: Mc-Graw-Hill.
9. Prakash, I. (1994). *Disaster Management*. Ghaziabad, India: Rastriya Prahari.
10. Sharma, V. K. (1995). *Disaster Management*. New Delhi, India: Indian Institute of Public Administration (IIPA).
11. Singh, S. (2015). *Environmental Geography*. Allahabad, India: Pravalika

#### **Suggested e-learning materials:**

1. Disaster management policy 2009  
<https://ndma.gov.in/images/guidelines/national-dm-policy2009.pdf>
2. Policies of Disaster Preparedness  
<https://www.ifrc.org/Global/Governance/Policies/disaster-policy-en.pdf>

### **GEOG 302 Geographical Thought**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Explain evolution of geographical thought and relationship of Geography with other branches of knowledge.
- Describe different tools and techniques of geographical study.

- Compare ancient, medieval and modern scholar's contributions in Geography.
- Elucidate important concepts of Geography as well as recent trends and current issues of subject.

### **Course Content:**

**Unit I** Definition and Aims of Geography, Branches of Geography. Relationship of Geography with other Sciences, Tools and Techniques in Geography; Evolution of Geographical Thought.

**Unit II** Beginning of Classical Geography: Contribution of Greeks (Herodotus & Eratosthenes); Contribution of Romans (Strabo & Ptolemy) Early Medieval Geography: Contribution of Arab geographers (Al – Burini & Ibn-Battuta); Renaissance : Marco polo, Varenus and E. Kant; Main Aspects of Geography in Ancient India.

**Unit III** Contribution of German Schools of Geography: Humboldt & Carl Ritter; Contribution of French School of Geography: Vidal –De-La Blache & Jean Brunhes; Contribution of British School of Geography: Halford J. Mackinder; Contribution of American School of Geography: E. Huntington & Carl O. Sauer; Contribution of Soviet School of Geography : Peter Kropotkin

**Unit IV** Man – Environment Relations: Determinism, Possibilism and Neo-Determinism; Dichotomies in Geography: Physical Vs Human Geography, Systematic vs Regional Geography; Positivism and Quantitative revolution; Behaviouralism in Geography; Radicalism: Origin, Salient features & Objectives of Radical Geography.

**Unit V** Concept of Areal differentiation, Concept of Region and Types of Region; Concept of Cultural Landscape: Meaning & Elements of Cultural Landscape; Recent trends of Modern Geography: Six Trends by Freeman; Applied Geography: Meaning and Methods of Applied Geography; Need of Applied Geography in India.

Stencils are to be permitted during the examination.

### **Recommended Books:**

1. Daniels, P., Bradshaw, M., Shaw, D. & Sidaway, J. (2008). *An Introduction to Human Geography: Issues for the 21st Century* (3<sup>rd</sup>ed.). London, UK: Prentice Hall.
2. Dikshit, R. D. (2018). *A Contextual History of Ideas* (2<sup>nd</sup>ed.). New Delhi, India: PHI.
3. Hussain, M. (2014). *Evolution of Geographical thought* (6<sup>th</sup>ed.). New Delhi, India: Rawat .

4. Kaushik, S. D. & Rawat. D. S. (2017). *Geographical thought and Methodology*. Meerut, India: Rastogi.
5. Martin, G. (2007). *All Possible Worlds. A History of Geographical Ideas* (4<sup>th</sup>ed.). New York, NY: Oxford University Press.
6. Maurya, S. D. (2013). *History Of Geographical Thought*. Allahabad, India: Sharda Pustak Bhawan.
7. Rana, L. (2008). *Geographical thought A systematic record of evolution*. New Delhi, India: Concept.
8. Singh, M. (2016). *Geographical Thought*. New Delhi, India: Sonali.
9. कौशिक, एस. डी., एवं रावत, डी. एस. (2017). *भौगोलिक विचारधारा एवं विधि तंत्र* (नवम् सं.). मेरठ, भारत, रस्तोगी.
10. जैन, एस. एम. (2018). *भौगोलिक चिन्तन का विकास* (संशोधित सं.). आगरा, भारत: साहित्य भवन.
11. प्रसाद, गोविन्द (2006). *भौगोलिक संकल्पनाएँ*. नई दिल्ली, भारत: डिसकवरी.
12. मौर्य, एस. डी. (2015). *भौगोलिक चिन्तन का इतिहास*. इलाहाबाद, भारत: प्रयाग पुस्तक भवन.
13. सिंह, जे. (2009). *भौगोलिक चिन्तन के मूल आधार*. नई दिल्ली, भारत: वसुन्धरा.
14. हुसैन, एम. (2006). *भौगोलिक चिन्तन का इतिहास*. जयपुर, भारत: रावत.

#### **Suggested e-Learning Materials:**

1. Man-Environment relations  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=17> P-06,M-12
2. Concept of Region  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=17> P-06, M-20
3. Behaviouralism in Geography  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=17> P-06, M-27
4. Radicalism  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=17> P-06,M-29
5. Applied Geography  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=17> P-06,M-34

## GEOG 306 Settlement Geography

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### Learning Outcomes:

After the completion of this course, students should be able to:

- Develop an approach to study settlements.
- Depict the evolution of settlements and relate it to the geographical factors.
- Describe rural and urban morphology, its meaning and types.
- Classify cities functionally into different zones.

### Course Content:

**Unit I** Settlement Geography: Meaning, Scope, Development and Approaches; Relation of Settlement Geography with Social Sciences; Concepts of Settlement Geography, importance of Settlement Study in Geography, Techniques and Tools of Settlement Geography.

**Unit II** Settlement: Meaning and Definition, Factors Affecting Origin and Evolution of Settlements, Sources related to the Origin and Growth of Settlements, Bases, Types and Classification of Settlements.

**Unit III** Types of Rural Settlements: Compact, semi-compact, hamlet and Dispersed; Types of Rural Settlements in India; Rural Morphology: Definition, Factors affecting, Stages of Development and Types – Physical, Functional and Social.

**Unit IV** Concept of Town and Urban Area: Difference between Rural and Urban Settlements, Definition of a Town; Factors affecting Origin and Evolution of Towns and Cities, Stages of Evolution of Cities according to G. Taylor; Urban Morphology: Definition, Factors Affecting, Stages of Development and their Types.

**Unit V** Theories of Urban Morphology: Concentric Zone Theory of Burgess, Sector Theory of Hoyt and Multiple Nuclei Theory of Harris & Ullman; Urban Land use and their Types; Functional Classification of cities according to C. D. Harris; Central Place Theory of Walter Christaller; Concept of Conurbation and Umland.

Stencils are to be permitted during the examination

**Recommended Books:**

1. Bansal, S. C. (2015). *Urban Geography* (2<sup>nd</sup> ed.). Meerut, India: Meenakshi.
2. Daniel, P. (2002). *Geography of Settlement*. Jaipur, India: Rawat.
3. Ghosh, S. (1999). *Geography of Settlements*. Kolkata, India: Orient Longman.
4. Hussain, M. (2003). *Urban Geography*. New Delhi, India: Anmol.
5. Mandal, R. B. (2000). *Urban Geography* (2<sup>nd</sup> ed.). New Delhi, India: Concept.
6. Singh, R. Y. (2014). *Geography of Settlements* (2<sup>nd</sup> ed.). Jaipur, India: Rawat.
7. तिवारी, आर. सी. (2016). *अधिवास भूगोल* (अष्ट सं.). इलाहाबाद, भारत: प्रयाग पुस्तक भवन.
8. बंसल, एस. सी. (2016). *ग्रामीण बस्ती भूगोल* (संशोधित सं.). मेरठ, भारत: मीनाक्षी.
9. मौर्य, एस. डी. (2017). *अधिवास भूगोल* (षष्ठ सं.). इलाहाबाद, भारत: शारदा पुस्तक भवन.
10. सिंह, आई. (2008). *अधिवास भूगोल*. नई दिल्ली, भारत: यूनिवर्सिटी.
11. सिंह, आर. (2005). *अधिवास भूगोल*. नई दिल्ली, भारत: रावत.

**Suggested e-learning materials:**

1. Settlement patterns  
<https://www.britannica.com/place/India/Caste#ref487283>
2. Rural settlement  
[https://www.jstor.org/stable/150101?seq=1#metadata\\_info\\_tab\\_contents](https://www.jstor.org/stable/150101?seq=1#metadata_info_tab_contents)
3. Origin and evolution of towns  
<http://www4.brandonu.ca/ebertsd/281/281f17unit02.pdf>

## GEOG 304 World Regional Geography

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### Learning Outcomes:

After the completion of this course, students should be able to:

- Elucidate physical aspects of Asia, Europe, Africa, North & South America and Oceania.
- Describe cultural aspects of Asia, Europe, Africa, North & South America and Oceania.
- Compare different continents of world.
- Illustrate terrain, drainage, climate, natural vegetation and Industrial regions of studied continents.

### Course Content:

**Unit I Asia-** Geographical Location and Extension, Unity in Diversity in Asia, Terrain and Drainage, Spatial Distribution of Population, Climate, Natural Vegetation & Soil, Industrial Regions of Japan and China.

**Unit II Europe-** Location, Extension and Geographical characteristics, Terrain & Drainage, Climate, Natural Vegetation & Soil, Spatial Distribution of Population, Industrial Regions of Britain.

**Unit III Africa-** Location and Extension, Terrain & Drainage, Climate, Natural Vegetation & Soil, Spatial Distribution of Population, Industrial Regions of Africa.

**Unit IV North & South America-** Location, Extension and Geographical Characteristics, Terrain & Drainage, Climate, Natural Vegetation & Soil, Spatial Distribution of Population, Industrial Regions of U.S.A.

**Unit V Oceania (Australia and New Zealand)-** Location, Extension and Geographical Characteristics, Terrain & Drainage, Climate, Natural Vegetation & Soil, Spatial Distribution of Population, Industrial Regions of Australia.

Stencils are to be permitted during the examination.

### Recommended Books:

1. Cole, J. (1996). *A Geography of the World's Major Regions*. London, UK: Routledge.

2. Cole, M. M. (1961). *South Africa*. New York, NY: Dutton.
3. Gourou, R. (1980). *The Tropical World* (5<sup>th</sup>ed.). London, UK: Longman.
4. Hussain, M. (2012). *World Geography* (4<sup>th</sup>ed.). Jaipur, India: Rawat.
5. Kolb, A. (1977). *Geography of a Cultural Region*. London, UK: Methuen.
6. Manku, D. S. (2017). *A Regional Geography of the World* (6<sup>th</sup>ed.). Ludhiana, India: Kalyani.
7. Minshull, G. N. (1984). *Western Europe*. New York, NY: Hodddard & Stoughton.
8. Songquiao, Z. (1994). *Geography of China*. New York, NY: John Wiley & Sons.
9. Ward, R. W. & Miller, A. (1989). *World Regional Geography: A Question of Place*. New York, NY: John Wiley & Sons.
10. अग्रवाल, एस. (2011). *विश्वका भूगोल*. जयपुर, भारत: इशिका.
11. राव, बी. पी., एवं सत्यपति, डी.पी. (2010). *एशिया की भौगोलिक समीक्षा* (द्वितीय सं.). गोरेखपुर, भारत: वसुन्धरा.
12. लोढा, आर. एम. (2010). *औद्योगिक भूगोल* (चतुर्थ सं.). जयपुर, भारत: राजस्थान हिन्दी ग्रंथ अकादमी.
13. सक्सेना, एच.एम. (2011). *विश्व का प्रादेशिक भूगोल*. मेरठ, भारत: रस्तोगी.
14. सिंह, जे., एवं राव, बी. पी. (2007). *तीन दक्षिणी महाद्वीप* (सप्तम् सं.). गोरेखपुर, भारत: वसुन्धरा.

#### **Suggested e-learning materials:**

1. Drainage of Australia  
<https://www.7continentslist.com/australia/rivers-in-australia.php>
2. Drainage of North America  
<https://www.7continentslist.com/north-america/rivers-in-north-america.php>
3. Physical features and climate of Australia  
[https://saylordotorg.github.io/text\\_world-regional-geography-people-places-and-globalization/s15-australia-and-new-zealand.html](https://saylordotorg.github.io/text_world-regional-geography-people-places-and-globalization/s15-australia-and-new-zealand.html)
4. Climate, natural vegetation  
[https://na.unep.net/atlas/africa/downloads/chapters/Africa\\_Atlas\\_English\\_Chapter\\_1.pdf](https://na.unep.net/atlas/africa/downloads/chapters/Africa_Atlas_English_Chapter_1.pdf)



# GEOLOGY

## Disciplinary Courses

### First Semester

#### GEOL 103 Physical Geology

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Elucidate the overall perspective about Earth science.
- Explain the underlying physical and chemical concepts governing the earth's processes.
- Identify tectonic, volcanic, fluvial, glacial and aeolian landforms.
- Determine the physical, chemical and biological processes that control the evolution of identified landforms.

#### **Course Content:**

**Unit I** Introduction to geology, its scope, sub disciplines and relationship with other branches of science. Earth in the solar system, origin, size, shape, mass, density, rotational and revolution parameters. Internal constitution of the Earth. Age of the Earth.

**Unit II** Introduction to minerals, rocks and fossils. Origin of oceans, continents and mountains. Types of mountains. Theory of Isostasy. Geological Time scale.

**Unit III** Earthquake: Introduction and terminology, seismic waves, causes, magnitude, intensity and types of Earthquake. Seismic zones of India. Effects of Earthquakes and distribution of Earthquake belts.  
 Volcano: Introduction, terminology, types, volcanic products, causes & effects and distribution of important volcanic belts.

**Unit IV** Definition, scope and fundamental concept of Geomorphology. Weathering and its types. Soil: Formation, soil profile and soil type. Mass wasting and landslides: An introduction.

**Unit V** Geological action of rivers, wind, groundwater and glaciers: their associated erosional and depositional landforms.

**Recommended Books:**

1. Bangar, K. M. (2009). *Principals of Engineering Geology*. New Delhi, India: Standard.
2. Fletcher, C. (2014). *Physical Geology* (2<sup>nd</sup> ed.). *The Science of Earth*. New York, NY: John Wiley and Sons.
3. Holmes, A. (1992). *Principles of Physical Geology*. London, UK: Chapman and Hall.
4. Leet, L. D. & Judson, S. (1969). *Physical Geology*. Englewood Cliffs, New Jersey, NJ: Prentice Hall.
5. Mahapatra, G. B. (2009). *A Text Book of Geology*. New Delhi, India: CBS.
6. Mukherjee, P. K. (2000). *A Text Book of Geology*. Kolkata, India: World Press.
7. Singh, P. (2010). *Engineering and General Geology*. New Delhi, India: S.K. Kataria& Sons.
8. Singh, S. (2006). *Physical Geomorphology*. Allahabad, India: PrayagPustakBhawan.
9. Tarbuck, E. J., Lutgens, F. K. &Tasa, D.G. (2014). *Illustrator Earth: An Introduction to Physical Geology* (11<sup>th</sup> ed.). New York, NY:Pearson.
10. Thornbury, W. D. (1980). *Principles of Geomorphology*. New York, NY: Wiley Eastern

**Suggested e-learning materials:**

1. Introduction to Geology  
<https://www.nature.com/articles/147556a0>
2. Solar system  
<https://www.nationalgeographic.com/science/space/solar-system/earth>
3. Landscape Evolution  
<https://www.sciencedirect.com/topics/earth-and-planetary-sciences/landscape-evolution>
4. Introduction to geomorphology <https://www.cambridge.org/core/books/geomorphology>

## GEOL 103L Physical Geology Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes:

After the completion of this course, students should be able to:

- Illustrate the relationship of earthquake and volcanic zones of the world with respect to plate boundaries.
- Delineate the seismic zones of India by studying major palaeo-earthquakes.
- Explain the evolution of life with respect to time as well as the major geological events of the past.
- Identify various drainage pattern and geomorphic features in the field.

### Course Content:

1. Preparation of map showing seismic zones of India
2. Marking important Earthquake locations of India
3. Earthquake and volcanic zones of the world
4. Exercises based on finding location of Earthquake epicenter
5. Exercises based on Geological Time scale
6. Identification of different drainage patterns
7. Identification of different geomorphological landforms

### Recommended Books:

1. Bangar, K. M. (2009). *Principles of Engineering Geology*. New Delhi, India: Standard.
2. Holmes, A. (1992). *Principles of Physical Geology*. London, UK: Chapman and Hall.
3. Mahapatra, G. B. (2009). *A Text Book of Geology*. New Delhi, India: CBS.
4. Mukherjee, P. K. (2000). *A Text Book of Geology*. Kolkata, India: World Press.
5. Singh, P. (2010). *Engineering and General Geology*. New Delhi, India: S K Kataria and Sons.

6. Singh, S. (2006). *Physical Geomorphology*. Allahabad, India: Prayag Pustak Bhawan.
7. Thornbury, W. D. (1980). *Principles of Geomorphology*. New York, NY: Wiley Eastern

**Suggested e-learning materials:**

1. Seismic zones  
<https://www.mapsofindia.com/maps/india/seismiczone. ht>
2. Drainage pattern  
<https://www.cambridge.org/core/journals/geological-magazine/article/reconstruction-of-ancestral-drainage-patterns-in-an-internally-draining-region>.  
<https://nptel.ac.in/courses/105105106/>
3. Introduction to geomorphological landforms  
<https://web.viu.ca/earle/ geol111/lecture-notes.htm>

## Second Semester

### GEOL 104 Structural Geology and Plate Tectonics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

**Learning Outcomes:**

After the completion of this course, students should be able to:

- Recognize and interpret the geological structures of deformed continental regimes, varying from simply deformed to superimposed structures.
- Interpret the relative timing of formation of structures, the kinematics of deformation, and the progressive deformation histories in these regimes.
- Interpret stress regimes and strain states during continental deformation.
- Apply the information of structural geology in the mining and resource exploration.

### Course Content:

- Unit I** Introduction to structural geology, Clinometer and Brunton compass, Strike and dip, Pitch/rake and plunge, Concept of stress: normal stress, shear stress, principal axes of stress, planes of maximum shear stress. Concept of Strain: Nature of Strain, homogeneous and inhomogeneous strain longitudinal and shear strain, Strain ellipsoid, Pure shear and simple shear.
- Unit II** Topography and its representation. Outcrop patterns of horizontal bed, gentle dipping bed and vertical bed. Rule of V. Outliers and Inliers; Forms of igneous bodies: concordant and discordant.
- Unit III** Folds: Parts of a fold. Classification of folds: On the direction of closure and fold profile, Fleuty and Ramsey's classification. Types of Foliation and Lineation.
- Unit IV** Faults: Nomenclature, classification of faults: Gravity fault, Strike slip Fault and Thrust fault, Nappes. Effect of faulting on folded strata. Joints: geometric classification. Unconformities.
- Unit V** Plate Tectonics: Continental drift hypothesis; Geological, palaeoclimatological and palaeontological evidence of breakup of Gondwanaland; criticism of continental drift hypothesis. Seafloor spreading, Plate boundary processes: subduction zones - volcanic arcs and island arcs, trenches, accretionary prism, Mid oceanic ridges and spreading rates; Transform fault. Driving mechanism of plate movement.

### Recommended Books:

1. Billings, M. P. (1972). *Structural Geology* (3<sup>rd</sup> ed.). New York, NY: Prentice Hall.
2. Condie, K. C. (1984). *Plate Tectonics & crustal Evolution*. (4<sup>th</sup> ed.). London, UK: Pergamon Press.
3. Condie, K. C. (2016). *Earth as an Evolving Planetary System* (3<sup>rd</sup> ed.). Amsterdam, Netherlands: Elsevier Academic Press.
4. Dennis, G. J. (1987). *Structural Geology An Introduction*. Iowa, IA: Wm. C. Brown.
5. Fossen, H. (2010). *Structural Geology* (2<sup>nd</sup> ed.). Cambridge, UK: Cambridge University Press.
6. George, H. D., Stephen J. R. & Charles F. K. (2013). *Structural Geology of Rocks and Region* (3<sup>rd</sup> ed.). Hoboken, NJ: John Wiley and Sons.

7. Ghosh, S. K. (1993). *Structural Geology Fundamentals and Modern Developments*. London, UK: Pergamon Press.
8. Hobbs, B. E. Means, W.D., & Williams, P. F. (1976). *An Outline of Structural Geology*. New York, NY: John Wiley and Sons.
9. Jain, A. K. (2014). *An Introduction to Structural Geology*, Bangalore, India: GSI.
10. Park, R. G. (1989). *Foundations of Structural Geology* (3<sup>rd</sup>ed.). New York, NY: Chapman & Hall.
11. Pluijm B. A., & Marshak, S. (2004). *Earth Structure An Introduction to Structural Geology and Tectonics* (2<sup>nd</sup> ed.). New York, NY: W. W. Norton.
12. Ramsay, J. G. & Huber, M. I. (1987). *The Techniques of Modern Structural Geology : Strain Analysis* (Vol. 1). London, UK: Elsevier Academic Press.
13. Ramsay, J.G., & Huber, M. I. (1987). *The Techniques of Modern Structural Geology): Folds and Fractures*(Vol. 2). London, UK: Elsevier Academic Press.
14. Ramsay, J. G. & Lisle, R. J. (2000). *The Techniques of Modern Structural Geology: Application of Continuum Mechanics in Structural Geology* (Vol. 3). London, UK: Elsevier Academic Press.
15. Twiss, R. J. & Moores, E. M. (2007). *Structural Geology* (2<sup>nd</sup>ed.). New York, NY: WH Freeman

#### **Suggested e-learning materials:**

1. Structural Geology Map Interpretation  
<https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/>
2. Geologic Structures Part – I  
<https://nptel.ac.in/courses/105105106/2>
3. Geologic Structures Part - II  
<https://nptel.ac.in/courses/105104152/18>
4. Structural Geology lecture notes  
<https://ocw.mit.edu/courses/earth-atmospheric-and-planetary-sciences/12-113-structural-geology-fall-2005/lecture-notes/>
5. Field Geology, Structural Geology and Tectonics lecture notes  
<http://www.uh.edu/~jbutler/anon/anoncoursestructure.html>

## GEOL 104L Structural Geology and Plate Tectonics Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### Learning Outcomes:

After the completion of this course, students should be able to:

- Interpret the toposheets for civil engineering purposes.
- Predict the geometry and location of structures at depth or in areas of less exposed outcrops.
- Interpret the geological history of the given area supplemented with structural data in geological maps.
- Identify the areas prone to geological hazards.

### Course Content:

1. Reading topographical maps of the Survey of India, Indexing of Toposheets, Determination of Map Scale
2. Use of Clinometer and Brunton compass to measure the dip and strike of bedding planes
3. Graphical solution of true dip–apparent dip problems, three-point problems
4. Completion of outcrops.
5. Drawing and interpretation of sections across elementary representative geological structures.
6. Stereographic projection of plane, line and fold (Non plunging and Plunging).
7. Marking important plate boundaries and orogenic belts.

### Recommended Books:

1. Lisle, R. J., Brabham P J. & Barnes, J. W. (2011). *Basic Geological Mapping* (5<sup>th</sup> ed.). England, UK: Wiley Blackwell Publishing.
2. Ragan, M. D. (2009). *Structural Geology an Introduction to Geometrical Techniques*. Cambridge, UK: Cambridge University Press.
3. Rowland, S. M., Duebendorfer, E. M. & Ilsa M. S. (2007). *Structural Analysis and Synthesis A Laboratory Course in Structural Geology* (3<sup>rd</sup> ed.). Victoria, Australia: Blackwell.

**Suggested e-learning materials:**

1. Online stereonet software <https://app.visiblegeology.com/stereonetApp.html>
2. Map Interpretation Techniques  
<https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/>
3. Field Mapping <http://www.geosci.usyd.edu.au/users/prey/FieldTrips/BrokenHillOlary/Mapping.html>
4. Geologic structures  
<https://nptel.ac.in/courses/105105106/>

**Third Semester****GEOL 203 Mineralogy, Crystallography and Geochemistry****Max. Marks : 100****(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

**Learning Outcomes:**

After the completion of this course, students should be able to:

- Recognize and identify the common rock-forming minerals on the basis of their physical properties.
- Make systematic descriptions of minerals by observing them in thin sections under polarizing microscope.
- Describe the parameters, symmetry, general principles of crystal and molecular structures.
- Explain the geochemical distribution of elements and various aspects of radioisotopes including their applications in geology.

**Course Content:**

**Unit I** Minerals: definition and classification. Common physical properties of minerals: form and shape, colour, streak, luster, cleavage, fracture, hardness, tenacity, transparency, specific gravity, magnetic nature. Classification of silicate minerals.

**Unit II** Polarizing microscope, its parts and functioning. Polarization of Light. Nicol Prism and its construction. Optical properties of minerals: optically isotropic and anisotropic substances. Pleochroism, Extinction, Birefringence, Interference colors, Optic sign, Twinning.



**Unit III** Introduction: Crystal, definition. Elementary idea of crystal structure. Parts of crystal- face, edge, apex, solid angle and interfacial angle. Crystallographic axes and angles. Elements of crystal symmetry.

**Unit IV** Parameters and indices. Common crystal forms - dome, prism, pyramid and pinacoid. Introduction to different crystals systems. Cubic (Galena Type), Tetragonal (Zircon Type), Hexagonal (Beryl Type), Trigonal (Calcite Type), Orthorhombic (Barite Type), Monoclinic (Gypsum Type), Triclinic (Axinite Type)

**Unit V** Definition and scope. Geochemical classification of elements. Principles of ionic substitutions in minerals. Radioactivity: Radioactive decay schemes, decay constant, half-life, parent-daughter relations. Radioactive and Stable isotopes: application and their use in geology

### **Recommended Books:**

1. Dana, E. S. & Ford, W. E. (2002). *A textbook of Mineralogy*. New York, NY: John Wiley and Sons.
2. Faure, G. & Mensing, T.M. (2005). *Isotope, principles and applications* (3<sup>rd</sup>ed.). New York, NY: John Wiley & Sons.
3. Gribble, C. D. (1991). *Rutley's Element of Mineralogy* (27<sup>th</sup>ed.). Delhi, India: CBS.
4. Kerr, P. F. (1959). *Optical Mineralogy*. New York, NY: McGraw Hill.
5. Mason, B. & Moore, C. B. (1982). *Introduction to Geochemistry*. New York, NY: Wiley Eastern.
6. Nesse, D. W. (1986). *Optical Mineralogy*. New Delhi, India: McGraw Hill, CBS.
7. Perkins, D. (2010). *Mineralogy* (3<sup>rd</sup>ed.). Edinburgh, UK: Pearson Education.
8. Phillips, W. R. & Griffen, D.T. (1986). *Optical Mineralogy*. New Delhi, India: CBS.

### **Suggested e-learning materials:**

1. Introduction to minerals and crystals <https://epgp.inflibnet.ac.in/ahl.php?csrno=448>
2. Mineral forms  
<http://www.webmineral.com/>  
[http://www.geology.com/mineral gallery](http://www.geology.com/mineral_gallery)

## GEOL 203L Mineralogy, Crystallography and Geochemistry Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### Learning Outcomes:

After the completion of this course, students will be able to:

- Recognize a variety of minerals and gemstones.
- Describe chemistry, crystal structure, and physical properties of minerals.
- Make systematic descriptions and identifications of minerals by observing their thin-sections under polarizing microscope.
- Explain the parameters, lattice structure and symmetry of crystals.

### Course Content:

1. Study of physical properties of following minerals:

Silicates: Olivine, Garnet, Staurolite, Topaz, Kyanite, Sillimanite, Andalusite, Tourmaline, Beryl, Augite, Hypersthene, Tremolite, Hornblende, Muscovite, Biotite, Chlorite, Serpentine, Talc, Kaolinite, Quartz, Orthoclase, Microcline, Albite, Labradorite, Nepheline.

Non Silicates: Gypsum, Graphite, Corundum, Apatite, Calcite, Dolomite.

2. Optical properties of some common rock forming minerals - Quartz, Orthoclase, Microcline, Albite, Garnet, Biotite, Muscovite, Augite, Hypersthene, Hornblende, Olivine and Calcite.
3. Study of elements of symmetry of representative crystals.
4. Calculations based on radioactive method.

### Recommended Books:

1. Dana, E. S. & Ford, W.E. (2002). *A Textbook of Mineralogy*. New York, NY: John Wiley and Sons.
2. Faure, G. & Mensing, T.M. (2005). *Isotope, principles and applications* (3<sup>rd</sup>ed.) New York, NY: John Wiley & Sons.
3. Gribble, C. D. (1991). *Rutley's Element of Mineralogy* (27<sup>th</sup> ed.). Delhi, India: CBS.
4. Kerr, P. F. (1959). *Optical Mineralogy*. New York, NY: USA, McGraw Hill.
5. Mason, B. & Moore, C.B. (1982). *Introduction to Geochemistry*. New York, NY: Wiley Eastern.

6. Nesse, D. W. (1986). *Optical Mineralogy*. New Delhi, India: McGraw Hill, CBS.
7. Perkins, D. (2010). *Mineralogy* (3<sup>rd</sup> ed.). Edinburgh, UK: Pearson.
8. Phillips, W. R. & Griffen, D. T. (1986). *Optical Mineralogy*. New Delhi, India: CBS.

**Suggested e-learning materials:**

1. Mineral forms  
<http://www.webmineral.com/>
2. Introduction to Minerals and crystals  
<https://nptel.ac.in/courses/112106227/>

## Fourth Semester

### GEOL 204 Petrology and Economic Geology

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

**Learning Outcomes:**

After the completion of this course, students will be able to

- Describe and identify igneous, metamorphic and sedimentary rocks.
- Classify magmatic, metamorphic and siliciclastic rocks, and understand the petrogenetic processes and their geologic significance.
- Identify the common ore types, their properties, geological settings to understand the processes and mechanisms of their genesis and devise strategies for exploration.
- Assess the applicability of different ore exploration methods and their utilization.

**Course Content:**

**Unit I** Magma and its composition. Magmatic differentiation and assimilation. Common textures and classification of igneous rocks. Phase rule, Unicomponent system, Bowen's reaction series.

**Unit II** Sediments and sedimentary rock: Origin of clastic and non-clastic of sedimentary rocks. Sedimentary structures. Elementary idea about texture and mineral composition of clastic and non-clastic sedimentary rocks. General classification of sedimentary rocks. Sedimentary facies and depositional environment.

**Unit III** Definition, types and agents of metamorphism. Classification of metamorphic rocks. Metamorphic textures and structures. Metamorphic zones, Isograds and facies.

**Unit IV** Definition of ore and gangue minerals, tenor and grade of ore minerals. Introduction to processes of mineral formation: magmatic concentration, hydrothermal, Residual and mechanical concentration, Oxidation and Supergene enrichment, metasomatism, evaporation, sedimentary and metamorphic.

**Unit V** Mode of occurrence, association, uses and Indian occurrences of metallic (iron, manganese, Chromium, copper, zinc, lead, aluminum, tungsten, gold, silver) and nonmetallic (mica, asbestos, graphite, gypsum) minerals. Elementary idea regarding origin, uses and distribution of coal (Types also) and petroleum in India.

### **Recommended Books:**

1. Bateman, A. M. (1962). *Economic Minerals Deposit* (2<sup>nd</sup>ed.). New York, NY: John Wiley & Sons.
2. Best, M. G. (2002). *Igneous and Metamorphic Petrology* (2<sup>nd</sup>ed.). Oxford, UK: Blackwell Science.
3. Blatt, H. & Tracy, R.J. (1996). *Petrology: Igneous, Sedimentary, Metamorphic* (2<sup>nd</sup>ed.). New York, NY: W.H. Freeman and Co.
4. Collins, J. D. & Thompson, D. B. (1982). *Sedimentary Structures*. London, UK: George Allen & Unwin.
5. Dana, E. S. & Ford, W.E. (2002). *A textbook of Mineralogy*. New York, NY: John Wiley and Sons.
6. Ehlers, E. G. & Blatt, H. (1982). *Igneous, Sedimentary and Metamorphic Petrology*. New Delhi, India: CBS.
7. Gokhale, K. Y. G. K. & Rao, T. C. (1978). *Ore deposits of India: their distribution and processing*. New Delhi, India: Tata-McGraw Hill.
8. LeMaitre, R. W. (2002). *Igneous Rocks: A classification and glossary of Terms*. New York, NY: Cambridge University Press.
9. Nockolds, S. R., Knox, R. W. O. B. & Chinner, G. A. (1978). *Petrology for students*. Cambridge, Cambridge University. Press.
10. Pettijohn, F. J. (1975). *Sedimentary Rocks* (3<sup>rd</sup>ed.). New Delhi, India: Harper and Row.

11. Prasad, U. (2015). *Economic Geology: Economic Mineral Deposits* (2<sup>nd</sup> ed.). New Delhi, India: CBS.
12. Sen, A. K. & Guha P. K. (1981). *A Handbook of Economic Geology*. Calcutta, India: Modern Book.
13. Tiwari, S. K. (2010). *Ore Geology, Economic Minerals and Mineral Economics*. New Delhi, India: Atlantic.
14. Tyrell, G. W. (1978). *The Principles of petrology: An Introduction to the Science of Rocks*. London, UK: Springer.
15. Winkler, H. G. F. (1967). *Petrogenesis of Metamorphic Rocks*. New York, NY: Springer-Verlag.

#### **Suggested e-learning materials:**

1. Introduction to rocks and economic minerals  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=448>
2. Introduction to rocks and economic minerals  
<https://nptel.ac.in/courses/105105170/>
3. Introduction to economic geology  
<https://www.oakton.edu/user/4/billtong/eas100/econgeol.htm>

### **GEOL 204L Petrology and Economic Geology Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

#### **Learning Outcomes:**

After the completion of this course, students should be able to:

- Recognize common ore minerals (metallic and nonmetallic) in hand samples, describe their distribution and uses.
- Describe the rocks based on mineralogical and textural characteristics and interpret the environment of formation
- Map distribution of economic minerals in India.
- Identify various rocks in thin-section under petrological microscope.

#### **Course Content:**

1. Megascopic study of the following Igneous rocks: Granite, gabbro, rhyolite, basalt, dolerite, trachyte

2. Megascopic study of the following Sedimentary rocks: Shale, sandstone, limestone, breccia, conglomerate.
3. Megascopic study of the following Metamorphic rocks: Gneiss, schist, quartzite, marble, slate, phyllite.
4. Microscopic study of Granite, gabbro, rhyolite, basalt, dolerite, sandstone, limestone, quartzite, marble.
5. Study of ore and economic minerals in hand specimens: Magnetite, hematite, limonite, siderite, pyrite, pyrolusite, psilomelane, chromite, chalcopyrite, azurite, malachite, cuprite, sphalerite, galena, wolframite, scheelite, gypsum, barite.
6. Preparation of maps showing distribution of important metallic and non-metallic deposits
7. Identification of different types of coal (lignite, anthracite and bituminous)
8. Distribution of important coal seams and petroliferous basins of India

#### **Recommended Books:**

1. Bateman, A. M. (1962). *Economic Minerals Deposit*. New York, NY: John Willy & Sons.
2. Best, M. G. (2002). *Igneous and Metamorphic Petrology*. Oxford, UK: Blackwell Science.
3. Blatt, H., & Tracy, R. J. (1996). *Petrology: Igneous, Sedimentary, Metamorphic*. New York, NY: W.H. Freeman and Co.
4. Collins, J. D. & Thompson, D.B. (1982). *Sedimentary Structures*. London, UK: George Allen & Unwin.
5. Ehlers, E. G. & Blatt, H. (1982). *Igneous, Sedimentary and Metamorphic Petrology*. New Delhi, India: CBS.
6. Gokhale, K. Y. G. K. & Rao, T. C. (1978). *Ore deposits of India: their distribution and processing*. New Delhi, India: Tata-McGraw Hill.
7. LeMaitre, R. W. (2002). *Igneous Rocks: A classification and glossary of Terms*. New York, NY: Cambridge University Press.
8. Nockolds, S. R. Knox, R. W. O. B. & Chinner, G. A. (1978). *Petrology for students*. Cambridge, UK: Cambridge University Press.
9. Pettijohn, F. J. (1975). *Sedimentary Rocks* (3rd ed.). New Delhi, India: Harper and Row.
10. Prasad, U. (2015). *Economic Geology: Economic Mineral Deposits*. New Delhi, India: CBS.
11. Sen, A.K. & Guha P.K. (1981). *A Handbook of Economic Geology*. Calcutta, India: Modern Book.

12. Tiwari, S. K. (2010). *Ore Geology, Economic Minerals and Mineral Economics*. New Delhi, India: Atlantic.

**Suggested e-learning materials:**

1. Distribution of economic minerals  
<https://www.mapsofindia.com/>
2. Igneous rock-slides  
<http://funnel.sfsu.edu/courses/geol426/>  
<http://www.geolab.ie/>

## Discipline Electives

### GEOL 304 Applied Geology

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

**Learning Outcomes:**

After the completion of this course, students will be able to:

- Describe the concepts & principles of photogrammetry, remote sensing and their applications in geology.
- Explain the hydrologic cycle and theory of plate tectonics as related to natural hazards.
- Describe earth processes that create hazards to life and property.
- Explain the applications of geology in Civil Engineering.

**Unit I** Introduction to Aerial photography. Types of aerial photos. Types of camera, films and filters. Flightplan. Introduction to forward and lateral overlap, drift, crab and fiducial marks. Geometric principles of aerial photographs-relief displacement. Taking measurement from aerial photographs: scale, distance, area and height. Elements of interpretation of aerial photograph.

**Unit II** Remote Sensing: Principles. Energy used in remote sensing. Electromagnetic Spectrum, Atmospheric windows, Energy interaction with Earth surface and atmosphere. Type of sensors: active and passive. Platforms. Resolutions - Spectral, spatial, radiometric and temporal. Applications of photogeology and remote sensing in geology.

**Unit III** Hydrological cycle. Darcy's law and its validity, surface and sub-surface explorations of ground water. Physical and chemical properties of Ground water. Types of aquifers. Water bearing properties of rocks - Porosity and Permeability.

**Unit IV** Definition and concepts of environmental geology. Composition of different environmental domains such as atmosphere, hydrosphere and biosphere. Types of environmental pollution (Air, Water and Soil). Environmental impact of Mining. Green House Effect. Elements of geological hazards (Flood, Landslides, Tsunami, Cyclone).

**Unit V** Elementary concept of rock and soil mechanics. Role of Geology in civil engineering: Geological site investigations foundation treatment and geotechnical considerations for construction of dams and reservoirs, tunnels, bridges and highway.

### **Recommended Books:**

1. Bell, F. G. (2009). *Fundamentals of Engineering Geology*. New Delhi, India: BS.
2. Bhatia, S. C. (2018). *Fundamentals of Remote Sensing*. New Delhi, India: Atlantic.
3. Bryant, E. (2005). *Natural Hazards*. Cambridge, UK: Cambridge University Press.
4. Gangopadhyay, S. (2013). *Engineering Geology*. New Delhi, India: Oxford University Press.
5. George, J. (2005). *Fundamentals of Remote Sensing*. Hyderabad, India: Universities Press.
6. Karanth, K. R. (1989). *Hydrogeology*. New Delhi, India: Tata McGraw Hill.
7. Keller, E. A. (2011). *Environmental Geology* (9<sup>th</sup>ed.). USA, Amsterdam, Netherland: Pearson.
8. Kesavulu, C. N. (2014). *Text Book of Engineering Geology*. New Delhi, India: Trinity Press.
9. Paine, D. P. & Kiser, J. D. (2012). *Aerial Photography and Image Interpretation* (3<sup>rd</sup>ed.). New York, NY: John Wiley and Sons.
10. Pandey, S. N. (2001). *Principle and Applications of Photogeology*. M.P. India: New Age International.
11. Patel, A. N. & Singh, S. (2011). *Principle of Remote Sensing*. New Delhi, India: Scientific.
12. Sabbins, F. F. (1987). *Remote Sensing-Principles and applications* (3<sup>rd</sup>ed.). New York, NY: Freeman.
13. Singh, P. (2011). *Engineering and General Geology*. New Delhi, India: S.K. Kataria & Sons.
14. Todd, D. K. (1995). *Groundwater Hydrology* (3<sup>rd</sup>ed.). New York, NY: John Wiley and Sons.
15. Valdiya, K. S. (1987). *Environmental Geology – Indian Context*. New Delhi, India: Tata McGraw Hill.



**Suggested e-learning materials:**

1. Introduction to hydrology, environment, engineering and remote sensing

<https://epgp.inflibnet.ac.in/ahl.php?csrno=448>

<https://nptel.ac.in/courses/105105106/>

**GEOL 304L Applied Geology Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

**Learning Outcomes:**

After the completion of this course, students will be able to:

- Use the elements and keys of visual image interpretation for aerial photographs and satellite data.
- Prepare maps showing geological hazards like seismic activities, earthquakes, landslides and floods affecting the different parts of India.
- Determine the different hydrological parameters like porosity and permeability of rocks.
- Determine the pH, EC, TDS of water samples

**Course Content:**

1. Elementary study of aerial photographs.
2. Visual interpretation of aerial photograph.
3. Stereo-pair interpretation and depth perception.
4. Visual interpretation of standard FCC data.
5. Graphical presentation of water quality data.
6. Groundwater provinces of India.
7. Major hydro-geochemical provinces of India.
8. Preparation of water table contour map and their interpretation.
9. Determination of permeability by falling and constant head method.
10. Preparation of seismic and flood zonation maps of India.

**Recommended Books:**

1. Davies, S. N. & De Wiest, R. J. N. (1966). *Hydrogeology*. New York, NY: John Wiley and Sons.

2. Karanth, K. R. (1989). *Hydrogeology*. New Delhi, India: Tata McGraw Hill.
3. Nagabhushaniah, H. S. (2001). *Groundwater in Hydrosphere*. New Delhi, India: CBS.
4. Paine, D. P. & Kiser, J. D. (2012). *Aerial Photography and Image Interpretation* (3<sup>rd</sup>ed.). New York, NY: John Wiley and Sons.
5. Pandey, S. N. (2001). *Principle and Applications of Photogeology*. M.P., India: New Age International.
6. Raghunath, H. M. (2010). *Groundwater*. New Delhi, India: New Age International.
7. Rampal, K. K. (1999). *Handbook of Aerial Photography and Interpretation*. New Delhi, India: Concept.

#### **Suggested e-learning materials:**

1. Introduction to hydrology, environment, engineering and remote sensing  
<https://epgp.inflibnet.ac.in/ahl.php?csrno=448https://nptel.ac.in/courses/105105106/>

### **GEOL 305 Field Geology: Tools and Techniques**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### **Learning Outcomes:**

After the completion of this course, students will be able to:

- Elucidate the uses of tools in field and in lab
- Describe the structural elements in field
- Discriminate between the primary and secondary structures
- Explain the geophysical method of prospecting

**Unit- I** Introduction to Geological field work, Orientation of toposheet in field, marking location in toposheet, forward and back Bearing, Essential tools of Field: Compass-clinometer and brunton haversack, hammer, Chisel, measuring tape; topographic sheet, field diary, field observations, collecting of specimens; field photographs.

**Unit II** Geological maps, topographic Maps: Classifications of the features, contours, scale; directions; Nature of profile section and

its construction. Procedure in Geological mappings; description of Geological maps. Nature of Legend, requisite data of the completed geological map.

**Unit III** Types of dip (true and apparent dip) measurement of dip and strike of the rock bed in the field. Field relations of Igneous rocks: flow structure, Pyroclastic rocks, shape of contacts, sharpness of contact, Field study of structure of Igneous rocks, topographic expression of igneous rock; difference between vesicular structure vs. weathering Pits; amygdaloidal vs. porphyritic structure.

**Unit IV** Field interpretation of sedimentary rocks: nature of parent rock; age relation of sedimentary material, bedding; causes of tilting and folding of beds; amount of tilting and direction of force. Topographic expression of folds; effect of topography on beneath of outcrop, correlation of outcrops. Evidence of faulting; faults in relation to their time of origin, Age of joints; Relation of joints to erosion and topography Interpretation of joints.

**Unit V** Prospecting methods: Airborne and ground prospecting methods, Seismic geophysical prospecting methods. Magnetic and gravity prospecting methods. Geophysical logging methods.

### **Recommended Books:**

1. Billings, M. P. (1972). *Structural Geology* (3<sup>rd</sup>ed.). New York, NY: Prentice Hall.
2. Compton, R. R. (1962). *Manual of field geology*. New York, NY: John Wiley & sons.
3. Lahee, F. H. (1961). *Field Geology* (6<sup>th</sup> ed.). New York, NY: McGraw Hills.
4. Mathur, S. M. (2010). *Guide to field Geology*. New Delhi, India: PHI Learning.
5. Ragan, M. D. (2009). *Structural Geology an Introduction to Geometrical Techniques* (3<sup>rd</sup>ed.). New York, NY: Cambridge University Press.
6. Rowland, S.M., Duebendorfer, E. M. & Ilsa, M. S. (2007). *Structural Analysis and Synthesis A Laboratory Course in Structural Geology* (3<sup>rd</sup>ed.). Victoria, Australia: Blackwell.

### **Suggested e-learning materials:**

1. Field Mapping  
<http://www.geosci.usyd.edu.au/users/prey/FieldTrips/BrokenHillOlary/Mapping.html>
2. Map interpretation  
<https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/>

## **GEOL 305L Field Geology: Tools and Techniques Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### **Learning Outcomes:**

After the completion of this course, students will be able to:

- Handle and Use Clinometer, Brunton and Global Positioning System (GPS)
- Identify the structural elements in field and hand specimen
- Solve problems related to map scales and toposheet indexing
- Perform geological mapping

### **Course Content:**

1. Introduction to cardinal directions
2. Uses of clinometers, Brunton compass and Global Positioning System
3. Numerical exercises based on map scales
4. Study of symbols used in geological and topographic maps
5. Indexing of toposheet and exercises based on indexing toposheets
6. Study of lineation and foliation in hand specimen
7. Collection of oriented samples
8. Field mapping

### **Recommended Books:**

1. Billings, M. P. (1972). *Structural Geology* (3<sup>rd</sup>ed.). New York, NY: Prentice Hall.
2. Compton, R. R. (1962). *Manual of field geology*. New York, NY: John Wiley & sons.
3. Lahee, F. H. (1961). *Field Geology* (6<sup>th</sup>ed.). New York, NY: McGraw Hills.
4. Mathur S. M. (2010). *Guide to field Geology*. New Delhi, India: PHI Learning.
5. Ragan, M. D. (2009). *Structural Geology an Introduction to Geometrical Techniques* (3<sup>rd</sup>ed.). New York, NY: Cambridge University Press.
6. Rowland, S. M., Duebendorfer, E. M. & Ilsa, M. S. (2007). *Structural Analysis and Synthesis A Laboratory Course in Structural Geology* (3<sup>rd</sup>ed.). Victoria, Australia: Blackwell.

**Suggested e-learning materials:**

## 1. Field Mapping

<http://www.geosci.usyd.edu.au/users/prey/FieldTrips/BrokenHillOlary/Mapping.html>

## 2. Map interpretation

<https://ocw.tudelft.nl/courses/structural-geology-map-interpretation/>

**GEOL 306 Geology of Rajasthan****Max. Marks : 100****(CA: 40 + ESA: 60)****L T P C****6 0 0 6****Learning Outcomes:**

After the completion of this course, students will be able to

- Describe the physiographic features and climate of Rajasthan.
- Explain the tectono-stratigraphy of the Rajasthan.
- Explore the economic viability of Rajasthan in terms of geological resources.
- Study saline lakes of Rajasthan in terms of their geological evolution.

**Course Content:**

**Unit I** Geomorphology and climate of Rajasthan. Archean Basement granitoids: Untala Granite, Gingla granite, Berach granite, Ahar river granite. Stratigraphy of Bhilwara Supergroup.

**Unit II** Stratigraphy, Tectonics and Economic importance of Aravalli Supergroup, Delhi Supergroup, Marwar Supergroup and Vindhyan Supergroup.

**Unit III** Magmatic activities in Rajasthan with special reference to Kishangarh Syenite, Jahaj Govinpura volcanic, Erinpura granite, Balda granite and Malani Igneous suite.

**Unit IV** Palaeozoic of Rajasthan: Bap and Badhaura formation. Mesozoic of Rajasthan: Jaisalmer and Barmer. Tertiary of Jaisalmer, Barmer and Bikaner-Nagaur basins.

**Unit V** Saline lakes of Rajasthan: Sambhar, Lunkaransar, Didwana and Pachpadralake. Characteristic features and geological evolution of Saline lakes of Rajasthan.

**Recommended Books:**

1. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India: New Age International.

2. Ramakrishnan, M. & Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India: Geological Society of India.
3. Ramakrishnan, M. & Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India.
4. Roy, A. B. & Jakhar, S. R. (2012). *Geology of Rajasthan (Northwest India) Precambrian to Recent*. Jodhpur, India: Scientific Publisher.
5. Sharma, R. (2010). *Cratons and Fold belts of India*. Berlin, Germany: Springer-Verlag.

#### **Suggested e-learning materials:**

1. Basins of Rajasthan  
[http://dghindia.gov.in/assets/downloads/56ceb6e098299Rajasthan\\_Basin\\_18.pdf](http://dghindia.gov.in/assets/downloads/56ceb6e098299Rajasthan_Basin_18.pdf)
2. International Commission on stratigraphy  
<http://www.stratigraphy.org/>
3. Petroleum basin in Rajasthan  
<http://petroleum.rajabasthan.gov.in/sedimentary-basins.htm>
4. Precambrian sedimentary basins of India  
<https://doi.org/10.1144/M43.3>

### **GEOL 306L Geology of Rajasthan Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

#### **Learning Outcomes:**

After the completion of this course, students will be able to:

- Describe the physiographic features and climate of Rajasthan.
- Explain the tectono-stratigraphy of the Rajasthan.
- Explore the economic viability of Rajasthan in terms of geological resources.
- Study saline lakes of Rajasthan in terms of their geological evolution.

#### **Course Content:**

1. Preparation of geological map of Rajasthan
2. Preparation of tectonostratigraphic map of Rajasthan

3. Preparation of minerals map of Rajasthan–Metallic and Non-Metallic
4. Identification of important rocks of Rajasthan.

### **Recommended Books:**

1. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India: New Age International.
2. Ramakrishnan, M. & Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India: Geological Society of India.
3. Ramakrishnan, M. & Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India.
4. Roy, A. B. and Jakhar, S. R. (2012). *Geology of Rajasthan (Northwest India) Precambrian to Recent*. Jodhpur, India: Scientific Publisher.
5. Sharma, R. (2010). *Cratons and Fold belts of India*. Berlin, Germany: Springer-Verlag.

### **Suggested e-learning materials:**

1. Basins of Rajasthan  
[http://dghindia.gov.in/assets/downloads/56ceb6e098299Rajasthan\\_Basin\\_18.pdf](http://dghindia.gov.in/assets/downloads/56ceb6e098299Rajasthan_Basin_18.pdf)
2. International Commission on stratigraphy  
<http://www.stratigraphy.org/>
3. Petroleum basin in Rajasthan  
<http://petroleum.rajabasthan.gov.in/sedimentary-basins.htm>
4. Precambrian sedimentary basins of India  
<https://doi.org/10.1144/M43.3>

## **GEOL 201 Palaeontology and Stratigraphy**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

### **Learning Outcomes:**

After the completion of this course, students will be able to

- Explain the principal elements of fossil preservation.
- Identify fossils based on morphology and evolutionary trends.
- Identify major lithotectonic units of India.

- Describe the geological evolution of the Earth and Indian continent.

### **Course Content:**

**Unit I** Palaeontology: Definition, subdivisions and its relationship with stratigraphy. Fossils: definition and mode of preservation of fossils (body and trace fossils). Index fossils. Incompleteness of fossils record. Elementary ideas about origin and evolution of life.

**Unit II** Morphology and geological distribution of the following fossil groups in India:

- a. Phylum Mollusca (Class: Lamellibranchia or Bivalvia, Class: Gastropoda and Class Cephalopoda)
- b. Phylum Brachiopoda
- c. Phylum Echinodermata (Class Echinoidea)
- d. Phylum Cnidaria (Corals)

**Unit III** Morphology and geological distribution of the following fossil groups in India:

- a. Phylum Arthropoda (Class Trilobita)
- b. Phylum Hemichordata (Class Graptolothina)

Introduction to palaeobotany. Brief account of Gondwana Supergroup and its flora. Introduction to Micropaleontology: foraminifera.

**Unit IV** Stratigraphy: definition and its scope. Principles of stratigraphy. Stratigraphic classification (Lithostratigraphy, Biostratigraphy and Chronostratigraphy) and correlation (Lithostratigraphy, Biostratigraphy and Subsurface). Brief account stratigraphic succession, correlation and economic significance of Dharwar, Aravalli, Cuddapah and Vindhya.

**Unit V** Brief account of Phanerozoic stratigraphic successions of Indian subcontinent as mentioned below:

Paleozoic (Spiti and Kashmir), Mesozoic (Spiti, Kutch and Jaisalmer) and Cenozoic (Assam and Siwaliks). Stratigraphic boundaries: Precambrian-Cambrian, Permian-Triassic and Cretaceous-Tertiary

### **Recommended Books:**

1. Black, R. M. (1988). *The Elements of Palaeontology* (2<sup>nd</sup> ed.). Cambridge, UK: Cambridge University Press.



2. Boggs, S. (2001). *Principles of Sedimentology and Stratigraphy* (3<sup>rd</sup>ed.). New Jersey, NJ: Prentice Hall.
3. Jain, P. C. & Anantharaman, M. S. (1983). *Palaeontology: Evolution and Animal Distribution*. New Delhi, India: Vishal.
4. Krishnan, M. S. (1968). *Geology of India and Burma* (6<sup>th</sup>ed.). Madras, India: CBS.
5. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India: New Age International.
6. Lehmann, U. & Hilmer, G. (1983). *Fossil Invertebrate*. Cambridge, UK: Cambridge Earth Science Series.
7. Moore, R. C. Lalicker, C. G. & Fischer, A. G. (1997). *Invertebrate Fossils*. New Delhi, India: CBS.
8. Nield, E. W. & Tucker, V. C. T. (1985) *Palaeontology: An Introduction*. London, UK: Pergmon Press.
9. Prothero, D. R. (2004). *Bringing Fossil to Life – An Introduction to Paleontology* (2<sup>nd</sup>ed.). New York, NY: McGraw Hill.
10. Ramakrishnan, M. & Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India: Geological Society of India.
11. Ramakrishnan, M. & Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India.
12. Shrock, R. R. & Twenhoffel, W. H. (1952). *Principles of Invertebrate Paleontology*. New Delhi, India: CBS.
13. Wadia, D. N. (1961). *Geology of India* (3<sup>rd</sup>ed.). London, UK: English language.
14. Weller, J. M. (1960). *Stratigraphic Principles and Practices*. New Delhi, India: Universal Book.
15. Woods, H. (2004). *Palaeontology Invertebrate* (8<sup>th</sup>ed.). New Delhi, India: CBS.

#### **Suggested e-learning materials:**

1. Morphology of fossils  
<http://www.ga.gov.au/scientific-topics/disciplines/palaeontology>
2. International Commission on stratigraphy  
<http://www.stratigraphy.org/>
3. International Chronostratigraphic Chart  
<http://www.stratigraphy.org/index.php/ics-chart-timescale>
4. Morphology of Fossils  
<https://www.palaeontologyonline.com/>

## GEOL 201L Palaeontology and Stratigraphy Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### Learning Outcomes:

After the completion of this course, students will be able to:

- Transform a stratigraphic cross-section into a historical summary.
- Explain Stratigraphy and broad tectono-stratigraphic divisions of India through maps.
- Identify different lithotectonic units of India and establish their stratigraphic correlations.
- Explain the morphological characters of different genera of fossils.

### Course Content:

1. Study of morphological characters of different genera pertaining to Brachiopoda, Lamellibranchia, Cephalopoda, Gastropoda, Trilobita, Echinoidea and Anthozoa.
2. Preparation of lithostratigraphic maps of India showing distribution of the following: Dharwar, Cuddapah, Vindhyan.
3. Distribution of Gondwana Rocks in map of India.
4. Study of important Rocks of Rajasthan.

### Recommended Books:

1. Black, R. M. (1988). *The Elements of Palaeontology* (2<sup>nd</sup>ed.). Cambridge, UK: Cambridge University Press
2. Boggs, S. (2001). *Principles of Sedimentology and Stratigraphy* (3<sup>rd</sup>ed.). New Jersey, NJ: Prentice Hall.
3. Jain, P.C. & Anantharaman, M. S. (1983). *Palaeontology: Evolution and Animal Distribution*. New Delhi, India: Vishal.
4. Krishnan, M. S. (1968). *Geology of India and Burma* (6<sup>th</sup>ed.). Madras, India: CBS.
5. Kumar, R. (1978). *Historical Geology and Stratigraphy of India*. New Delhi, India: New Age International.
6. Lehmann, U. & Hilmer, G. (1983). *Fossil Invertebrate*. Cambridge, UK: Cambridge Earth Science Series.
7. Moore, R. C. Lalicker, C. G. & Fischer, A. G. (1997). *Invertebrate Fossils*. New Delhi, India: CBS.
8. Nield, E. W. & Tucker, V. C. T. (1985) *Palaeontology: An Introduction*. London, UK: Pergmon Press.

9. Prothero, D. R. (2004). *Bringing Fossil to Life – An Introduction to Paleontology* (2<sup>nd</sup>ed.). New York, NY: McGraw Hill.
10. Ramakrishnan, M. & Vaidyanathan, R. (2010). *Geology of India* (Vol. 1). Bangalore, India: Geological Society of India.
11. Ramakrishnan, M. & Vaidyanathan, R. (2010). *Geology of India* (Vol. 2). Bangalore, India: Geological Society of India.
12. Shrock, R. R. & Twenhoffel, W.H. (1952). *Principles of Invertebrate Paleontology*. New Delhi, India: CBS.
13. Wadia, D. N. (1961). *Geology of India* (3<sup>rd</sup>ed.). London, UK: English.
14. Weller, J. M. (1960). *Stratigraphic Principles and Practices*. New Delhi, India: Universal Book.
15. Woods, H. (2004). *Palaeontology Invertebrate* (8<sup>th</sup>ed.). New Delhi, India: CBS.

**Suggested e-learning materials:**

1. Palaeontology  
<http://www.ga.gov.au/scientific-topics/disciplines/palaeontology>
2. International Chronostratigraphic Chart  
<http://www.stratigraphy.org/index.php/ics-chart-timescale>
3. Global standard Section and Points (GSSPs)  
<http://www.stratigraphy.org/index.php/ics-gssps>
4. Fossils  
<https://www.palaeontologyonline.com/>

# MATHEMATICS

## First Semester

### MATH 106 Introduction to Calculus

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

#### Learning Outcomes:

On completion of the course, the student will be able to,

- Apply the concept and principles of differential and integral calculus to solve geometric and physical problems.
- Evaluate various limit problems both algebraically and graphically
- Differentiate and integrate the functions which are applicable in real life situations.
- Interpret the geometric meaning of differential and integral calculus
- Apply differentiation to find linear approximation, extrema, monotonicity, and concavity of functions.

**Unit 1** Tangents and normals, Subtangent and sub-normal (Cartesian & polar forms), Derivative of an arc (Cartesian and polar), Pedal equations, Curvature.

**Unit 2** Partial differentiation with Euler's theorem and its applications, Total derivative, Change of variables (polar to Cartesian and Cartesian to polar), Concept of tangent plane and normal to a surface. Maxima and minima of two variables including method of undetermined multipliers.

**Unit 3** Asymptotes, Multiple points, Curve tracing (Cartesian, Parametric and Polar), Envelops & Evolutes.

**Unit 4** Reduction Formulae, Double and Triple Integrals, Change of order of integration in double integrals, Change of variables in multiple integration.

**Unit 5** Quadrature, Rectification, Volume and Surface of solids formed by revolution.

#### Text Books:

1. Narayan S. & Mittal P. K. (2007). *Differential Calculus* (30<sup>th</sup>ed.). New Delhi, Sultan Chand & Sons.

- Narayan S. & Mittal P. K. (2007). *Integral Calculus* (36<sup>th</sup>ed.). New Delhi, Sultan Chand & Sons.

### Reference Books:

- Kishan H. (2007). *Differential Calculus*, New Delhi, Atlantic Publishers.
- Ram Babu (2010). *Engineering Mathematics*, Pearson Education.
- Kreyszig E. (2007). *Advanced Engineering Mathematics* (9<sup>th</sup>ed.), John Wiley.

### Suggested E-learning material:

- Single Variable Calculus  
<https://ocw.mit.edu/courses/mathematics/18-01sc-single-variable-calculus-fall-2010/>
- Differentiation of two variables  
<https://nptel.ac.in/courses/111104085/21>
- Multiple Integral  
<https://nptel.ac.in/courses/111104085/29>

## STAT 104 Introduction to Probability and Statistics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

### Learning Outcomes:

On completion of the course, the student will be able to,

- Compute numerical quantities that measure the central tendency and dispersion of a set of data.
- Understand basic probability axioms and rules and the moments of discrete and continuous random variables as well as be familiar with common named discrete and continuous random variables.
- Apply general properties of the expectation and variance operators.
- Understand the properties and fitting of the Normal, Binomial and Poisson distribution.
- Fit the straight line, second degree parabola and curves of type:  $ab^x$  and  $ax^b$
- Understand the concept of Correlation (Karl Pearson) and Linear Regression.

- Unit 1** Theory of probability, Law of total and compound probability, Conditional probability, Baye's theorem, Random variable, Discrete random variable, Continuous random variable, Distribution function.
- Unit 2** Measures of central tendency, Measures of dispersion, Moments, Sheppard's correction (without proof), Skewness and Kurtosis.
- Unit 3** Mathematical expectation, Addition and multiplication theorem of expectation, Moment generating functions, Cumulants and cumulant generating functions.
- Unit 4** Discrete and continuous probability distributions: Binomial, Poisson and Normal distributions with important properties. Fitting of Binomial, Poisson and Normal distributions.
- Unit 5** The principle of least squares and curve fitting, Fitting of straight line and second degree parabola, Fitting of the curves of type:  $ab^x$  and  $ax^b$ ; Correlation (Karl Pearson) and Linear regression.

#### **Text Books:**

1. Goon, A. M., Gupta, M. K. & Gupta, B. D. (1968). *Fundamental of Statistics*. (Volume I). Kolkata, The World Press Pvt. Ltd.
2. Rohtagi, V. K. (2008). *An Introduction to probability Theory and Mathematical Statistics*. (2<sup>nd</sup> ed.). John Wiley & Wiley Eastern.

#### **Reference Books:**

1. Mood, A. M., Graybill, F. A. & Boes, D. C. (1974). *Introduction to Theory of Statistics*. McGraw-Hill International.
2. Johnson. R. A., Miller, I. & Freund. J. (2011). *Probability and Statistics For Engineers*. Prentice Hall.
3. Feller, W. (1968). *An introduction to probability theory and its applications*. (Volume I), (3<sup>rd</sup>ed.), John Wiley & Sons.
4. Gupta, S. C. & Kapoor, V. K. (2013). *Fundamental of Mathematical Statistics* (11<sup>th</sup>ed.). Sultan Chand Publication, New Delhi.
5. Gupta, S. P. (2017). *Statistical Methods* (17<sup>th</sup>ed.). Sultan Chand & Sons, New Delhi.

#### **Suggested E-learning material:**

1. Probability and Mathematical Statistics; Platform:  
<http://www.math.louisville.edu/~pksaho01/teaching/Math662TB-09S.pdf>

## Second Semester

### MATH 101 Analytical Solid Geometry

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

#### Learning Outcomes:

On completion of this course, student will be able to,

- Understand the basic applications of analytic and solid geometry.
- Understand geometrical terminology for planes, tetrahedron, spheres, paraboloids, hyperboloids and ellipsoids.
- Visualize and represent geometric figures and classify different geometric solids.

**Unit 1** Plane, Straight line.

**Unit 2** Equations of two skew lines in simplest form, Line intersecting two lines, Locus of a line intersecting three given lines, Intersection of three planes, Volume of a tetrahedron.

**Unit 3** Sphere: Equation of Sphere through four given points, Plane Section of a sphere, Intersection of two spheres, Intersection of a sphere and line, Power of a point, Tangent plane, Plane of Contact, Pole and Polar, Condition for orthogonality, Radical- Plane, Line, center, Coaxial system of spheres. Cylinder.

**Unit 4** Cone, Enveloping Cone, Enveloping Cylinder

**Unit 5** The Central Conicoids (Referred to principal axes), Tangent plane, Polar plane, Equation of the normal to an ellipsoid, Number of normals from a given point to an ellipsoid, Cone through six normal.

#### Text Books:

1. Golas P. C., Tandon O. P., & Bhargava S. L. (1999). *Analytical Solid Geometry*. Jaipur Publishing House.

#### Reference Books:

1. Narayan, S. & Mittal P. K. (2004). *Analytical Solid Geometry*. New Delhi, S. Chand.
2. Loney, S. L. (1962). *Co-ordinate Geometry*. London, MacMillan.
3. Chatterji, P. N. (2009). *Solid Geometry*. Meerut, Rajhans Agencies.
4. Sharma, B. D., Tyagi B. S. & BrahmaNand (2016). *Co-ordinate Solid Geometry*. Meerut, Kedarnath Publishing House.

**Suggested E-learning material:**

1. Plane and solid Geometry:  
<http://www.aproged.pt/biblioteca/planeandsolidgeometry.pdf>
2. Solid Geometry introduction:  
[http://altairuniversity.com/wp-content/uploads/2014/02/HM\\_SolidGeomintro.pdf](http://altairuniversity.com/wp-content/uploads/2014/02/HM_SolidGeomintro.pdf)
3. Math handbook of formulas, Process & Tricks: <http://www.mathguy.us/Handbooks/GeometryHandbook.pdf>

**MATH 104 Differential Equations****Max. Marks : 100****L T P C****(CA: 40 + ESA: 60)****4 0 0 4****Learning Outcomes:**

On completion of this course, the student will be able to:

- Identify the type of a given differential equation and select and apply the appropriate analytical technique for finding the solution.
- Student will be able to solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases.
- Create and analyze mathematical models using first order differential equations to solve application problems.
- Determine solutions to the linear and nonlinear ordinary differential equations of first and second order.
- Determine the complete solution of a differential equation with constant coefficients by variation of parameters
- Evaluate the Laplace and Inverse Laplace transform of functions of one variable

**Unit 1** Solution of differential equations of first order and first degree, Solution of differential equations of first order and any degree, Applications of first order differential equations.

**Unit 2** Singular solutions & extraneous loci, Trajectories of a family of curves, Orthogonal trajectories.

**Unit 3** Linear differential equations with constant coefficients, Homogeneous linear differential equations.



**Unit 4** Linear differential equations of second order: The complete solution in terms of known integral, Method of removal of first derivative (or Reduction to normal form or Change of dependent variable), Transformation of equations by changing the independent variable, Method of variation of parameters.

**Unit 5** Laplace transform: Definition, Laplace transform of certain elementary functions, Change of scale property, First and second translation properties, Laplace transform of derivatives, Inverse Laplace transform: Definition, Change of scale property, First and second translation properties, Inverse Laplace transform of derivatives.

**Text Books:**

1. Raisinghania, M. D. & Aggarwal, R. S. (1983). *Ordinary and partial differential equations*. (2<sup>nd</sup> ed.). New Delhi, S. Chand.
2. Sneddon, I. N. (1979). *The use of integral transforms*. New Delhi, Tata Mac Graw-Hill.

**Reference Books:**

3. Ayres, F. (1981). *Schaum's Outline of Theory and Problems of Differential Equation in SI metric units*. Singapore, McGraw-Hill Book Company.

**Suggested E-learning material:**

1. Separable, homogeneous, exact, Linear differential equations, Laplace transform <https://nptel.ac.in/courses/122104018/7>
2. Open course in Differential Equations (All topics) <https://nptel.ac.in/courses/111106100/>
3. Open course in Differential Equations (All topics) <https://swayam.gov.in/course/3787-differential-equations>
4. Second order linear differential equation with constant coefficient <https://ocw.mit.edu/courses/mathematics/18-03sc-differential-equations-fall-2011/>
5. Laplace transform <https://www.math.ust.hk/~machas/differential-equations.pdf>

## Third Semester

### MATH 201 Abstract Algebra

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
4	0	0	4

#### **Learning Outcomes:**

On completion of the course, the student will be able to:

- Demonstrate the mathematical maturity of understanding the proof.
- Understand the definition of a group and be able to test a set with binary operation to determine if it is a group.
- Find the order of elements of groups.
- Identify subgroups of a given group, cycle groups, normal groups.
- Understand permutation groups and be able to decompose permutations into 2-cycles.
- Grasp the significance of the concepts of homomorphism, isomorphism, and automorphism and be able to check a given function is one of these.
- Classify groups up to isomorphism.
- Identify a set with to binary operation forms a ring or not.
- Really understand the special types of rings and be able to construct new examples from the old ones.
- Check a subset of a ring is an ideal or not and be able to identify proper and maximal ideal.

**Unit 1** Divisibility in  $\mathbb{Z}$ , division algorithm, greatest common divisor, Euclidean Algorithm, modular arithmetic, Binary Operations, Group: Definition, examples and properties of group.

**Unit 2** Subgroups, Cyclic groups, Permutation group, symmetric and alternating groups of degree  $n$ , external direct products of groups.

**Unit 3** Cosets, Lagrange's theorem, Homomorphism and Isomorphism of group, Cayley's theorem, Normal subgroups and Factor groups.

**Unit 4** Fundamental theorem of homomorphism of group (First, Second and third theorem of isomorphism).

Rings: Definition and examples, Integral Domain, Division ring, fields

**Unit 5** Ideal, Principal ideal, Principal ideal domain, Factor ring, Prime ideal, Maximal ideal, Ring homomorphism and ring isomorphism.

**Text Books:**

1. Gallian, J. A. (2013). *Contemporary Abstract Algebra* (8<sup>th</sup> Ed.). Cengage Learning.

**Reference Books:**

1. Hillman, A. P. & Alexandersor, G. L. (2015). *Abstract Algebra: A First Undergraduate Course* (5<sup>th</sup> Ed.) CBS Publishers & Distributors Pvt. Ltd.
2. Fraleigh, J. B. (2003). *A First Course in Abstract Algebra* (7<sup>th</sup> Ed.). Pearson.
3. Sen, M. K., Ghosh, S., Mukhopadhyay, P. & Maity, S. K. (2019). *Topics in Abstract Algebra* (3<sup>rd</sup> Ed.). University Press.
4. Khanna, V. K. & Bhambri, S. K. (2008). *A Course in Abstract Algebra* (3rd ed. ). New Delhi: Vikas Publication House.
5. Herstein, I. N. (1991). *Topics in Algebra* (2<sup>nd</sup> ed.). New Delhi: Wiley Eastern

**Suggested E-learning material:**

1. <https://ocw.mit.edu/courses/mathematics/18-703-modern-algebra-spring-2013/related-resources/>
2. <https://www.extension.harvard.edu/open-learning-initiative/abstract-algebra>

**MATH 206 Real Analysis****Max. Marks : 100****(CA: 40 + ESA: 60)****L T P C****4 0 0 4****Learning Outcomes:**

On completion of the course, the student will be able to,

- Think about basic proof techniques and fundamental definitions related to the real number system.
- Understand the concept of real-valued functions, limit, continuity, and differentiability.
- Find expansions of real functions in series forms.
- Demonstrate some of the fundamental theorems of analysis.
- Develop the capacity to solve real integral while understanding of integrable functions.

- Unit 1** Set, Function, Bounded and unbounded set, Supremum and Infimum of a set, Limit point, Closure of a set, Closed and Open set, Interior and boundary point. Description of the real number system as a complete ordered Field, Analytic properties of real number system.
- Unit 2** Real sequences and their convergence, Cauchy sequence, Convergence of series: Comparison test, Root test, Ratio test, Raabe's test, De Morgan's and Bertrand's test, Gauss test, Logarithmic and Integral test, Leibniz test.
- Unit 3** Real valued function, Limit of a function, Continuous function and their properties, Heine's theorem, Uniform continuity.
- Unit 4** Derivability, Rolle's theorem, Lagrange's mean value theorem, Cauchy's mean value theorem, Taylor's and Maclaurin's theorem, Power series, Expansion of  $\sin x$ ,  $\cos x$ ,  $\log(1+x)$ ,  $(1+x)^n$  and  $e^x$ .
- Unit 5** Riemann integration, Properties of Riemann integrals, Fundamental theorem of integral calculus, Pointwise and uniform convergence,  $M_n$ -test, Weierstrass M-test, Abel's test, Dirichlet's test, Uniform convergence and continuity, Term by term differentiation and integration.

***Text Books:***

1. Malik, S.C. (2004). Principles of Real Analysis. New Delhi, India: New Age International.

***Reference Books:***

1. Apostol, T. M. (1985). *Real Analysis*. New Delhi, India: Narosa Publishing House.
2. Royden, H. L. (1993). *Real Analysis*. New York: Macmillan.
3. Rudin, W. (1985). *Principles of Mathematical Analysis*. Auckland: McGraw Hill.

***Suggested E-learning material***

1. Real Analysis; NPTEL:<https://nptel.ac.in/courses/111106053/>

## Fourth Semester

### MATH 202 Introduction to Linear Algebra

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

#### Learning Outcomes:

On Completion of this course, the students will be able to:

- Understand vector spaces over a field and subspaces and apply their properties.
- Understand linear independence and dependence.
- Find basis and dimension of a vector space, and understand change of basis.
- Compute linear transformations, kernel and range, and inverse linear transformations, and find matrices of general linear transformations.
- Find eigenvalues and eigenvectors of a matrix and of linear transformation.
- Understand inner product on a vector space.
- Understand the concept of orthogonality in inner product spaces.
- Create orthogonal and orthonormal bases: Gram-Schmidt process.

**Unit 1** Vector space over a field, Vector subspaces, Algebra of vectors, Linear sum and direct sum of subspaces, Linear combination, Linear span, Linear dependence and independence of vectors and its properties.

**Unit 2** Basis and dimension of vector space and subspace, Linear mappings, Kernel and Range of linear mapping, Singular and non-singular mappings, Linear operator, Algebra of linear operators, Invertible operators.

**Unit 3** Matrix representation of a linear transformation, Change of basis, Range rank and Kernel nullity of a matrix, Elementary transformations, Matrix inversion with elementary transformations, Normal form of a matrix.

**Unit 4** Matrix polynomials, Characteristics polynomial of a matrix, Characteristics values, Characteristics vector, Cayley-Hamilton theorem, system of linear equations.

**Unit 5** Inner product spaces, Orthogonality, Orthogonal sets and bases, Projection of a vector, Gram-Schmidt orthogonalization process, Fourier coefficients, Introduction to Linear Functional with simple examples.

**Text Books:**

1. Sheldon, A. (1996). *Linear algebra done right* (2<sup>nd</sup> ed.). Springer.
2. Krishnamurthy, V., Mainra, V. P. & Arora, J. L. (1976). *An introduction to linear algebra*. New Delhi, East-West Press.

**Reference Books:**

1. Friedberg, S. H., Insel, A. & Spence, L. (2016). *Linear algebra*. (4<sup>th</sup> Ed.). Noida (U.P.), India Pearson.
2. Halmos, P. R. (2013). *Finite dimensional vector spaces*. (2<sup>nd</sup> ed.). S.I.: Literary Licensing, LLC.
3. S. Kumaresam, S. (2000). *Linear algebra: A geometrical approach*, New Delhi: PHI Learning.
4. Hoffman, K. & Kunze, R. A. (2010). *Linear algebra*. New Delhi: PHI Learning.

**Suggested E-learning Material:**

1. Video Lectures: <https://www.edx.org/learn/linear-algebra>
2. Video Lectures: <https://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/>
3. Video Lectures: [https://onlinecourses.nptel.ac.in/noc17\\_ma04/preview](https://onlinecourses.nptel.ac.in/noc17_ma04/preview)

**MATH 301 Complex Analysis****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

**Learning Outcomes:**

On completion of the course, the student will be able to,

- Demonstrate understanding of the basic concepts and fundamental definitions underlying complex analysis.
- Investigate complex functions, concept of limit, continuity and differentiability of complex functions.
- Demonstrate capacity for mathematical reasoning through analyzing analytic functions.
- Prove and explain concepts of series and integration complex functions.
- Understand problem-solving using complex analysis techniques.
- Enjoy the roll of complex functions today's mathematics and applied contexts.

- Unit 1** Complex Numbers, concept of limit, continuity and differentiability, Analytic Functions, Necessary and sufficient condition for a function to be analytic, Polar form of Cauchy-Riemann equations, Construction of an analytic functions.
- Unit 2** Conformal Transformation and representation, Bilinear Transformation, Transformations  $w = z^2$ ,  $w = \sqrt{z}$ ,  $w = e^z$  and  $w = \log z$ .
- Unit 3** Complex Integration - Definition, Cauchy's theorem, Cauchy's Goursat's Lemma, Cauchy's theorem, Cauchy's integral formula and its generalized form, Morera's theorem, Liouville's theorem, Taylor's and Laurent's expansion
- Unit 4** Singularities: Zeros of an analytic function, Singular points, Different type of singularities, Residue at a pole, Residue at infinity, Cauchy's residue theorem, Computation of residue at a (i) simple pole, (ii) multiple pole.
- Unit 5** Integration round the unit circle, Integration of  $f(z)$  when it has no pole on the real line, Integration of  $f(z)$  when it has poles on real line.

#### **Suggested Reference Books:**

1. Lang, S. (1999). *Complex Analysis*. New York : Springer.
2. Ahlfors, L. (1988). *Complex Analysis*. Auckland: McGraw-Hill.
3. Churchill, R.V. & Brown, J. W. (1995). *Complex Variables and Applications* (6<sup>th</sup> ed.). New York: McGraw-Hill.

#### **Suggested E-learning material**

1. Complex Analysis; NPTEL <https://nptel.ac.in/courses/111103070/>

## Fifth Semester

### Core Paper (Mathematics)

#### MATH 302 Introduction to Discrete Mathematics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**4 0 0 4**

#### **Learning Outcomes:**

On completion of the course, the student will be able to:

- Write an argument using logical notation and determine if the argument is or is not valid.
- Demonstrate the ability to write and evaluate a proof or outline the basic structure of and give examples of each proof technique described.
- Understand the basic principles of sets and operations in sets.
- Prove basic set equalities.
- Apply counting principles to determine probabilities.
- Demonstrate an understanding of relations and functions and be able to determine their properties.
- Determine when a function is 1-1 and "onto".
- Demonstrate different traversal methods for trees and graphs.
- Model problems in Computer Science using graphs and trees.

**Unit 1** Sets and Multisets, Relations and Functions, Equivalence relations, Partial order relations, Chains and Antichains. Permutations, Combinations, selection with & without replacement, Permutation and Combinations of multisets. Discrete probability. The rules of sum and product.

**Unit 2** Basic concepts of graph theory, Multi-graphs, Paths & Circuits, Eulerian path and circuits, Hamiltonian path and circuits, weighted graphs, Shortest path in weighted graph, Planar graphs, Vertex connectivity and edge connectivity of graphs.



- Unit 3** Vertex coloring and edge coloring of graphs, Vizing's theorem, Trees and cut sets- Trees, Rooted tree, Path lengths in rooted trees, Spanning tree and cut set, Minimum spanning tree, Matrix representation of graphs.
- Unit 4** Pigeon hole principle, Inclusion-exclusion principle. Discrete numeric functions-manipulation of numeric functions. Asymptotic behavior of numeric functions. Generating functions and recurrence relations. Linear recurrence relation with constant coefficients and their solutions.
- Unit 5** Mathematical logic: Basic Connectives, normal forms (CNF and DNF), proof of Validity, Predicate logic, Lattices and Boolean algebra. Uniqueness of finite Boolean algebra. Boolean functions and Boolean expressions. Propositional Calculus.

**Text Books:**

1. Rosen, K.H. (1999). Discrete Mathematics and its Applications. McGraw Hill.
2. Liu, C.L. & Mohapatra, D.P. (2008). Elements of Discrete Mathematics, Tata McGraw Hill.
3. Deo, N. (2004). Graph Theory. Prentice Hall of India, New Delhi.

**Reference Books:**

1. Biggs, N. L. (1985). Discrete Mathematics. Oxford Science Publication.
2. Koshy, T. (2005). Discrete Mathematics with Applications. Academic Press.

**Suggested E-learning material:**

1. <https://www.geeksforgeeks.org/engineering-mathematics-tutorials/>
2. <http://mathworld.wolfram.com/DiscreteMathematics.html>

## Sixth Semester

### Core Paper (Mathematics)

#### MATH 303 Introduction to Numerical Analysis

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**4 0 0 4**

#### **Learning Outcomes:**

On completion of the course, the student will be able to:

- Apply numerical methods to obtain approximate solutions to mathematical problems.
- Solve the nonlinear equations, system of linear equations and interpolation problems using numerical methods.
- Examine the appropriate numerical differentiation and integration methods to solve problems.
- Apply the numerical methods to solve differential equations.

**Unit 1** Error analysis: Exact and approximate numbers, rounding of numbers, Significant digits, various types of errors encountered in computations, error in function approximation, the general error formula, Taylor's series, error in series approximation. Numerical solution of system of linear equations: Direct methods: The matrix inversion method, Gauss elimination method with pivoting strategies, Gauss-Jordan method, Factorization methods (LU-Doolittle, Crout,  $LDL^T$ , Cholesky), computing inverse of a matrix. Iterative methods: Gauss-Jacobi Method, Gauss-Siedel method.

**Unit 2** Finite differences: forward, backward, central and divided difference operators, their properties and difference tables, propagation of error in difference table, missing data calculation, Relation between difference and derivatives, differences of polynomials. Polynomial interpolation: Newton-Gregory forward and backward interpolation, Gauss's forward and backward, Stirling's, Bessel's interpolation, Lagrange's and Newton's divided differences interpolation, inverse interpolation, computation errors in these formulae and analysis of errors.

- Unit 3** Numerical differentiation, Numerical integration: Newton's Cotes Quadrature formula, Simpson's, Weddle's and Trapezoidal rules, Gauss Quadrature formula.
- Unit 4** Root finding for nonlinear equations (Transcendental and Algebraic equations), Iterative method, Bisection method, Regula-Falsi method, Newton Raphson's method, order of convergence.
- Unit 5** Numerical solution of first and second order differential equations: Euler's Method, Picard's Method, Taylor's series approximation, Runge-Kutta's Method.

**Text Books:**

1. Sastry, S.S. (2012). *Introductory methods of numerical analysis*. New Delhi, ND: PHI Learning Private Limited.
2. Chauhan, D. S., Vyas, P., & Soni, V. (2005). *Studies in numerical analysis*. Jaipur, Jaipur Publishing House.

**Reference Books:**

1. Jain, M. K., Iyengar, S. R. K. & Jain, R. K. (2007). *Numerical methods for scientific and engineering computations*. New Delhi, ND: New Age International.
2. Rajaraman, V. (1984). *Computer oriented numerical methods*. New Delhi, ND: Prentice Hall of India.
3. Phillips, G. M. & Taylor, P.J. (1996). *Theory and applications of numerical analysis*. Academic Press, Elsevier.
4. Burden, R. L., Faires, D. J. & Burden, A. M. (2016). *Numerical Analysis*. Cengage learning.

**Suggested E-learning material:**

1. Elementary Numerical Analysis; Platform: Nptel <https://nptel.ac.in/courses/111101003/>
2. Numerical Differentiation and Numerical Integration; Platform: MIT open courseware [https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/lecture-notes/lect\\_9.pdf](https://ocw.mit.edu/courses/mechanical-engineering/2-993j-introduction-to-numerical-analysis-for-engineering-13-002j-spring-2005/lecture-notes/lect_9.pdf)
3. Computational Error; Platform: Nptel <https://nptel.ac.in/courses/111107062/>

## Discipline Electives (Mathematics)

### MATH 203 Introduction to Mechanics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**4 0 0 4**

#### **Learning Outcomes:**

On completion of the course, the student will be able to,

- Explain the geometry of the motion of particle in plane curve, i.e. position, velocity, and acceleration, and how those quantities are related through calculus.
- Learn Newton's laws of motion and examines their application to a wide variety of problems.
- Learn the basic concept of composition and resolution of forces and friction.
- Understand and visualize the real physical problem in terms of Mathematics.
- Learn one-dimensional (SHM), multi-dimensional (Projectile motion), and constrained motion, motion of particle with or without connecting with string.

**Unit 1** Motion in a Plane Curve: Velocity and acceleration (radial, transverse, tangential and normal), Motion of two particles connected by a string.

**Unit 2** Projectile on a horizontal plane, Simple harmonic motion.

**Unit 3** Constrained motion: Motion along a smooth vertical circle and smooth cycloid, Hooke's law, Motion of a particle attached to an elastic string.

**Unit 4** Composition and resolution of forces, Equilibrium of forces acting at a point (Lami's theorem only), Parallel forces, Moments.

**Unit 5** Friction-definition, Statical friction, Dynamical friction, Limiting equilibrium-an inclined plane, Common catenary.

#### **Text Books:**

1. Ray, M. & Sharma, G. C. (2006). *A Text Book on Dynamics* (13th revised ed.). New Delhi, S. Chand and Company.
2. Gokhroo, D. C. & Bhargava, S. L. (2009). *Elementary Mechanics*, Jaipur: Jaipur Publishing House (JPH).
3. Gokhroo, D. C., Saini, S. R. & Arora, R. K. (2017). *Elements of Dynamics*, Jaipur: Jaipur Publishing House (JPH).

**Reference Books:**

1. Ramsay, A. S. (2004). *Statics* (2<sup>nd</sup>ed.). CBS Publishers and Distributors.
2. Ramsay, A. S. (2002). *Dynamics* (2<sup>nd</sup>ed.). CBS Publishers and Distributors.
3. Gaur, Y. N., Mathur, A. K., Goyal, M. C. & Manohar, P. (2018-19). *Dynamics*, Jaipur & New Delhi: Ramesh Book Depot Publishing House.
4. Goyal, M. C., Sharma, O. P & Goyal, M. (2018-19). *Statics*, Jaipur & New Delhi: Ramesh Book Depot Publishing House.
5. Sharma, K.C., Gokhroo, D. C. & Saini, S. R. (1996). *Elements of Statics*. Jaipur: Jaipur Publishing House (JPH).

**Suggested E-learning material:**

1. Engineering Mechanics: Statics & Dynamics; Platform: cosmolearning, <https://cosmolearning.org/courses/engineering-mechanics-statics-dynamics/>
2. Engineering Mechanics: Statics & Dynamics; Platform: nptel <https://nptel.ac.in/courses/112106180/>
3. Engineering Dynamics; Platform: MIT Open courseware, <https://ocw.mit.edu/courses/mechanical-engineering/2-003sc-engineering-dynamics-fall-2011/>

**MATH 304 Linear Programing and Its Applications****Max. Marks : 100****(CA: 40 + ESA: 60)****L T P C****4 0 0 4****Learning Outcomes:**

On completion of the course, the student will be able to:

- Formulate the LPP.
- Conceptualize the feasible region.
- Solve the LPP with two variables using graphical method.
- Solve the LPP using simplex method.
- Formulate the dual problem from primal.
- Solve Transportation and Assignment problems

- Solve the problems of competitive situations between two competitors.

**Unit 1** Linear Programming Problem: Definition, Formulation of LPP, Graphical Method

**Unit 2** Simplex Method, Big-M and Two-Phase Method, Degeneracy, Resolution of degeneracy. Limitation of LPP.

**Unit 3** Duality in LPP, Important results in Duality, Dual Simplex Method.

Integer Programming: Definition, Gomory's Method.

**Unit 4** Transportation: Definition, Solution by Simplex Method.

Assignment: Definition, Solution by Simplex Method.

**Unit 5** Game Theory: Definition, 2 person zero-sum Game, Game with mixed strategies Solution by using Simplex Method.

#### **Text Books :**

1. Kambo, N. S. (1991). *Mathematical programming techniques*. New Delhi: East-West Press.
2. Chatterjee, D. (2005). *Linear programming and game theory*. New Delhi: Prentice-Hall of India Private Ltd.

#### **Reference Book:**

1. Swarup, K., Gupta, P. K. & Mohan, M. (1977). *Operations Research (Answers to problems)*. New Delhi: Sultan Chand & Sons.
2. Pant, J. C. (2004). *Introduction to optimization: Operations Research*. New Delhi: Jain Brothers.
3. Taha, H. A. & Pearson Education. (2017). *Operations research: An introduction*. Harlow [i 21 pozostałych: Pearson.
4. Hillier, F. S. & Lieberman, G. J. (1972). *Introduction to operation research*. San Francisco: Holden-Day.

#### **Suggested E-learning material**

1. Linear Programming, a CPLEX tutorial [https://ibmdecisionoptimization.github.io/tutorials/html/Linear\\_Programming.html](https://ibmdecisionoptimization.github.io/tutorials/html/Linear_Programming.html)
2. Linear Programming Tutorial | Sophia Learning <https://www.sophia.org/tutorials/linear-programming--5>
3. Lectures – nptel: <https://nptel.ac.in/courses/111102012/>

## MATH 312 Vector Calculus

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**4 0 0 4**

### Learning Outcomes:

On completion of this course, students will be able to:

- Manipulate vectors to perform geometrical calculations in three dimensions.
- Use Green's theorem and the Divergence theorem to compute integrals. Explain how Green's Theorem is a generalization of the Fundamental Theorem of Calculus.
- Communicate Calculus and other mathematical ideas effectively in speech and in writing.
- Recognize when it is appropriate to use a scalar and when to use a vector in problem solving.

**Unit 1** Definition and examples of vector and scalar; Basic operations: addition, subtraction, multiplication and scalar product of vectors, geometric representation of vectors, magnitude and direction, dot product and cross product.

**Unit 2** Scalar and vector product of three vectors, product of four vectors, vector-valued function; Scalar-valued function, limit, Continuity, differentiability and Integration of vector-valued functions of one variable.

**Unit 3** Partial derivatives: chain rule, exact differentials, Del Applied to scalar valued Function (gradient), Del applied to vector point function (Divergence, Curl), Physical interpretation of divergence, Physical interpretation of curl, Irrotational and Solenoidal vector-valued function.

**Unit 4** Directional derivative, tangent planes and normals lines, Tangential line integral, Circulation, Work, Independence of path, Conservative fields, Normal Surface integral, Flux across a surface.

**Unit 5** Vector fields, characterization of Irrotational and Solenoidal vector fields, Green's theorem in a plane, Gauss divergence theorem and Stoke's theorem, Simple applications.

### Text / Reference Books

1. Thomas, G. B., Weir, M. D. & Hass, J. (2011). *Thomas' Calculus*, (11<sup>th</sup>ed.). Pearson Education.

2. Grewal, B. S. & Grewal, J. S. (2005). *Higher Engineering Mathematics* (37<sup>th</sup> ed.). New Delhi: Khanna Publishers.
3. Davis, H. F. & Snider, A. D. (1998). *Introduction to Vector Analysis* (7<sup>th</sup> ed.). William C Brown Pub.
4. Matthews, P. C. (1998). *Vector Calculus*. Springer-Verlag.

### **Suggested E-learning material**

<https://www.brightstorm.com/tag/scalar/>

## **MATH 310 Number Theory**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>4</b>	<b>0</b>	<b>0</b>	<b>4</b>

### **Learning Outcomes:**

On completion of this course, students will be able to:

- Understand the concept of divisibility and able to find greatest common divisor of large integers using Euclidean algorithm.
- Appreciate the importance of prime numbers and their distribution.
- Solve linear congruences and system of linear congruences.
- Know Euler's theorem, Fermat's theorem and Wilson's theorem.
- Demonstrate the applications of number theory in cryptography.

**Unit 1** Integers, well-ordering principle, induction, Fibonacci numbers, divisibility, Greatest Common Divisor, least common multiple, Euclidean algorithm, prime numbers, distribution of primes, fundamental theorem of arithmetic.

**Unit 2** Congruences, linear congruences, Chinese remainder theorem, congruences with prime power moduli. linear Diophantine equations.

**Unit 3** Arithmetic function, Euler's Theorem, Fermat's little theorem, Wilson's theorem, primality testing and pseudoprimes and Carmichael numbers.

**Unit 4** Group of units, Euler's function, primitive root, the group  $U_p^\times$  and  $U_2^\times$ . Mobius inversion formula, Quadratic residues, Legendre symbol, Gauss's lemma, quadratic reciprocity,

**Unit 5** Perfect numbers, Fermat and Mersenne prime. Applications of number theory in cryptography.



**Text Books:**

1. Burton, D. M. (2012). *Elementary number theory*. McGraw-Hill Education (India).

**Reference Books:**

1. Niven, I., Zuckerman, H. S. & Montgomery, H. L. (2013). *An introduction to the theory of numbers*. New York: Wiley.
2. Rosen, K. H. (2005). *Elementary number theory and its applications*. Boston: Pearson/Addison Wesley.

**Suggested E-learning Material:**

1. Lecture Notes: NPTEL: <https://nptel.ac.in/courses/111103020/>
2. Lecture Notes: MIT OPEN COURSE WARE: <https://ocw.mit.edu/courses/mathematics/18-781-theory-of-numbers-spring-2012/index.htm>

## PHYSICS

### First semester

#### PHY 103 Electricity and Electronics

Max. Marks : 100

(CA: 40 + ESA: 60)

L	T	P	C
6	0	0	6

**Learning Outcomes:**

After completion of this course, the students will be able to:

- Learn fundamentals and concepts of electricity and electronics
- Learn about the basic concepts of electronic and electrical circuit analysis techniques
- Apply the above motioned concept to design a range of electronic devices and circuit configurations.

**Unit 1** Electric potential: Gradient of a scalar function, line integral of vector field, potential difference and potential function. Potential energy of a system, energy required to build a uniformly charged sphere, classical radius of an electron, Potential and field due to a short dipole, torque and force on a dipole in an external field.

Magnetic field (definition and properties), Amperes circuital law with applications, Ampere's law in differential form, vector potential, field of a current carrying conductor and deduction of Biot-Savart law.

**Unit 2** Electromagnetic Fields in Matter: The moment of a charge distribution, atomic and molecular dipoles, permanent dipole moments, potential and field due to a polarized sphere, dielectric sphere in a uniform field, the field of charge in a dielectric medium and Gauss's law, electric susceptibility and atomic polarizability, polarization in changing fields, polarization currents; Electric currents in atoms-Bohr Magneton, electron spin and magnetic moment, magnetic susceptibility, the magnetic field due to magnetized matter.

Electromagnetic Induction: Faraday's laws in differential form, the displacement current, Maxwell's equations in differential and integral forms.

**Unit 3** Circuit Analysis: Networks-Some important definitions, deriving point and transfer impedances, Four terminal Network parameters, Open circuit, short circuit and hybrid, Parameters Network theorems-Superposition, Thevenin, Norton, Reciprocity, Compensation, Maximum power transfer theorems.

Fundamentals of semiconductors: Intrinsic & extrinsic semiconductors, charge densities in N and P materials, conduction by drift and diffusion of charge, PN diode equation (no derivation, only physical concept), capacitance effects.

Rectification Half wave, full wave and bridge rectifiers, Ripple factor, efficiency and regulation, Zener diode, Voltage multiplier.

**Unit 4** Transistor and Transistor Amplifiers: Notations and Volt-ampere relations for bipolar junction transistor, Concept of load line and operating point, Hybrid parameters, Field effect Transistor and their circuit characteristics, Configurations and their equivalent circuits, Field and emitter bias, bias stability.

Amplifier with feed back : Concept of feed back, stabilization of gain by negative feed back, Effect of feed back on output and input resistance, Reduction of nonlinear distortion by negative feed back.

**Unit 5** Oscillators and Digital Circuits: Feed back requirements for oscillators, circuit requirement for oscillation. Basic oscillator analysis - Colpitt's and Hartley oscillators, R-C oscillators, Piezo-electric frequency control.

Operational Amplifier: Differential amplifier, Input and output impedances, Input offset current, Applications : Unit gain buffer, Adder, Subtractor, Integrator and differentiator, Comparator, Idea of wave form generator. Voltage regulator using integrated amplifiers.

Digital Circuits: Binary, Hexadecimal and Octal number systems, Binary arithmetic, Logic fundamentals-AND, OR, NOT, NOR, NAND. XOR Boolean theorems, Transistor as a switch, Logic gates Circuit realization on logic functions.

### Recommended Books:

1. Tayal, D. C. (2005). Electricity and Magnetism, Himalaya Publishing House.
2. Saxena, M. P. (1997). Electricity and Magnetism, College Book House.
3. Bhargava, N. N. (2000). Basic Electronic, Tata McGraw Hill.
4. Mehta, V.K. (2002). Principles of Electronics, S. Chand publisher.

### References Books:

1. Sadiku Mathew, N.O. (2005). Elements of Electromagnetics, New Delhi, Oxford Univ. Press
2. Purcell, E. M. (1963). Berkeley physics course. *Electricity and magnetism*.
3. Millman, J. & Halkias, C. C. (1972). *Integrated electronics: analog and digital circuits and systems*. McGraw-Hill.

### Suggested web-resources:

<https://www.coursera.org/browse/physical-science-and-engineering/electrical-engineering>

<https://www.edx.org/learn/electronics>

## PHY 108L Electronics Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### Learning Outcomes:

After completion of this course, the students will be able to:

- demonstrate laboratory skills in physics laboratory and analyze the measurements to draw valid conclusions.

- have oral and written scientific communication, and to think critically and work independently.
- to understand principles of law of electricity magnetism.

**Students are required to perform any ten experiments.**

1. Determine the energy gap using junction diode
2. Study the characteristics of junction diode and zener diode
3. Study the voltage regulation and ripple factor of half and full wave rectifier
4. Study the bridge rectifier with filters
5. Study the characteristics of PNP/NPN junction transistor
6. Study the characteristics of FET
7. Study a voltage multiplier circuit to generate high voltage DC from AC
8. Study the characteristics of optoelectronic devices (LED, Photodiode and Phototransistor)
9. Study the OPAMP in (i) inverting mod (ii) noninverting mod (iii) integrator (iv) differentiator
10. Study AND, OR, NOT, NOR and NAND logic gates and verify the truth tables
11. Study of electromagnetic induction by oscillation of bar magnet.
12. Mutual induction by direct method.
13. Verification of Faraday's law and Lenz's law.
14. B-H Curve using Magnetometer.
15. To determine Self Inductance of a Coil by Anderson's Bridge using AC
16. To determine Self Inductance of a Coil by Rayleigh's Method.
17. Determination of mutual inductance of a pair of coils using BG.

## Second Semester

### PHY 107 Optics

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### Learning Outcomes:

After completion of this course, the students will be able to:

- Appreciate the efficacy of Fourier transforms and their application to physical systems.
- Understand the role of the wave equation and appreciate the universal nature of wave motion in a range of physical systems
- Understand dispersion in waves and model dispersion using Fourier theory.
- Understand diffraction and imaging in terms of Fourier optics and gain physical and intuitive insight in a range of physics via the spatial Fourier Transform.

**Unit 1** Geometrical Optics: Formation of images, sign convention, position of object and its image formed by refraction on spherical surfaces, lateral, axial and angular magnification, Abbe's sine condition, apertic points, deviation produced by thin lenses, equivalent focal length, combination of two thin lenses, Abberations: chromatic, Achromatic Combination of lenses, spherical, method of reducing spherical aberrations, Eye-piece: Huygen's, Ramsden's, Comparison of Huygen's and Ramsden's Eye-pieces.

**Unit 2** Interference : Superposition of waves from two point sources, the necessity of coherence, spatial & temporal coherence, Effective size of a point source, Shape of interference fringes, Intensity distribution in space, Fresnel's biprism experiment, Interference by division of amplitude, Interference in thin films, colour of thin films in transmission and reflection, Newton's rings, Michelson's interferometer, fringes of different shapes Determination of  $\lambda$  and  $\Delta\lambda$  with Michelson's interferometer.

**Unit 3** Diffraction : Fraunhofer diffraction by a single slit, circular aperture, two parallel slits, Plane diffraction grating, Transmission and reflection gratings, Characteristics of grating spectra, Dispersion by grating, Resolving power, Resolving limit, Rayleigh's criterion of resolution, Resolving power of a grating,

Resolving power of a telescope, Fresnel's diffraction, half-period zones, Fresnel's diffraction by a circular aperture, Straight edge and thin slit, Cornu's (geometrical) spiral to study Fresnel's diffraction, Zone plate.

**Unit 4** EM waves and Polarisation: Electromagnetic waves in isotropic medium, Properties of electromagnetic waves, Energy density, radiation pressure, momentum and pointing vector, radiation resistance of free space, Spectrum of electromagnetic waves.

Polarised light, Production and analysis of plane, circularly and elliptically polarised light, Huygen's theory of double refraction using Fresnel ellipsoidal surfaces (No mathematical derivation), Theory of polarized light, Quarter and half wave plates

Optical activity, Specific rotation, Fresnel's explanation for optical rotation, Biquartz and half shade Polarimeters.

**Unit 5** Lasers and Non-linear optics: Spontaneous and stimulated emission, Einstein's A and B coefficients, Laser Criterion, Condition for amplification, population inversion, methods of optical pumping, He-Ne Laser, Ruby lasers, Holography, Construction of hologram and reconstruction of the image.

Fiber Optics: Basic characteristics of the optical fiber, Structure of optical fiber, Types of optical fibers, Total internal reflection, acceptance angle, acceptance cone, Numerical aperture, Attenuation, Pulse dispersion

### **Recommended Books:**

1. Khandelwal, D.P. (1973), Text book of optics and Atomic Physics, Pub. Shivalal Darwal, Agra.
2. Lal, B. & Subramaniam (2006), Optics by Brij Lal and Subrahmaniam, S. Chand Publication.
3. Ghatak, A. & Thyagarajan, K. (1998). An introduction to fiber optics. Cambridge university press.
4. Ghatak, A. K. (1971). An introduction to modern optics. New York, NY (USA): McGraw-Hill.

### **Reference Books:**

1. Ghatak, A. K. (2012). Contemporary optics. Springer Science & Business Media.
2. Hecht, J. & Long, L. (1993). Understanding fiber optics (Vol. 3). Prentice Hall.

3. Cherin, A. H. & Short, L. (1983). An introduction to optical fibers (p. 135). New York: McGraw-Hill.
4. Hecht, E. (2006) Optics, Pearson Education.
5. Ghatak, A. K. & Thyagarajan, K. (1989). Optical electronics. Cambridge University Press.

**Suggested web-resources:**

<https://www.coursera.org/courses?query=optics>

<https://swayam.gov.in/courses/4906-july-2018-modern-optics>

## **PHY 107L Optics Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**Learning Outcomes:**

After completion of this course, the students will be able to:

- demonstrate laboratory skills in physics laboratory and analyze the measurements to draw valid conclusions.
- have oral and written scientific communication, and to think critically and work independently.
- to understand principles of Optics and wave nature of light.

**Students are required to perform any ten experiments.**

1. Determine the wavelength of sodium light using Newton's ring method.
2. Determine refractive index of liquid using Newton's ring method.
3. Determine the wavelength of sodium light using Fresnel's biprism.
4. Determine the wavelength of sodium light using Michelson's interferometer.
5. Determine the difference between two wavelength of sodium light with the help of Michelson's interferometer.
6. Determine the dispersive power of the material of prism with the help of spectrometer.
7. Determine the wavelength of prominent lines of mercury light using plane diffraction grating.
8. Determine the resolving power of plane transmission grating.
9. Determine the resolving power of telescope.

10. Determine the specific rotation of sugar solution using polarimeter.
11. Determine the angular divergence of laser beam.
12. Determine the numerical aperture of an optical fiber

## Third Semester

### PHY 201 Mechanics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

After completion of this course, the students will be able to:

- demonstrate proficiency in mathematics and the mathematical concepts needed for a proper understanding of physics.
- show that they have learned laboratory skills, enabling them to take measurements in a physics laboratory and analyze the measurements to draw valid conclusions.
- have oral and written scientific communication, and think critically and work independently.

**Unit 1** Inertial and rotating frame of references: Motion and rest, frame of references, transformation of displacement, velocity and acceleration between different frames of references involving uniform translation, uniform relative motion, inertial frame of reference, Galilean transformations and invariance of Newton's laws; Rotating frame of references, transformation of velocity and acceleration between rotating frames, Fictitious forces-Coriolis and centrifugal forces, effects of coriolis and centrifugal forces due to Earth's rotation, Foucault's pendulum-demonstration of earth's rotation

**Unit 2** Conservation Laws: Conservative forces, potential energy, Gravitational Potential, electric potential, center of mass and motion of center of mass of a system of particles, two particle system and reduced mass, conservation of linear momentum, collision of two bodies in one and two dimensions (elastic and inelastic), slowing down of neutrons in a moderator, motion of a



system with varying mass, conservation of angular momentum, scattering of charged particles by heavy nucleus, angular acceleration, planetary motion.

**Unit 3** Dynamics of rigid body and motion under central forces: Rotational motion of a body, inertial coefficients, kinetic energy of rotation and concept of principal axes, Precessional motion of a spinning top and spin precession in constant magnetic field, Hooke's law, three moduli of elasticity (Young's modulus, Bulk modulus and modulus of rigidity, Poison's ratio, Relation between various elastic constants, torsion of a Cylinder, bending of beam, experimental determination of elastic constants, motion under central forces, general solution under gravitational interaction, cases of elliptical and circular orbits, Kepler's Laws.

**Unit 4** Free, damped, forced and Anharmonic oscillations: Oscillations in a potential well, harmonic oscillator, examples - mass on a spring, torsional oscillators, LC circuit, energy of the oscillator, damping, viscous and solid friction damping, damped harmonic oscillator, power dissipation, Forced harmonic oscillator with viscous damping, frequency response, phase relation, quality factor, resonance, electrical oscillation, Anharmonic oscillator, simple pendulum as an example.

**Unit 5** Coupled Oscillators: Equation of motion of two coupled simple harmonic oscillators, normal modes, motion in mixed modes, transient behavior, effect of coupling in mechanical systems, electrically coupled circuits, frequency response, reflected impedance, effect of coupling and resistive load, Dynamics of number of oscillators with near-neighbour interactions, equation of motion for one dimensional monoatomic and diatomic lattices, acoustic and optical mode, dispersion relations, concept of group and phase velocities.

### **Recommended Books:**

1. Saxena, M. P., Rawat S. S. (2000). Mechanics, College Book House.
2. Saxena, M. P., Rawat S. S. (1997). Oscillations and Waves, College Book House.
3. Mathur, D. S. (2005). Mechanics, S. Chand publishing.

4. Satya, Prakash (2007). Waves & Oscillations, Kedar Nath Ram Nath publishing.

### Reference Books:

1. Srivasatava, P. K. (2006). Mechanics New Age International Publisher, Delhi.
2. Alonso, M. & Finn, E. J. (1967). *Fundamental university physics* (Vol. 2). Reading, MA: Addison-Wesley.
3. Purcell, E. M. (1963). Berkeley physics course. *Electricity and magnetism, UC Berkeley*.
4. French, A. P. (1971). *Vibrations and waves*. CRC press.

### Suggested web-resources:

<https://ocw.mit.edu/courses/physics/>

<https://academicearth.org/physics/>

<https://www.khanacademy.org/science/physics>

## PHY 201L Mechanics Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### Learning Outcomes:

After completion of this course, the students will be able to:

- demonstrate laboratory skills in physics laboratory and analyze the measurements to draw valid conclusions.
- have oral and written scientific communication, and to think critically and work independently.
- to understand principles of Newtonian mechanics, friction, and motion of bodies.

### Students are required to perform any ten experiments.

1. Determine the Young's modulus of the material, by bending of beam.
2. Determine the modulus of rigidity using Maxwell's needle.
3. Determine Poisson's ratio of rubber.
4. Determine Young modulus, Modulus of rigidity and Poisson ratio by searl's method.

5. Study the damping of a compound pendulum and determine the damping coefficient and quality factor.
6. Conversion of a galvanometer in to an ammeter and to calibrate it.
7. Conversion of a galvanometer in to a voltmeter and to calibrate it.
8. Study Maximum power transfer theorem.
9. Study of charging and discharging of a capacitor through a resistance.
10. Study the behaviour of RC circuit with AC source and determine the impedance and phase relation.
11. Study the behaviour of growth and decay of current in LR circuit with DC source.
12. Study the resonance in series and parallel LCR circuit and determine the quality factor.

## Fourth Semester

### PHY 204L Physics Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

#### Learning Outcomes:

After completion of this course, the students will be able to:

- demonstrate laboratory skills in physics laboratory and analyze the measurements to draw valid conclusions.
- have oral and written scientific communication, and to think critically and work independently.
- to understand principles of thermodynamic laws experimentally

#### Students are required to perform any ten experiments.

1. Determine the mechanical equivalent of heat (J) by using Calendar and Barn's constant flow meter.
2. To Determine the thermal conductivity of bad conductor (samples may be Glass or Ply Wood or Cardboard) using Lee's disc method.
3. Determine the melting point of given material using platinum resistance thermometer.
4. Plot thermo emf Vs temperature graph and find the inversion temperature and neutral temperature

5. To determine the thermodynamic constant ( $C_p/C_v$ ) using Clement and Desorme's method.
6. To verify the Stefan's law by electrical method.
7. To determine the value of stefan's constant.
8. Verify certain laws of probability.
9. To determine the resistance per unit length of Carey Fosters bridge and finds the resistance of a given wire (Unknown resistance).
10. Determination of the coefficient of linear thermal expansion ( $\alpha$ ) of the given sample. Compare and verification of ( $\alpha_{\text{copper}} < \alpha_{\text{brass}} < \alpha_{\text{aluminum}}$ ).
11. To determine mechanical equivalent of heat (J) Joule's constant by electrical method.
12. Determine the resistance per unit length of bridge wire and then determine the temperature coefficient of Platinum resistance thermometer (PTR).
13. To demonstrate Seebeck Effect with the help of Thermocouple module.

## **PHY 205 Thermodynamics, Statistical and Mathematical Physics**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### **Learning Outcomes:**

After completion of this course, the students will be able to:

- understand the laws of thermodynamics in their various forms and explain their physical significance.
- state the thermodynamic potentials and recognize the most appropriate potential for application to a particular problem.
- derive and state the Boltzmann, Fermi-Dirac and Bose-Einstein distributions.
- know the key links between thermodynamics and statistical physics and apply these to problems

**Unit 1** Basic Principles and applications of Thermodynamics: Thermodynamic equilibrium, infinitesimal quasistatic process, reversible & irreversible processes, Carnot's engine, Carnot's cycle and efficiency of Carnot's engine reversibility of Carnot's engine,

second law of Thermodynamics [different statements and their equivalence], Thermodynamic scale as an absolute scale, Entropy, Entropy and irreversibility, Entropy and unavailable energy, Principle of increase of entropy. Entropy of an ideal gas (expressions in terms of  $V$  &  $T$ ,  $P$  &  $T$ , and  $P$  &  $V$ ).

Maxwell's relations, Equilibrium between Phases, Triple point, Clausius Clapeyron's equation, Helmholtz free energy, Enthalpy (total heat function), Gibb's function, Thermodynamic potentials, Deduction of Maxwell's equations from thermodynamic potentials.

**Unit 2** Production of Low Temperature and Applications: Chemical Thermodynamics-Dalton's law, Gibb's phase rule, Entropy and Gibb's function of a mixture of inert ideal gases, chemical equilibrium, chemical potential (definition only).

Joule Thomson expansion and J.T. coefficients for ideal and van der Waal's gas, Porous plug experiment, Temperature inversion, Regenerative cooling and cooling by adiabatic expansion and demagnetisation, Superfluidity.

Classical Statistics: Phase space, Micro and Macro states, Thermodynamic probability, Entropy and probability. The Monoatomic ideal gas, Entropy of mixing, Gibb's paradox, Ensembles: canonical, micro canonical and grand canonical.

**Unit 3** Kinetic theory of gases: Distribution of molecular velocities, Energy distribution function, most probable, average & r.m.s. velocities, principle of equipartition of energy, specific heat of gases, classical theory of specific heat capacity.

Quantum Statistics: Failures of Classical statistics (black body radiation and various laws of distribution of radiation, qualitative discussion of Wien's and Rayleigh-Jeans' (No derivation) laws, postulates of quantum statistics, Bose-Einstein's statistics- Planck's distribution law, Fermi-Dirac statistics and their partition functions.

**Unit 4** Introduction to mathematical Physics: Vectors, gradient, divergence and curl, their physical significance, line integral, surface integral, volume integral, Gauss divergence theorem, Stokes theorem, Green's theorem, orthogonal curvilinear coordinate systems, scale factors, expressions for grad, divergence and curl and their applications to cartesian, circular, cylindrical and spherical polar coordinate systems, Dirac Delta function and its properties Coordinate transformation & Jacobian, Transformation of covariant, contravariant and mixed tensor, addition, multiplication and contraction of tensor, Quotient law.

**Unit 5** Four vector formulation : Lorentz transformation and rotation in space-time, time like and space like vector, worldline macro-causality, energy-momentum four vector, relativistic equation of motion, Invariance of Lorentz force as an example of four force, transformation of four frequency vector, longitudinal & transverse Doppler's effect.

Transformation between laboratory and centre of mass systems, four momentum conservation, kinematics of decay products of an unstable particle and reaction thresholds, pair production, Inelastic collision of two particles, compton effect.

### **Recommended Books:**

1. Zeemansky, M.W. (1968). Heat and Thermodynamics, McGraw Hill, 5th ed.
2. Singhal, Agrawal Prakash (2007). Heat and Thermodynamics, Pragati Prakashan.
3. Kakani, S. L. Hemraj C (1994). Mathematical Physics and Special Theory of Relativity College Book Centre, Jaipur.
4. Rajput, B. S. (2005). Mathematical Physics, Pragati Prakashan.

### **Reference Books:**

1. Reif, F. (2009). Fundamentals of statistical and thermal physics. Waveland Press.
2. Holman, J. P. (1974). Thermodynamics McGraw-Hill. New York.
3. Lokanathan, S. & Gambhir, R. S. (1991). Statistical and Thermal Physics: an Introduction. Prentice Hall.
4. French, A. P. (2017). Special relativity. CRC Press.
5. Arfken, G. B. & Weber, H. J. (1999). Mathematical methods for physicists, Elsevier.

### **Suggested web-resources:**

<https://cosmolearning.org/courses/thermal-statistical-physics/>

<https://ocw.mit.edu/courses/physics/8-333-statistical-mechanics-i-statistical-mechanics-of-particles-fall-2013/video-lectures/lecture-1-thermodynamics-part-1/>

<https://programsandcourses.anu.edu.au/course/PHYS2020>

## V Semester and VI Semester

### Discipline Electives

#### PHY 306 Quantum Mechanics and Spectroscopy

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### Learning Outcomes:

After completion of this course, the students will be able to:

- solve the Schrödinger equation for model systems of relevance within chemistry and physics
- describe many-electron atoms with the independent particle model
- describe the structure of the periodic system and the connections between the properties of the elements and their electron configurations
- describe the bases behind interaction between light and matter and account for the most common spectroscopic methods for studies of molecules in the IR and UV/Vis areas

**Unit 1** Body radiation, Planck's quantum theory, photo electric effect, Einstein's explanation, Compton effect, Ritz combination principle in spectra, Bohr's quantization of angular momentum and application to Hydrogen atom, limitations of Bohr theory, Wave - particle duality, de Broglie waves, Electron diffraction experiment, group and phase velocities, uncertainty principle, formulation and its applications, finite size of atom, non existence of electrons in nucleus, Gaussian wave packet, Bohr's principle of complementarity, schrodinger's equation: its need and justification, time dependent and time independent forms, physical significance of wave function (Schrodinger's and Born's interpretation), boundary and continuity conditions of wave function, probability current density.

**Unit 2** Postulates of Quantum mechanics, eigen functions & eigen values, degeneracy, parity and orthogonality of eigen function, expectation values of dynamical variables -position, momentum, energy, ehrenfest theorem, time independent Schrodinger's equation and stationary state solution, Particle in a one-dimensional box (infinite potential well) - eigen functions and

eigen values, Discrete energy levels, generalization to three dimensions and degeneracy of levels, Potential step and rectangular potential barrier, calculation of reflection and transmission coefficients, alpha decay, square well potential problem (attractive), calculation of transmission and reflection coefficients, operators in quantum mechanics, Definition of an operator, linear and Hermitian Operator.

**Unit 3** Application of series solution method to Legendre's and Hermite's and differential equations, basic properties like – orthogonality, recurrence relations, graphical representations, generating functions etc. of Legendre's and Hermite's Polynomials.

Bound state problems: Particle in a one-dimensional box -(finite square potential well), Energy eigen values and eigen functions, simple harmonic oscillator (One dimensional case), Zero point energy. Quantum Mechanical States: Ket Bra notation.

**Unit 4** Particle in spherically symmetric potential, Schrodinger's equation for one electron atom in spherical coordinates, separation of variables, orbital angular momentum and its quantization, spherical harmonics, Energy levels of hydrogen atom, calculation of average radius, hydrogen atom spectrum, probability density distribution.

Bohr's correspondence principle, Stern Gerlach experiment, spin of electron, spin and magnetic moment, total angular momentum, spectroscopic notation, fine structure, line width, atoms in magnetic field, Zeeman effect (normal and anomalous) and Paschen back effect for one electron atom.

**Unit 5** Molecular bonding: ionic and covalent bonding, molecular spectra, rotational energy levels of diatomic molecules, rotation spectra, selection rules, vibrational energy levels of diatomic molecules, vibration spectra, selection rules, vibrational-rotational energy levels of diatomic molecules, vibration-rotation spectra, selection rules, electronic spectra, selection rules, Franck-Condon principle, Raman effect, Classical and quantum theory of Raman effect

### **Recommended Books:**

1. Kakani, S. L. & Hemrajni C. (1995) Elementary Quantum Mechanics and Spectroscopy, College Book Centre, Jaipur.
2. Singh, K. & Singh S. P. (2005) Elements of Quantum Mechanics, S. Chand.



2. Raj Kumar (1997), Atomic and Molecular Spectra, Kedar Nath Ram Nath publisher.
3. Rawat, S. S. & Singh, S. (2000) Prarambhik Quantum Yantriki avam Spectroscopy, CBH publisher.
4. Kakani, S. L. & Hemraj, C. (1994) Mathematical Physics and Special Theory of Relativity College Book Centre, Jaipur.

#### Reference Books:

1. Ghatak, A. K. & Lokanathan, S. (2004). Quantum mechanics: theory and applications. Macmillan.
2. Beiser, A. (1969). Perspectives of modern physics. McGraw-Hill series in fundamentals of physics, Tata McGraw-Hill.
3. White, H. E. (1934). Atomic Spectra. New York-London: McGraw-Hill, 15, 132.

#### Suggested web-resources:

<https://swayam.gov.in/course/4250-quantum-chemistry-spectroscopy-photochemistry>

<https://www.edx.org/course/quantum-mechanics-molecular-structures-utokyo-utokyo003x-1>

## PHY 306L Quantum Mechanics and Spectroscopy Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

#### Learning Outcomes:

After completion of this course, the students will be able to:

- demonstrate measurements skills in a physics laboratory
- Analyze the measurement results to draw valid conclusions.
- Have oral and written scientific communication, and think critically and work independently.

#### Students are required to perform any ten experiments.

1. Determine the value of Planck constant using Photo cell.
2. Determine the value of Planck constant using solar cell.
3. Study the absorption spectrum of Iodine Molecule.
4. Study the Franck Hertz experiment and determine the ionization potential of inert gas.

5. Study the hyperfine structure of spectral lines and Zeeman effect by constant deviation method
6. Determine the electrical charge ( $e/m$ ) using Millikan's oil drop method.
7. Determine the specific charge ( $e/m$ ) using Thomson method.
8. Determine the specific charge ( $e/m$ ) using helical method.
9. To study the hydrogen spectrum and determination of Rydberg's constant.
10. Verify the inverse square law using photocell.
11. Determine the value of Planck constant using LED.
12. To determine the unknown inductance of the coil ( $L$ ) using Anderson's bridge.
13. To determine the unknown capacitance using Desauty's bridge
14. To obtain Lande- $g$  factor by ESR method.
15. To determine the workfunction of given metal by suitable method.

### **PHY 304 Advance Quantum Mechanics**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### **Learning Outcomes:**

After completion of this course, the students will be able to:

- solve the Schrödinger equation for complex systems
- describe the structure of the periodic system and the connections between the properties of the elements and their electron configurations
- understand the effect of external parameters on the quantum systems

**Unit-1** Postulates of Quantum Mechanics, Planck's Quantum theory, Einstein's explanation, Compton Effect, Wave Particle Duality, de-Broglie waves, Electron Diffraction Experiment, Uncertainty Principle: Formulation and its applications, Bohr's principle of complementarity, Time dependent and time independent forms of Schrodinger's equation: need and justification

**Unit-2** Wave Function, its physical significance and properties, Schrodinger and Born interpretation, Probability Current Density, eigenvalues and eigenfunctions, degeneracy, parity and

orthogonality of eigenfunctions, expectation values of dynamical variables-position, momentum, energy, Ehrenfest Theorem, Time independent schrodinger equation and stationary state solution, particle in one dimensional box: eigenfunctions and eigenvalues

**Unit-3** Discrete energy levels, generalization to three dimensions and degeneracy of levels, Potential step and rectangular potential barrier, Calculation of reflection and transmission coefficients, Alpha Decay, Square Well Potential Problem(attractive), Calculation of transmission and reflection coefficients, Applications of Schrodinger Equation in Spherically symmetric systems: Rigid Rotator and Hydrogen Atom

**Unit-4** Operators in quantum mechanics: Definition, Orthogonal Sets, Completeness, Eigen values and Eigenfunction, Operator Formalism, Commutation Algebra, Linear and Hermitian Operators, Commutativity and simultaneous eigenfunctions, Hilbert Space, Operators as matrix, Matrix form of wave equation, Schrodinger, Heisenberg and Interaction matrix representation, Dirac's Bra and Ket vectors, Direct Sum and product of Hilbert space, Co-ordinate and momentum representation

**Unit-5** Approximation Methods: perturbation theory, motivation of approximation methods, Variational methods, WKB Approximation, Applications of Variational and WKB methods. Time dependent perturbation theory, Harmonic perturbation.

### **Recommended Books:**

1. Singh, K. & Singh, S. P. (2005). Elements of Quantum Mechanics, S. Chand.
2. Ghatak, A. & Lokanathan, S. (2001) Quantum Mechanics (McMillan India Ltd.)
3. Sakurai, J. J. (2005). Modern Quantum Mechanics (Pearson Education)
4. Griffiths, D. (2006). Introduction to Quantum Mechanics (Pearson Education)
5. Bjorken, J. D. & Drell, S. D. (1997). Relativistic Quantum Mechanics (McGraw Hill)
6. Greiner, W. & Bromley, D. A. (2003). Relativistic Quantum Mechanics (Springer)

**Reference Books:**

1. Ghatak, A. K. & Lokanathan, S. (2004). Quantum mechanics: theory and applications. Macmillan.
2. Beiser, A. (1969). Perspectives of modern physics. McGraw-Hill series in fundamentals of physics, Tata McGraw-Hill.
3. White, H. E. (1934). Atomic Spectra. New York-London: McGraw-Hill, 15, 132.

**Suggested web-resources:**

<https://swayam.gov.in/course/4250-quantum-chemistry-spectroscopy-photochemistry>

<https://www.edx.org/course/quantum-mechanics-molecular-structures-utokyox-utokyo003x-1>

**PHY 304L Advance Quantum Mechanics Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Learning Outcomes:**

After completion of this course, the students will be able to:

- Demonstrate measurements skills in a physics laboratory
- Analyze the measurement results to draw valid conclusions.
- Have oral and written scientific communication, and think critically and work independently.

**Students are required to perform any ten experiments.**

1. Determine the specific charge ( $e/m$ ) using Thomson method.
2. Determine the specific charge ( $e/m$ ) using helical method.
3. Study the hyperfine structure of spectral lines and Zeeman effect by constant deviation method
4. Determine the electrical charge ( $e/m$ ) using Millikan's oil drop method.
5. To study the hydrogen spectrum and determination of Rydberg's constant.
6. Verify the inverse square law using photocell.
7. Determine the value of Planck constant using Photo cell.

8. Determine the value of Planck constant using solar cell.
9. Study the absorption spectrum of Iodine Molecule.
10. Study the Franck Hertz experiment and determine the ionization potential of inert gas.
11. Determine the value of Planck constant using LED.
12. To determine the workfunction of given metal by suitable method.

## PHY 302 Nuclear and Solid State Physics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

### Learning Outcomes:

After completion of this course, the students will be able to:

- account for interatomic forces and bonds
- have a basic knowledge of crystal systems and spatial symmetries
- account for how crystalline materials are studied using diffraction, including concepts like form factor, structure factor, and scattering amplitude.
- understand the concepts of nuclear physics
- understand the elementary particles and their interactions

**Unit 1** Nuclear Properties: Mass, radius, angular momentum, magnetic moment, electric quadrupole moment, parity, estimation of mass, basic concepts of mass spectrographs, Bainbridge Jordan double focussing spectrograph, Advantages of double focussing and doublet method in mass spectroscopy, Coulomb scattering of a charged particle by a nucleus, Electron scattering by a nucleus, variation of nuclear radius with mass number A.

Nuclear Binding : Constituents of the nucleus, properties of nuclear forces, Binding energy, mass defect, variation of binding energy with mass number A. Liquid drop model, Semi-empirical mass formula, origin of various terms, stable nucleus and conditions for stability (e.g.  $\beta$  emission for different isobars).

**Unit 2** Subatomic Particles : Properties of particles, classification into leptons, mesons and baryons, matter and antimatter, conservation laws (qualitative discussion only) Energy, momentum, angular momentum, charge, lepton number, baryon number, isospin,

strangeness etc. fundamental interactions, quark model for the structure of matter.

Particle Accelerator: Linear accelerator, cyclotron, synchrocyclotron, betatron, synchrotron, Electron Synchrotron, proton synchrotron.

Nuclear detectors: Ionisation chamber, proportional counter, GM counter, Scintillation counter.

**Unit 3** Nuclear Fission : Energy release in nuclear fission (using BE curve) spontaneous fission and potential barrier, liquid drop model, self sustaining chain reaction, neutron balance in a nuclear reactor, classification of reactors (fast, thermal and breeder etc.), Qualitative discussion of elements of a nuclear reactor, uncontrolled reaction and atomic bomb.

Nuclear Fusion : Energy released in nuclear (use of BE Curve) fusion in stars, carbon-nitrogen and proton-proton cycle, problems of controlled fusion and present status, transuranic elements.

**Unit 4** Crystal structure : Symmetry elements in crystal, fundamental lattice systems and types, Miller indices and direction indices, crystal structures of simple cubic, FCC, BCC, HCP, diamond and Zinc blend, Crystal Diffraction: Bragg's law, X-ray and neutron diffraction, rotating crystal and powder methods, reciprocal lattice, Brillouin zones. Crystal binding and vibrations : Various binding types and repulsive interaction.

Electrical and Thermal Properties of Solids : Free electron model of a solid, Band theory of solids, difference between conductors, insulators, semiconductors, quantum theory of electrical conductivity, Thermal properties of Solids: Einstein's theory of specific heats, Debye's model of lattice specific heat.

**Unit 5** Superconductivity: Definition, Critical Parameters, Meissner effect, Josephson's effect, Type-I and Type-II Superconductors, Theoretical survey of Superconductivity, London Theory, Ginzberg Landau theory, BCS theory (Qualitative discussion only), High Temperature Superconductivity, Applications of Superconductivity.

Magnetism: Diamagnetism, Langevin Diamagnetism equation, Quantum theory of Diamagnetism, Paramagnetism, Quantum theory of Paramagnetism, Ferromagnetism, Anti-ferromagnetism and ferrimagnetism

**Recommended Books:**

1. Tayal, D. C. (1992). Nuclear physics, Himalya Pub. House, Bombay.
2. Kaplan, I. (1963). Nuclear physics, Oxford & IBH Pub.
3. Pillai, S. O. (2005). Solid State Physics, New Age International.
4. Singhal, R. L. & Alvi, P. A. (2015). Solid State Physics, Kedarnath Ramnath, Meerut.

**Reference Books:**

1. Singru, R. M. (1974). Introduction to experimental nuclear physics, Wiley Eastern Pvt. Ltd.
2. Ghoshal, S. N. (2006). Nuclear Physics by S. N., S. Chand.
3. Kittel, C. (1976). Introduction to solid state physics (Vol. 8). New York: Wiley.
4. Ashcroft, N. W. & Mermin, N. D. (1976). Solid state physics, Cornell University Saunders College Publishing.

**Suggested web-resources:**

<https://swayam.gov.in/course/3817-solid-state-physics>

<https://nptel.ac.in/courses/115105099/>

<https://ocw.mit.edu/courses/nuclear-engineering/>

## PHY 302L Nuclear and Solid State Physics Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

**Learning Outcomes:**

After completion of this course, the students will be able to:

- demonstrate measurements skills in a physics laboratory
- analyze the measurement results to draw valid conclusions.
- have oral and written scientific communication, and think critically and work independently.
- to understand the laws of nuclear and solid state physics

**Students are required to perform any ten experiments.**

1. Determine hall voltage, mobility, carrier concentration and hall coefficient in a given semiconductor.

2. Determine the band gap in a semiconductor using four-probe method.
3. Determine the magnetic susceptibility of a paramagnetic salt by Quinck's method.
4. Determine the power factor of a coil using CRO.
5. Determine hysteresis loss using CRO.
6. Study the dynamics of a lattice using electrical analogue.
7. Study the random decay and determine the decay coefficient.
8. Study the characteristics of a G.M counter and verify the inverse square law.
9. Study of  $\alpha$ -absorption in aluminium foil using G.M counter.
10. Determine the g- factor by ESR- step up.
11. Study of variation of modulus of rigidity of a given specimen as a function of temperature.
12. Study the Compton scattering of  $\gamma$ - ray and verify the Compton shift formula.

### **PHY 305 Advanced Semiconductor Devices**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### **Learning Outcomes:**

After completion of this course, the students will be able to:

- understand the mechanism of semiconductor devices
- understand the applications of semiconductor devices in routine life
- make advancement in these devices

**Unit-1** Energy Bands, direct and indirect semiconductors, effective mass, Intrinsic and Extrinsic semiconductors, Occupation Probability and carrier concentration, Temperature Dependence of carrier concentration, Fermi Level, Quasi Fermi Level, mobility and conductivity, Hall effect, four probe method of resistivity measurement



**Unit-2** Generation and Recombination of Charges, Diffusion, Continuity Equation, Injected Minority charge carriers, potential variation within a graded semiconductor, Schottky Junction and Ohmic Contact, pn junction diode, Zener diode, Zener and avalanche breakdown, Tunnel diode, Semiconductor Photodiode and Light Emitting Diode

**Unit-3** Avalanche Photodiode: Structure, Materials, Characteristics and device performance Bipolar Junction Transistor: Types, Current components, CB,CC,CE configuration, Ebers-Moll model of transistors.

Concept of Load Line and Operating Point, Thermal stability of transistor, Fixed Bias, Emitter Bias, Voltage Divider Bias, Collector Feedback Configuration

**Unit-4** Junction Field Effect transistor, depletion and enhancement type MOSFET, V-I characteristic, operation methods, FET biasing: Fixed, self and Voltage Divider Bias

Four Layer Diode (p-n-p-n), SCR, Principle of operation, transistor analogy, methods of turning on and turning off (only reference), Gate characteristic, DIAC, TRIAC, light activated thyristor

**Unit-5** Operational Amplifier and its applications, inverting and non-inverting amplifiers, adder, integrator, differentiator, wave-form generator, comparator, Schmitt trigger.

### **Recommended Books:**

1. Millaman, J. & Halkias C. (1972). Integrated Electronics (McGraw Hill, New York),
2. Malvino, L. (1999). Electronic Devices and circuits
3. Sterectman, B. G. (1995). Solid State Electronic Devices and Integrated Circuits (Prentice Hall Inc.).
4. Sze, S. M. (1999). Physics of Semiconductors Devices by (John Wiley & Sons).

### **Suggested e-resources:**

1. <https://nptel.ac.in/courses/115102014/>
2. <https://nptel.ac.in/courses/113106062/>
3. <https://nptel.ac.in/courses/117106091/>

## PHY 305L Advanced Semiconductor Devices Lab

**Max. Marks : 100**

**L   T   P   C**

**(CA: 40 + ESA: 60)**

**0   0   4   2**

### **Learning Outcomes:**

After completion of this course, the students will be able to:

- assess the validity of physical theories through the design and execution of an experiment, the analysis of uncertainties associated with the measurement of data and the interpretation of the data to draw valid scientific conclusions (lab skills).
- connect a digital oscilloscope to a computer and record a signal with an appropriate sampling rate
- generate and interpret the power spectrum of the recorded data, use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations

### **Students are required to perform any ten experiments.**

- 1 To study the V-I characteristics of FET using discrete components on bread board.
- 2 To study the V-I characteristics of UJT.
- 3 To study the output and transfer characteristics of FET.
- 4 To study the input and output characteristics of BJT.
- 5 To study the V-I characteristics of DIAC.
- 6 To study the V-I characteristics of TRIAC.
- 7 To study the V-I characteristics of SCR.
- 8 To study the characteristics of optocoupler and draw its frequency response.
- 9 To study the V-I characteristics of Photodiode.
- 10 To study the V-I characteristics of p-n junction diode using discrete components on bread board.
- 11 To study the V-I characteristics of pnp or npn transistor using discrete components on bread board.

## STATISTICS

### First Semester

#### STAT 106 Probability and Descriptive Statistics

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### **Learning Outcomes:s:**

On completion of the course, the student will be able to,

- Differentiate between the two definitions of Statistics
- Understand and differentiate between population and sample, variables and attributes in any survey
- Chose between the type of survey, census or sample, and the method of data collection, primary and secondary methods for a study,
- Represent the data using suitable tabular and/or graphical method
- Identify and calculate appropriate summary statistics for the data
- Understand the concept of various definitions of probability and calculate probability for any given problem.
- Define a random variable for a study variable and obtain its properties.

**Unit 1** Definition, Scope and limitations of Statistics, Concept of Statistical population. Attributes and variables. Types of data, Collection of primary and secondary data. Sample and census survey - their advantages and disadvantages. Types of Sampling and Non-Sampling errors. Classification and Tabulation of data.

**Unit 2** Graphical and diagrammatic representation of data. Measures of central tendency. Measures of dispersion. Moments, Measures of skewness and kurtosis. Sheppard's correction (without proof) for moments. Charlier check.

**Unit 3** Probability: Random experiment, Sample space, events, Combination of two or more events, Basic concept of probability. Classical, Empirical and Axiomatic approach to probability. Marginal, Joint and Conditional probability, Addition and Multiplication theorems of probability, Baye's theorem and its simple applications.

**Unit 4** Random variable: Discrete, Continuous, Univariate and Bivariate. Probability mass function and Probability density functions, Distribution function, Conditional and Marginal distributions. Independence of random variables.

**Unit 5** Mathematical Expectation: Expectation of sum and product of random variables. Variance and Covariance, Conditional expectation. Moments and Moment generating function, Characteristic function (definition and statement of properties only) Cumulant generating function, Relation between moments and cumulants.

Note: Use of scientific calculator is permissible

### **Text Books:**

1. Goon, A. M., Gupta, M. K. & Dasgupta, B. (1968). *Fundamentals of Statistics: Vol.: 1*. Calcutta: The World Press Private Ltd.
2. Meyer, P. L. (1970). *Introductory probability and statistical applications*. Reading, Mass: Addison-Wesley Pub. Co.

### **Reference Books:**

1. Mood, A. M., Boes, D. C., & Graybill, F. A. (1974). *Introduction to the theory of statistics*. East Windsor, NJ: McGraw-Hill, Inc.
2. Srinivasan, S. K., & Mehata, K. M. (1988). *Probability and random processes*. New Delhi: Tata McGraw-Hill.
3. Johnson, R. A., Miller, I., & Freund, J. E. (2011). *Miller & Freund's probability and statistics for engineers*. Boston: Prentice Hall.
4. Feller, W. (1968). *An introduction to probability theory and its applications: V. I*. New York: Wiley.
5. Gupta, S. C., & Kapoor, V. K. (2000). *Fundamentals of mathematical statistics: A modern approach*. New Delhi: Sultan Chand.
6. Gupta, S. P. (2014). *Statistical Methods*. New Delhi: Sultan Chand and Sons.

### **Suggested E-learning material:**

1. Video lectures on Probability and Statistics:  
<https://nptel.ac.in/courses/111105090/>
2. Video lectures on Introduction to Data Analytics:  
<https://nptel.ac.in/courses/110106072/>

## STAT 106L Probability and Descriptive Statistics Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### Learning Outcomes:

After completion of this course, the students will be able to:

- Express raw data in terms of frequency table by using exclusive and inclusive method of classification for continuous/discrete variable.
  - Apply and justify the use of, various graphical representations such as Histogram, Frequency polygon etc.
  - Interpret and analyze the data using various averages such as arithmetic Mean, Median and Mode.
  - Compare different data sets using methods such as standard deviation, mean deviation, quartile deviation and coefficient of variation.
  - Employ and interpret the measures of Skewness and Kurtosis.
1. Preparation of frequency table by using exclusive and inclusive method of classification for continuous/discrete variable.
  2. Tabulation of data.
  3. Graphical representation of data by:
    - (i) Histogram
    - (ii) Frequency polygon
    - (iii) Frequency Curve
    - (iv) Ogives
  4. Diagrammatic representation of data by:  
Simple Bar, Sub-divided Bar and Multiple Bar diagrams. Squares, Circles and Pie-diagrams.
  5. Determination of Mean, Median, Mode, G.M., H.M., Quartiles, Deciles and Percentiles.
  6. Computation of Range, Standard deviation, Mean deviation, Quartile deviation and Coefficient of variation.
  7. Combined mean and combined standard deviation.
  8. Computation of first four moments, Measures of Skewness and Kurtosis.

- Note:** (i) The above list is only for the guidance of the students. Any practical from the syllabus may be set in the practical examination.
- (ii) Whenever it is feasible, students should be asked to collect the required data themselves to use it in their practicals.
- (iii) Where it is feasible practical practice should be done through spreadsheet, package or programming.

## Second Semester

### STAT 109 Measures of Association and Probability Distributions

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

After completion of this course, the students will be able to:

- Formulate the mathematical/statistical models for real data sets arising in various fields of the populations.
- Understand how to use probability distributions in real life problems.
- Understand how to check the independence of attributes.

**Unit 1** Theory of Attributes: Classes and class frequencies, Consistency of data. Independence of attributes, Contingency table. Association of attributes, Measures of association. Curve fitting by the principle of least squares. Fitting of straight line, parabola, power curves and exponential curve.

**Unit 2** Bivariate distributions, Correlation and Regression, Pearson's correlation coefficient, Lines of Regression and Regression coefficient, Rank Correlation and Spearman's rank Correlation coefficient. Partial and multiple Correlation for three variables only.

**Unit 3** Binomial, Poisson, & Negative Binomial distributions, Limiting cases of Binomial and Poisson distributions, Fittings of Binomial and Poisson distributions.

**Unit 4** Geometric, Multinomial and Hypergeometric distribution with simple properties and applications. Normal distribution with its properties & fitting.

**Unit 5** Rectangular, Exponential, Gamma, Beta, Laplace and Cauchy with simple properties and applications.

**NOTE:** Use of scientific calculator is permissible.

**Books Recommended:**

1. Goon, A. M., Gupta, M. K. & Gupta, B.D. (2001). *Fundamental of Statistics*. (Volume I). Kolkata, The World Press Pvt. Ltd.
2. Gupta, S. C. & Kapoor, V. K. (2002). *Fundamental of Mathematical Statistics*. (11<sup>th</sup>ed.). Sultan Chand & Sons.
3. Gupta, S. P. (2010). *Statistical Methods* (39<sup>th</sup>ed.). New Delhi, Himalaya Publication.
4. Mood, A. M., Graybill, F. A. & Boes, D. C. (2001). *Introduction to the theory of Statistics*. (3<sup>rd</sup>ed.). Tata McGraw Hill.
5. Meyer, P. L. (1970). *Introductory probability and Statistical Applications*. (2<sup>nd</sup>ed.) Oxford & IBH Publishing Co. Pvt. Ltd.

**Suggested E-learning material:**

1. Probability and Random variables. MIT Open Course.  
<https://ocw.mit.edu/courses/mathematics/18-440-probability-and-random-variables-spring-2014/lecture-notes/>
2. Probability and Statistics, NPTEL.  
<https://nptel.ac.in/courses/111105041/27>

## STAT 109L Measures of Association and Probability Distributions Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**Learning Outcomes:**

After completion of this course, the students will be able to:

- Apply and use fitting of various curves such as Straight line, parabola, exponential curve etc.
- Effectively distinguish between and compute, correlation and rank correlation, Partial and Multiple correlations.

- Understand and perform the Fitting of Binomial, Poisson and Normal distribution

1. Fitting of the following curves by the method of least squares:
  - (i) Straight line
  - (ii) Parabola
  - (iii) Exponential Curve
  - (iv) Power Curve
2. Computation of coefficients of correlation and rank correlation.
3. Fitting of regression lines.
4. Computation of Partial and Multiple Correlation
5. Testing of independence of attributes.
6. Yule's coefficient of association for attributes.
7. Fitting of (i) Binomial, (ii) Poisson and (iii) Normal distribution.

**Note:** (i) The above list is only for the guidance of the students. Any practical from the syllabus may be set in the practical examination.

(ii) Whenever it is feasible, students should be asked to collect the required data themselves to use it in their practicals.

(iii) Where it is feasible practical practice should be done through spreadsheet.

## Third Semester

### STAT 209 Sampling Distributions

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### Learning Outcomes:

After completion of this course, the students will be able to:

- Understand the difference between probability distribution and sampling distribution.
- Understand the sampling distribution of the mean of a sample from a Normal Population.
- Understand the properties of the sampling distribution of the sample mean in general situations, using the Central Limit Theorem.
- Understand the concepts of the t, F and  $\chi^2$  distributions.
- Apply t, F and  $\chi^2$  tests on real life data.



- Unit 1** Limit laws: convergence in probability, almost sure convergence, convergence in mean square and convergence in distribution and their inter relations, Chebyshev's inequality, W.L.L.N., S.L.L.N. and their applications, De-Moivre Laplace theorem, Central Limit Theorem (C.L.T.) for i.i.d. variates, applications of C.L.T. and Liapunov Theorem (without proof).
- Unit 2** Basic concept of Sampling and sampling distribution, sampling distribution of sample mean for Binomial, Poisson and Normal populations, standard errors of sample mean, sample variance and sample proportion. Null and alternative hypotheses, level of significance, Type I and Type II errors, their probabilities and critical region. Concept of p-values.
- Unit 3** Large sample tests of significance: Sampling for attributes and variables, Tests of significance and confidence intervals for proportion, difference of two proportions, single mean, difference of two means, standard deviation and difference of standard deviations.
- Unit 4** Chi-square distribution with its moment generating function, moments and cumulant, Additive property of chi-square variates, Limiting case of chi-square distribution. Tests of significance and confidence intervals based on Chi- Square distribution. Yates Correction for 2x2 contingency table.
- Unit 5** Students 't' and Fishers 't' statistics and their distributions Application of 't' test for one sample and two sample problems and for testing the significance of a sample, Correlation coefficient Paired 't' test, F-statistic and its distribution. Application of F-test for testing the equality of variance, Fisher's transformation and its uses. Relationship between 't' and 'F' statistics and F and Chi-square statistics

**Note:** Use of scientific calculator is permissible.

#### **Text Books:**

1. Hogg, R. V. & Tanis, E. (2009). *Probability and Statistical Inference*. Prentice Hall.
2. Goon, A. M., Gupta, B. D. & M. K. Gupta.(1968). *Fundamental of Statistics*. (Vol. I). The World Press Pvt. Ltd. Kolkata.

#### **Reference Books:**

1. Mood, A. M., Graybill, F. A. & Boes, D. C. (1974). *Introduction to Theory of Statistics*. McGraw- Hill International.

2. Gupta, S. C. & Kapoor, V. K. (2013). *Fundamental of Mathematical Statistics* (11<sup>th</sup>ed.). New Delhi: Sultan Chand Publication.
3. Gupta, S.P. (2014). *Statistical Methods* (44<sup>th</sup>ed.). Sultan Chand & Sons.
4. Freund, J. E. (2004). *Modern Elementary Statistics* (12<sup>th</sup>ed.). New Jersey: Pearson Prentice Hall.

#### **Suggested E-learning material:**

1. Sampling distribution and central limit; Platform: Colorado State University  
[https://www.stat.colostate.edu/~vollmer/stat307pdfs/LN5\\_2017.pdf](https://www.stat.colostate.edu/~vollmer/stat307pdfs/LN5_2017.pdf)

### **STAT 209L Sampling Distributions Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **Learning Outcomes:**

After completion of this course, the students will be able to:

- Effectively compute and understand testing of significance and confidence intervals in various contexts such as, for single proportion, difference of two proportions for large sample, for single mean, difference of two means for large sample.
- Proficiently test for goodness of fit, independence of attributes.
- Understand how and when to use testing for equality of two population variances

#### **List of Practicals**

1. Testing of significance and confidence intervals for single proportion and difference of two proportions for large sample.
2. Testing of significance and confidence intervals for single mean and difference of two means for large sample.
3. Testing of significance and confidence for mean and difference of means (paired and unpaired cases) and for correlation coefficient
4. Testing of significance and confidence intervals for difference of two standard deviations.
5. Testing if the population variance has a specific value and its confidence intervals.
6. Testing of goodness of fit.
7. Testing of independence of attributes.

8. Testing based on 2 X 2 contingency table without and with Yates' corrections.
9. Testing of significance and confidence intervals of an observed sample correlation coefficient.
10. Testing and confidence intervals of equality of two population variances

**Note:** (i) The above list is only for the guidance of the students.

(ii) Whenever it is feasible, students should be asked to collect the required data themselves to use it in their practical.

(iii) Where it is feasible practical practice should be done through spreadsheet, package or programming.

## Fourth Semester

### STAT 207 Statistical Inference and Quality Control

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

After completion of this course, the students will be able to:

- Apply various basic parametric, non-parametric and sequential estimation techniques and testing procedures to deal with real life problems.
- Understand confidence interval in normal case, Neyman-Pearson fundamental lemma, UMP test.
- Understand SPRT, OC and ASN function.
- Understand some non-parametric techniques.

**Unit 1** Theory of Estimation – Problems of point estimation, Properties of a good point estimator–Unbiasedness, Consistency, Efficiency & Sufficiency, Minimum variance unbiased estimator, Factorization theorems (without proof) and its applications. Confidence interval for normal case and Confidence coefficient.

**Unit 2** Methods of Estimation: Method of maximum likelihood, Minimum variance, Moments, Least squares and minimum Chi-square with their properties (Statements only).

**Unit 3** Testing of Hypothesis: Simple and Composite Hypothesis, Null and Alternative Hypothesis, First and Second types of errors, Power and size of the test, Level of significance, Critical region

and best critical region, Neyman- Pearson lemma and its application for finding BCR.

Sequential test procedure, Sequential probability ratio test (Properties are excluded), OC and ASN functions (simple ideas only).

**Unit 4** Order Statistics- Definition and their distribution, Distribution of sample range and sample median for continuous variable only (Confidence intervals and quartiles are excluded).

Non parametric tests; Sign Median and Run tests for small and large samples.

**Unit 5** Statistical Quality Control: Process control, Control charts for  $\bar{X}$ ,  $R$ ,  $s$ ,  $p$  and  $c$  and their uses. Sampling plan: Acceptance sampling for attributes, Single and Double sampling inspection plans, Concept of OC, ASN, AOQ and AOQL.

**Note:** Use of scientific calculator is permissible.

#### **Suggested Text Books:**

1. Mood, A. M., Graybill, F. A. & Boes, D. C. (1974). *Introduction to the Theory of Statistics*. Tata McGraw-Hill.
2. Goon, A. M., Gupta, M. K. & Gupta, B. D. (2001). *An Outline of Statistical Theory* (Volume 2). The world Press Pvt. Ltd.

#### **Suggested Reference Books:**

1. Rohatgi, V. K. & Saleh, A. M. E. (2015). *An introduction to probability and statistics*. (2nd.ed.) John Wiley & Sons.
2. Lehmann, E. L. & Romano, J. P. (2006). *Testing statistical hypotheses*. Springer Science & Business Media.
3. Lehmann, E. L. & Casella, G. (2006). *Theory of point estimation*. Springer Science & Business Media.
4. Zacks, S. (1971). *The theory of statistical inference*. John Wiley & Sons.

#### **Suggested E-learning material**

1. Statistical Inference; Platform: MITOPENCOURSEWARE <https://ocw.mit.edu/index.htm>
2. Statistical Inference; Platform: Coursera <https://www.coursera.org>
3. Statistical Inference; Platform: e-PG Pathshala <https://epgp.inflibnet.ac.in>

## STAT 207L Statistical Inference and Quality Control Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes:

After completion of this course, the students will be able to:

- Understand when and how to use various control charts such as  $\bar{X}$ , R, and s charts.
- Effectively understand and determine the AOQ and AOQL plots.
- Understand when and how to use various non - parametric tests such as Sign test, Run test, Median test etc.

### 1. Controls Charts:

- $\bar{X}$ , R, and s charts
- p and np charts for equal and unequal sample sizes.
- c-chart.
- Determination of AOQ & AOQL

### 2. Non Parametric Tests:

- Sign Test
- Run Test
- Median Test
- Mann Whitney U Test
- Five problems on primary data

**Note:** (i) The above list is only for the guidance of the students. Any practical from the syllabus of papers I & II may be set in the practical examination.

(ii) Whenever it is feasible, students should be asked to collect the required data themselves to use it in their practicals.

(iii) Where it is feasible practical practice should be done through spreadsheet, package or programming.

## Fifth Semester/Sixth Semester

### Discipline Electives (Statistics)

#### STAT 302 Sampling Techniques and Design of Experiments

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### Learning Outcomes:

After completion of this course, the students will be able to:

- Understand the Simple and Stratified random sampling techniques.
- Understand the ratio estimation procedure.
- Apply ANOVA for one-way and two-way classification, fixed effect models with equal number of observations per cell.

**Unit 1** Sample survey procedures, Role of sampling theory, Probability and non-probability sampling. Mean square error. Accuracy and precision of an Estimator. SRSWR and SRSWOR. Variance of the estimate of population mean and population total. Estimation of standard error for sample mean. Sampling for proportions and percentages (with/without replacement). Variance of sample estimate, estimated variances of these estimates.

**Unit 2** Stratified Random Sampling: Estimate of Population mean and its variance.

Allocation of sample size: Proportional allocation and optimum allocation (with/without varying cost). Comparison of simple random sampling with proportional and optimum allocation. Estimation of the sample size.

**Unit 3** Systematic Sampling-Estimation of variance of the systematic sample mean. Comparison of systematic Sampling with simple random and stratified sampling. Estimation of the ratio and ratio estimates for population mean and population total. Approximate formula for variance and Bias of the ratio estimates.

**Unit 4** Concept of Analysis of variance (i) One-way classification with equal/unequal observations per class. (ii) Two-way classification with one observation per cell. Fixed effect models of (i) and (ii)

and the assumptions involved. Estimation of treatment effects, treatment differences and confidence limits for the same. Expectations of sum of squares, variances of the estimates.

**Unit 5** Meaning of experiment, Experimental unit, Treatment, Field, Block, Experimental error, Precision, Uniformity trials, Principles of designs-replication, Randomization and Local Control, Efficiency of design choice of size and shape of plots and blocks. Completely Randomized design, Randomized Block design and Latin square Design-Analysis of these designs, standard error of treatment differences, comparison of their efficiencies.

**Note:** Use of Scientific calculator is permissible.

#### **Text Books:**

1. Sukhatme, P. V. & Sukhatme, B. V. (1970). *Sampling Theory of Survey with Applications*. (2<sup>nd</sup> ed.), Piyush Publication.
2. Goon, A. M., Gupta, M. K. & Gupta, B. D. (2001). *Fundamental of Statistics*. (Volume. II). The World Press pvt. ltd.

#### **Reference Books:**

1. Cochran, W. G. (1977). *Sampling Techniques*. (3<sup>rd</sup> ed.). Wiley Eastern Limited.
2. Singh, D. & Chaudhary, F. S. (2002). *Theory and Analysis of Sample survey Design*. New Age International Publisher.
3. Joshi, D. D. (2003). *Linear Estimation and Design of Experiments*. New Age International Publisher.
4. Das, M. N. & Giri, N. G. (2002). *Design and Analysis of Experiments*. New Age International Publisher.

#### **Suggested E-learning material:**

1. Sampling Theory, NPTEL. <https://nptel.ac.in/courses/111104073/>
2. Biostatistics and Design of Experiments, NPTEL, <https://nptel.ac.in/courses/102106051/>
3. Design of Experiments and sample Survey. ePATHSHALA. <https://epgp.inflibnet.ac.in/ahl.php?csrno=34>

## STAT 302L Sampling Techniques and Design of Experiments Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes:

On completion of this course, the students will be able to:

- Leave the basic principles underlying survey design and estimation.
- Draw a random sample by using with and with replacement sampling technique in excel.
- Calculate the sampling mean and sampling variance in case of SRSWR and SRSWOR.
- Draw a random sample from stratified and systematic sampling and also to compare the efficiencies of these sampling techniques with respect to each other.
- Analyze the results of a designed experiment in order to conduct the appropriate statistical analysis of the data.
- Compare several means by using the concept of one way and two way ANOVA.
- Compare the three designs named CRD, RBD and LSD in terms of their efficiencies.

### 1. Sample Surveys:

**SRS Sampling:** To draw a simple random sample (SRS) with and without replacements, to obtain an estimate of the population mean along with the estimate of their variances. To compare their efficiency of SRSWOR and SRSWR.

To draw all the possible samples by SRS technique and then to show that expected value of the sample mean equals the population mean and to find the expected value of S in SRSWOR and in SRSWR.

**Stratified Sampling:**

Estimate the sample sizes by proportional allocation and Neymann's optimum allocation.

Estimate the mean of the population under the above scheme.

Calculation of the sampling variances.



Comparison of efficiencies of the allocation scheme amongst themselves as well as with SRS.

Systematic Sampling:

Systematic sampling and its comparison with SRSS and stratified sampling.

Estimation of mean and variance by ratio method of estimation.

## 2. Analysis of variance and Design of Experiments:

One way and two-way classifications.

Completely Randomised Design (CRD).

Randomised Block Design (RBD) and its efficiency with CRD.

Latin Square Design (LSD) and its efficiency with CRD and RBD.

### Project Work:

The candidate is to write a report on some project work based on Primary or Secondary data on any one selected topic with the permission of the Head of the Department.

- Note:** (i) The above list is only for the guidance of the students. Any practical from the syllabus of papers I & II may be set in the practical examination.
- (ii) Whenever it is feasible, students should be asked to collect the required data themselves to use it in their practicals.
- (iii) Where it is feasible practical practice should be done through spreadsheet, package or programming.

## STAT 301 Applied Statistics

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

### Learning Outcomes:

After completion of this course, the students will be able to:

- Understand the concept of time series data and application in various fields.
- Identify principle sources of demographic data and assess their strengths and weaknesses.

- Understand the calculation and interpretation of the principal demographic measures, and standardize these measures for comparison and construct and interpret life tables.
- Understand the uses of index number with their construction methods.
- Understand the concept of demand and supply theory.
- Understand the concept of scaling of scores.

**Unit 1** Time series analysis: Components of a time series, Additive and multiplicative models. Methods of determining trend and seasonal components.

**Unit 2** Vital Statistics: Indices of mortality and fertility, Mortality- Crude and Standardized death rates. Fertility- Crude birth rate, general fertility rate, Gross and Net reproduction rates, Definition, evaluation and uses of above indices, Stable and stationary populations- concept, determination of the rate of increase in a stable populations, Life table: construction of life table from graduated rates of mortality and evaluation of probabilities of survival and death from a life table.

**Unit 3** Economic statistics: Meaning and uses of Index Numbers, Problems in construction of Index Numbers, Prices and quantity indices, Fixed base and chain base Index numbers. Weighted and unweighted index numbers-Laspeyre's, Pasche's, Marshal-Edgeworth's and Fisher's ideal Index numbers, Time reversal, factor reversal and circular tests, Base shifting, splicing and deflating.

Construction of cost of living and wholesale price index numbers.

**Unit 4** Educational Statistics: Statistics in Psychology and Education, Scaling of scores, Standard scores, Normalized scores, T scores, Reliability and validity of test scores, intelligence quotient.

**Unit 5** Demand Analysis: Demand and supply, Law of Demand and Supply. Price elasticity of demand, Partial elasticity of demand. Engel's curve and Engel's law, Pareto's law of income distribution.

**Note:** Use of Scientific calculator is permissible.

**Text Books:**

1. Gupta, S. C. & Kapoor, V. K. (2000). *Fundamentals of mathematical statistics*. New Delhi, Sultan Chand & Sons. (for applications)
2. Goon, A.M., Gupta, M.K. & Dasgupta, B. (2001). *Fundamental of Statistics*. (Volume.II). The World Press Pvt. Ltd.

**Reference Books:**

1. Hooda, R.P. Introduction to Statistics. (7<sup>th</sup>ed.). Macmillan India Ltd.
2. Croxton, F.E. & Cowden, D. J. (1955). Applied General Statistics. (2<sup>nd</sup>ed.). New York, Prentice-Hall.

**STAT 301L Applied Statistics Lab****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Learning Outcomes:**

After completion of this course, the students will be able to:

- Find the trend and seasonal components in the given dataset and separate these components on excel.
  - Calculate and interpret the basic demographic measures and compare the measure for two different populations.
  - Construct the life table with the help of some given life table columns.
  - Calculate the index numbers for different commodities.
  - Scaling the scores, test the reliability of these scores and compute the IQ of any individual.
1. (i) Measurement of trend by method of moving averages and curve fitting by least squares.  
(ii) Measurement of seasonal fluctuations by-
    - (a) Ratio to trend
    - (b) Ratio to moving averages
    - (c) Link relative method.
  2. Vital Statistics:
    - (i) CDR, CBR, Age specific death rates, standardized with and death rates.

- (ii) GFR, ASFR, TFR.
  - (iii) Crude rate of natural increase GRR, NRR.
  - (iv) Life table and finding out certain values with its help.
3. Economic Statistics:
- (i) Laspeyre's, Pasche's and Fisher's Index numbers.
  - (ii) Fixed base and chain base index numbers.
  - (iii) Wholesale price index numbers.
  - (iv) Cost of living index numbers.
4. Educational Statistics: Computation of different scores, reliability of test scores and IQ.

### STAT 303 Financial Statistics

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### **Learning Outcomes:**

On completion of the course, the students will be able to:

- Understand acquisition of financial data
- Describe financial data using distributions
- Find relation between two or more financial series
- Understand the concept of stochastic process
- Apply basic stochastic models in financial data.

**Unit 1** Essential practical familiarization with financial data. Typical challenges with real financial data. Basics on data acquisition, manipulation, filtering, graphical representation and plotting.

**Unit 2** Statistical distribution of returns. Moments of the distribution. Non-Normal distributions and fat-tails. Large fluctuations and tail risk. Stable distributions. Generalized extreme value distribution. Estimation methods to characterize the tails of the distributions. Calibration and validation. Applications to measures of risk.

**Unit 3** Measures of dependency: linear and non-linear correlations. Lagged correlations and causality. Information theoretic perspective: mutual information, transfer entropy. Spurious

correlations. Correlation filtering through networks. Calibration, validation and application issues.

**Unit 4** Stochastic Process: Concept, types, properties. Discrete Stochastic Processes, Binomial processes, Gaussian Process. Random walk, General random walks, Geometric random walks, Binomial models with state dependent increments.

**Unit 5** Stochastic Models in Finance: Discrete time process- binomial model with period one. Stochastic Models in Finance: Continuous time process- geometric Brownian motion.

### Suggested Readings:

1. Franke, J., Hardle, W.K. & Hafner, C.M. (2011). *Statistics of Financial Markets: An Introduction*, (3<sup>rd</sup>ed.). Springer Publications.
2. Stanley, L. S. (2012). *A Course on Statistics for Finance*, Chapman and Hall/CRC.
3. Casella, G. & Berger, R. L. (2002). *Statistical Inference*, Brooks/Coles.
4. Bouchaud, J.- P. & Potters, M. (2003). *Theory of Financial Risk and Derivative Pricing: from Statistical Physics to Risk Management*, Cambridge University Press.
5. Lehmann, E. L. & Romano, J. P. (2006). *Testing Statistical Hypotheses*, Springer, 2006.

### Reference Books

1. Coles, S. (2001). *An Introduction to Statistical Modeling of Extreme Values*, Springer.
2. Gumbel, E. J. (2013). *Statistics of Extremes*, Echo Point Books & Media.

## STAT 303L Financial Statistics Lab

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes:

On completion of this course, the students will be able to:

- Understand the behavior of financial data through graphs
- Describe the nature of financial data
- Calculate risk through financial data
- Find relationship between financial series
- Model financial data using some simple stochastic models.

**List of Practical (Using spreadsheet/ R)**

1. Graphical representation of financial data
2. Fit non-normal distributions to financial data
3. Obtain characteristics of the distribution
4. Find measures of risk
5. Measure relationships between financial series.
6. Apply stochastic processes for a financial data

**STAT 304 Health Statistics and Population Dynamics****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

**Learning Outcomes:**

After completion of this course, the students will be able to:

- Understand different measures related to health statistic.
- Able to calculate morbidity measures.
- Identify principle sources of demographic data and assess their strengths and weaknesses.
- Discuss the demographic significance of age and sex structures and the implications of variations in age & sex structure.
- Construct and interpret life tables.
- Calculation and interpretation of the principal demographic measures, and standardize these measures for comparison.
- Understand the components of population change, including the effects of changing birth, death and migration rates, and demonstrate their influences on age structure.
- Estimate and project the population by different methods.

**Unit 1** Health statistics: Introduction, utilization of basic data, sources of health statistics, problems in the collection of sickness data, measurement of sickness, hospital statistics and the international classification of diseases, different measures: incidence rates, prevalence rate, attack rate, case fatality rate. Measures of accuracy or validity, sensitivity index, specificity index.

**Unit 2** Sources of demographic data in India: census, vital events, registration, survey, extent of under registration, Population

pyramids and its use. Population growth rates: arithmetic, geometric and exponential growth rates, population estimation and projection.

**Unit 3** Mortality and its measures: Crude, direct and indirect standardization of death rates, age specific death rate, infant mortality rate, neo- natal mortality rate, definitions and their evaluation.

Fertility and its measures: CBR, ASBR, measures of reproduction: GFR, TFR, GRR, NRR, cohort fertility analysis.

**Unit 4** Measures of migration crude, specific and standardized rates survival ratio and national growth rate method.

Urbanization - Growth and distribution of rural - urban population in developed and developing countries.

**Unit 5** Life tables and their application: construction of complete and abridged life tables and their interrelationship, force of mortality, evaluation of probabilities of survival and death from life table.

### Text Books

1. Rao, P. S. S., Sundar & Richard, J. (2004). *An introduction to Biostatistics (A manual for students in health sciences)*, Prentice Hall of India, Pvt. Ltd.
2. Misra, B. D. (2004). *An introduction to the study of population*, South Asian Publishers Pvt. Ltd.
3. Ramkumar, R. (2006). *Technical Demography*. New Age International.
4. Pathak, K. B. & Ram, F. (2019). *Techniques of Demographic Analysis* (2<sup>nd</sup>ed.). Himalaya Publishing House.

### Reference Books

1. Keyfitz, N. (2013). *Applied Mathematical Demography*, New York: John Wiley.
2. Bhinde, A. A. & Kanitker, T. (2018). *Principles of Population Studies* (19<sup>th</sup>ed.). Himalaya Publishing House.

### Suggested E- Learning Material

1. Demographic data; Platform: National Family Health Survey, India <http://rchiips.org>
2. Population Studies; Platform; e-PG Pathshala <https://epgp.inflibnet.ac.in>

3. Demography ; Platform: University Library - The University of Adelaide  
<https://www.adelaide.edu.au/library/>
4. Demography; Platform: MITOPENCOURSEWARE <https://ocw.mit.edu/index.htm>

## **STAT 304L Health Statistics and Population Dynamics Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

### **Learning Outcomes:**

After completion of this course, the students will be able to:

- Calculate various measures of morbidity and their accuracy
- Construct population pyramid and identify its features
- Estimate population growth rates and project for future
- Calculate measures of mortality and fertility for a given population
- Calculate simple measures of life table and analyze it.

### **List of Practicals**

1. Measures of morbidity
2. Measures of accuracy or validity, sensitivity index, specificity index
3. Construction of population pyramid
4. Population growth rate
5. Measures based on mortality
6. Measures based based on fertility
7. Construction of Life table



# ZOOLOGY

## First Semester

### ZOO 102 Taxonomy, Classification and Evolution

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Gain fundamental understanding of the taxonomy and systematics.
- Describe salient features and classification of major phyla of invertebrates and protochordates.
- Develop a better understanding about classical and modern theories of evolution along with factors affecting evolution and detail of evolution of man, camel and horse.

#### **Unit 1**

- Basic concept of taxonomy and systematics: Terms, definition, contribution and role of systematics.
- Zoological classification: International code of zoological nomenclature, principles of nomenclature, kinds of classification, Linnaean hierarchy.

#### **Unit 2**

- Distinguishing characters and classification up to orders (excluding extinct forms) of the followings:
- Lower non-chordates (protozoa, porifera, coelenterata, platyhelminthes & nematods).
- Higher non-chordates (annelida, arthropoda, mollusca and echinodermata).
- Protochordates.

#### **Unit 3**

- Lamarckism, Neo Lamarckism, Darwinism and Neo Darwinism.
- Theory of mutation with special reference to chromosomal aberrations and gene mutations.
- Modern synthetic theory of evolution.

## Unit 4

- Evidences in favour of organic evolution.
- Role of variations, adaptation, speciation and isolation in the process of evolution.
- Fossils: Formation of fossils, kinds of fossils, significance of the study of fossils.

## Unit 5

- Genetic basis of evolution including Hardy-Weinberg's law.
- Geological time scale and the distribution of animals in time and space.
- Evolution of man, horse and camel.

### Suggested Books:

- Arora, M.P. & Arora, H. (2013). *A Textbook of Organic Evolution*. New Delhi: Himalaya Publishing House.
- Chaki, K.K., Kundu, G. & Sarkar, S. (2016). *Introduction to General Zoology* Vol-II. Kolkata: New Central Book Agency.
- Ghoshe, K.C. & Manna, B. (2012). *Fundamentals of Zoology*. Kolkata: New Central Book Agency.
- Kapoor, V.C. (2018). *Theory & Practice of Animal Taxonomy and Biodiversity* (8<sup>th</sup> ed.). New Delhi: CBS Publishers & Distributors.
- Kotpal, R.L. (2014). *Modern Textbook of Zoology: Invertebrates* (11<sup>th</sup> ed.). Meerut: Rastogi Publications.
- Mayr, E. & Ashlock, P.D. (1991). *Principles of Systematic Zoology* (2nd ed.). New Delhi: McGraw-Hill College.
- Nigam, H.C. (2013). *Biology of Non-Chordates*. New Delhi: Vishal Publishing Co.
- Prasad, S.N. & Kashyap, V. (2012). *A text book of Invertebrate Zoology* (14<sup>th</sup> ed.). New Delhi: New Age International (P) Limited.
- Rastogi, V.B. (2016). *Organic Evolution* (1<sup>st</sup> ed.). Medtech.

### Suggested e-Resources:

- **Taxonomy & classification**

<http://www.austinncc.edu/sziser/Biol%201413/LectureNotes/lnexamI/taxonomyClassification.pdf>

<http://www.iaszoology.com/zoological-nomenclature/>

➤ **Evolution**

<http://www.iaszoology.com/category/evolution/>

➤ **Origin of life**

<https://nptel.ac.in/courses/122103039/10>

➤ **Chromosomal mutations**

<http://www.wou.edu/~guralnl/311Chromosomal%20Mutations.pdf>

<https://facultystaff.richmond.edu/~lrnyenjbio554/lectnotes/chapter9.pdf>

➤ **Invertebrate phyla**

<https://www.slideshare.net/godhxbwnkkdn/animal-diversity-zoology-notes>

➤ **Geological time scale**

<http://geoscience.msc.sa.edu.au/library/3-3%20Geological%20Timescale.pdf>

## **ZOO 104L Taxonomy, Classification and Evolution Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### **Learning Outcomes:**

On completion of the course, students will be able to:

- Identify and characterize different organisms of major phyla of non chordates based on the morphology.
- Understand the internal structures of lower non chordates through microscopic study of prepared slides.
- Understand the anatomy of *Fasciola*, *Pheretima* and *Unio* with the help of charts.
- Learn the technique of preparation of permanent slide.
- Apply acquired knowledge for the preparation of phylogenetic tree of invertebrates.

### **1. Study of museum specimens:**

- Porifera: *Sycon*, *Hyalonema*, *Euspongia*.
- Coelenterata: *Porpita*, *Velella*, *Gorgonia*, *Pennatula*, *Alcyonium*, *Adamsia*.
- Platyhelminthes: *Fasciola*, *Echinococcus*.
- Nematelminthes: *Dracunculus* and *Enterobius*.

- Annelida: *Pheretima*, *Aphrodite*, *Terebella*, *Pontobdella*
- Arthropoda: *Lepus*, *Sacculina*, Crab, Hermit crab, *Melanopus*, Queen-termite, *Limulus* and *Peripatus*.
- Mollusca: *Chiton*, *Aplysia*, *Dentalium*, *Mytilus*, *Teredo*, *Sepia*, *Loligo*.
- Echinodermata: *Asterias*, *Holothuria*, *Echinus*, *Clypeaster*.
- Protochordata: *Ascidia*, *Botryllus*.

## 2. Study of microscopic slides:

- Protozoa: *Euglena*, *Plasmodium*, *Opalina*, *Nyctotherus*, *Vorticella*, *Balantidium*, Foraminiferous shells.
- Porifera: W.M. of *Leucosolenia*, Sponge gemmule.
- Coelenterata: *Hydra*, *Obelia* medusa.
- Platyhelminthes: W.M. of *Planaria*, W.M. of scolex, gravid proglottid, onchosphere and bladder worm of *Taenia*, T.S. of the proglottid of *Taenia*.
- Nemathelminthes: T.S. through the body of male and female *Ascaris*.
- Annelida: T.S. of *Hirudinaria* through jaws, pharynx and crop region.
- Arthropoda: Male and female *Drosophila*, sex comb of *Drosophila*.
- Mollusca: V.S. of molluscan shell, T.S. of gill of *Pila*, radula of *Pila*.
- Echinodermata: T.S. through the arm of *Asterias*, Pedicellaria of *Asterias*.
- Hemichordata: W.M. of tornaria larva.
- Protochordata: W.M. of *Pyrosoma*, *Doliolum* and *Oikopleura*.

## 3. Anatomy:

- Anatomical study of various systems with the help of chart/model/CD.

### *Fasciola hepatica*

1. Digestive system
2. Excretory system
3. Reproductive system

***Pheretima posthuma***

1. Digestive system
2. Nervous system
3. Reproductive system

***Unio***

1. Digestive system
2. Nervous system

**4. Organization and working of optical microscope: Dissecting and compound microscopes.****5. Preparation of permanent slides:**

- Protozoa: *Euglena*.
- Porifera: Sponge spicules.
- Coelenterata: *Hydra* with extended tentacles, *Hydra* with bud.
- Annelida: Setae of earthworm, Parapodium of *Nereis*.
- Arthropoda: Statocyst of *Palaemon*, *Cyclops*, *Mysis* and *Daphnia*.
- Mollusca: Radula of *Pila*.
- Echinodermata: Pedicellaria.

**6. Collection and culture methods**

- (i) Collection of animals from their natural habitat: *Amoeba*, *Paramecium*, *Euglena*.
- (ii) Culture of *Paramecium* in the laboratory and study of its structure, life processes and behavior in live state.

**7. Preparation of phylogentic tree/cladogram of invertebrates including minor phyla.****8. Preparation of permanent mount of mouth parts of mosquito.****9. Study the evidences of evolution (Analogy and homology) through charts/ models.****Suggested Books:**

- Lal, S. S. (2015). *Practical Zoology Invertebrates* (11<sup>th</sup>ed.). Meerut: Rastogi Publication.
- Verma, P. S. (2010). *A Manual of Practical Zoology: Invertebrates* (11<sup>th</sup>ed.). New Delhi: S Chand Publishing.

## Second Semester

### ZOO 101 Non-Chordates and Proto-Chordates

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### Learning Outcomes:

On completion of the course, students will be able to:

- Describe the habit, habitat, morphology, structure and functions of important animals of different major phyla of invertebrates and lower chordates.
- Understand the economic importance of various invertebrate phyla and affinities of lower chordate animals.
- Gain a high degree of competence in its field of specialization in response to the changing demands of the times.

#### Unit 1

##### Protozoa

- Habitat, habits, external features, locomotion, osmoregulation, nutrition, reproduction and life cycle of *Euglena*, *Paramecium* and *Monocystis*.
- Economic importance of protozoans.

##### Porifera

- Habitat, habits, structural organization, canal system, reproduction and development of *Sycon* including evolution of canal system in sponges.
- Economic importance of sponges.

#### Unit 2

##### Coelenterata

- Habitat, habits, external features, nutrition, structural organization, reproduction and life cycle of *Obelia*.
- Corals and coral reefs.

##### Helminthes

- Habitat, habits, external features, different systems and life history of following animal types: *Fasciola*, *Taenia* and *Ascaris*.
- Parasitic adaptations and diseases caused by helminthes.

### Unit 3

#### Annelida

- Habitat, habits, external features, different systems and development of *Pheretima*.
- Habitat, habits, external features and life history of *Neanthes*.

#### Arthropoda

- Habitat, habits, external features and different systems of *Palaemon*.
- Economic importance of insecta.

### Unit 4

#### Mollusca

- Habitat, habits, external features, various organs and organ systems of *Pila* and *Unio*; pearl formation.
- Economic importance of mollusca.

#### Echinodermata

- Habitat, habits, external features and water-vascular system of *Asterias*.
- Larval forms of echinoderms.

#### Hemichordata

- Habitat, habits, external features and different system of *Balanoglossus*.
- Affinities of hemichordates.

### Unit 5

#### Urochordata

- Habitat, habits, structural organisation and various systems of *Herdmania*.
- Tadpole larva and retrogressive metamorphosis in *Herdmania*.

#### Cephalochordata

- Habitat, habits, morphology, different systems and affinities of *Amphioxus*.
- Development of coelom and atrium of *Amphioxus*.

#### Suggested Books:

- Chaki, K.K., Kundu, G. & Sarkar, S. (2014). *Introduction to Economic Zoology*. Kolkata: New Central Book Agency.

- Chaki, K.K., Kundu, G. & Sarkar, S. (2015). *Introduction to General Zoology* Vol-I. Kolkata: New Central Book Agency.
- Dhama P.S. & Dhama, J.K. (2015). *Invertebrate Zoology*. New Delhi: R. Chand and Co.
- Hyman, L.H. *The Invertebrates*. Vol-I-IX. New York: McGraw Hill.
- Jordan, E.L. & Verma, P.S. (2018). *Invertebrate Zoology*. New Delhi: S. Chand & Company Ltd.
- Kotpal, R.L. (2014). *Modern Textbook of Zoology: Invertebrates* (11<sup>th</sup> ed.). Meerut: Rastogi Publications.
- Kotpal, R.L. (2018). *Modern Text book of Zoology: Vertebrates* (4<sup>th</sup> ed.). Meerut: Rastogi Publications.
- Lahiri, B.K. (2013). *College Zoology* Vol-I. Mumbai: Himalaya Publishing House.
- Majumuria, T.C. (1962). *A textbook of invertebrate Zoology* (1<sup>st</sup> ed.). Jullundur City: S. Nagin Publishers.
- Nigam, H.C. (2013). *Biology of Non-Chordates*. New Delhi: Vishal Publishing Co.
- Pechenik, J.A. (2015). *Biology of the Invertebrates* (7<sup>th</sup> ed.). New Delhi: Mc Graw Hill Education.
- Prasad, S.N. & Kashyap, V. (2012). *A Textbook of Invertebrate Zoology* (XIV Ed.). New Delhi: New Age International (P) Limited.
- Rastogi, V.B. (2017). *Invertebrate Zoology*. Meerut: Kedar Nath Ram Nath.
- Shukla, G.S. & Upadhyay, V.B. (2017). *Economic Zoology* (5<sup>th</sup> ed.). Meerut: Rastogi Publication.

### **Suggested e-Resources:**

- **Corals**  
<https://www.icriforum.org/about-coral-reefs/what-are-corals>
- **Paramecium**  
<https://www.microscopemaster.com/paramecium.html>
- **Prawn**  
<http://www.biologydiscussion.com/invertebrate-zoology/phylum-arthropoda/study-notes-on-prawn/33417>



➤ ***Amphioxus***

[https://embryology.med.unsw.edu.au/embryology/index.php/Book\\_-\\_Text-Book\\_of\\_Embryology\\_4](https://embryology.med.unsw.edu.au/embryology/index.php/Book_-_Text-Book_of_Embryology_4)

➤ **Invertebrate animals**

<http://www.iaszoology.com/category/animal-diversity-nonchordata/>

➤ **Non chordate animals**

<https://www.slideshare.net/godhxbwnkkdn/animal-diversity-zoology-notes>

<http://abacus.bates.edu/acad/depts/biobook/AnimPhyl.pdf>

## **ZOO 103L Non-Chordates and Proto-Chordates Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

### **Learning Outcomes:**

On completion of the course, students will be able to:

- Identify and characterize different organisms of invertebrate based on the external features.
- Describe different organ systems of important invertebrate animals like *Palaemone*, *Pila* and *Asterias*.
- Gain practical understanding of preparation of permanent slide and study of internal structures of higher invertebrate animals through microscopic study of prepared slides.
- Understand the collection of certain arthropods from their natural habitat and develop the skills of vermiculture.

### **1. Study of museum specimens:**

- Porifera: *Euplectella*, *Chalina*, *Grantia* and *Spongilla*.
- Coelenterata: *Physalia*, *Aurelia*, *Millipora*, *Tubipora*, *Corallium*, *Antipathes* (black only), *Fungia* (mushroom coral).
- Platyhelminthes: *Schistosoma* and *Taenia*.
- Nematelminthes: Male and female *Ascaris*.
- Annelida: *Nereis*, *Chaetopterus*, *Sabella*, *Arenicola*, *Hirudinaria*.
- Arthropoda: *Balanus*, *Squilla*, *Julus*, *Scolopendra*, Locust, Butterfly, *Cimex*, Scorpion, Spider.

- Mollusca: *Patella*, *Cypraea*, *Pecten*, *Octopus*, Pearl oyster, *Nautilus*.
- Echinodermata: *Antedon*, *Clypeaster*, *Cucumara*, *Ophiothrix*.
- Hemichordata: *Balanoglossus*.
- Protochordata: *Ciona* and *Salpa*.

## 2. Study of microscopic slides:

- Protozoa: *Amoeba*, *Polystomella*, *Monocystis*, Binary fission and conjugation in *Paramecium*.
- Porifera: T.S. and L.S. of *Sycon*, Spicules of sponge, Canal system of sponge.
- Coelenterata: *Obelia*.
- Platyhelminthes: W.M. of miracidium, sporocyst, redia, cercaria and metacercaria larva of *Fasciola*.
- Annelida: T.S. of *Nereis* through trunk region, T.S. of *Pheretima posthuma* through gizzard, typhlosolar region, prostrate glands and seminal vesicles.
- Arthropoda: V.S. of compound eye, *Pediculus*.
- Mollusca: T.S. of gill of *Unio*, Glochidium larva.
- Echinodermata: Larval forms (Bipinnaria, Echinopluteus, Ophiopluteus).
- Hemichordata: T.S. of *Balanoglossus* through proboscis, collar and trunk region.
- Protochordata: W.M. velum and pharyngeal wall of *Amphioxus*, T.S. of *Amphioxus* through various regions; tadpole larva of *Ascidia*.

## 3. Anatomy:

- Anatomical study of various systems with the help of chart/model/CD.

### *Palaemon*

1. Appendages
2. Digestive system
3. Nervous system

### *Pila globosa*

1. Digestive system

2. Structure of radula

3. Nervous system

### ***Asterias***

1. Water vascular system

#### **4. To study methods of preservation of museum specimens.**

#### **5. Preparation of permanent slides**

- Protozoa: *Paramecium*.
- Porifera: Spongin fibers and gemmule.
- Coelenterata: *Obelia* colony and medusa of *Obelia*.
- Annelida: Parapodium of heteronereis.
- Arthropoda: Crustacean larva (nauplius, metanauplius, megalopa, Zoea).
- Mollusca: Glochidium larva of *Unio*.
- Echinodermata: Tube feet of *Asterias*.

#### **6. Collection and culture methods**

- (i) Collection of animals from their natural habitat: *Pheretima*, *Daphnia*, *Cyclops*, house flies, mosquitoes.
- (ii) Culture of *Pheretima*.

#### **7. Preparation of permanent mount of mouth parts of cockroach/housefly.**

#### **Suggested Books:**

- Lal, S.S. (2015). *Practical Zoology: Invertebrates* (11<sup>th</sup> ed.). Meerut: Rastogi Publication.
- Verma, P.S. (2010). *A Manual of Practical Zoology: Invertebrates* (11<sup>th</sup> ed.). New Delhi: S Chand Publishing.

# ZOOLOGY

## Third Semester

### ZOO 203 Cell Biology, Molecular Biology, Histology and Genetics

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>6</b>	<b>0</b>	<b>0</b>	<b>6</b>

#### Learning Outcomes:

On completion of the course, students will be able to:

- Understand the fundamental knowledge of cell and its organization.
- Describe the classification, structure and functions of carbohydrates, proteins and lipids.
- Understand the theoretical aspects of structure and location of various tissues and histology of various body organs.
- Describe the molecular structure and types of nucleic acids along with DNA replication and translation.
- Describe fundamental and molecular principles of genetics and human genetic traits.

#### Unit 1

- Definition of cell and molecular biology and the differences between the two sciences. Cell theory; morphology, size, shape and characteristics of prokaryotic and eukaryotic cells.
- Physical and biochemical makeup of protoplasm, formation of cell membranes and movement of protoplasm.
- Classification, structure and functions of carbohydrates, proteins and lipids. Classification, nomenclature and functions of enzymes. Structure and functions of vitamins and hormones.

#### Unit 2 Biological organization of cell:

- Plasma membrane, cell wall and endoplasmic Reticulum (rough and smooth)
- Structure and functions of mitochondria, golgi body and lysosomes.
- Nucleus, nucleolus and chromosomes with special reference to polytene and lampbrush chromosomes.

### Unit 3

- An idea about the structure and location of epithelial and connective tissue; cartilage and bone.
- Histology of digestive organs and associated glands, blood vessels, trachea and lung.
- Histology of kidney, ovary, testis, vas deferens and oviduct.

### Unit 4

- Occurrence, morphology, chemical composition, molecular structure, functions and replication of DNA.
- Occurrence, morphology, chemical composition, molecular structure and functions of various types of RNA.
- Mechanism of protein synthesis and genetic code.

### Unit 5

- Overview of Mendel's law of inheritance, concept of gene: allele, multiple alleles, extensions of Mendelian principles: codominance, incomplete dominance, gene interactions, pleiotropy, linkage and crossing over.
- Sex chromosomes, sex determination in animals, sex-linked inheritance.
- Human genetics: Pedigree analysis, karyotypes, disorders of allosomes & autosomes. Quantitative genetics: Polygenic inheritance, heritability and its measurements.

### Suggested Books:

- De Robertis, E.D.P. & De Robertis, E.M.F. (1987). *Cell and Molecular Biology* (8<sup>th</sup>ed.). USA: Lea & Febiger.
- Gardner, E.J., Simmons, M.J. & Snustad, D.P. (2005). *Principles of Genetics* (8<sup>th</sup>ed.). New Jersey, USA: John Wiley & Sons Ltd.
- Gardner, E.J., Simmons, M.J. & Snustad, D.P. (2006). *Principles of Genetics* (8<sup>th</sup>ed.). USA: John Wiley & Sons.
- Gartner, L.P. (2016). *Text Book of Histology* (4<sup>th</sup>ed.). Elsevier.
- Gupta, P.K. (2018). *Cell and Molecular Biology* (5<sup>th</sup> ed.). Meerut: Rastogi Publications.
- Gupta, S.N. (2015). *Biochemistry* (2<sup>nd</sup>ed.). Meerut: Rastogi Publication.
- Kar, D.K. & Halder, S. (2018). *Cell Biology, Genetics & Molecular Biology*. Kolkata: New Central Book Agency.

- Karp, G., Iwasa, J. & Marshall, W. (2018). *Karp's Cell Biology*. New Jersey: Wiley Publication.
- Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A. & Killian, D. (2018). *Concepts of Genetics* (12<sup>th</sup>ed.). USA: Pearson.
- Lodish, H., Berk, A. Kaiser, C.A., Krieger, M. & Scott, M.P. (2007). *Molecular Cell Biology* (6<sup>th</sup>ed.). USA: W H Freeman.
- Malacinski, G.M. (2015). *Freifelders Essentials of Molecular Biology* (4<sup>th</sup> ed.). USA: Jones & Bartlett.
- Miglani, G.S. (2007). *Advanced Genetics*. New Delhi: Narosa.
- Powar, C.B. (2014). *Essentials of Cytology*. Mumbai: Himalaya Publishing House.
- Rastogi, V.B. (2010). *Fundamental of Molecular Biology*. New Delhi: ANE Books.
- Rastogi, V.B. (2016). *Introductory Cytology – Knrn*. Meerut: Kedar Nath Ram Nath Publishers.
- Rej, S.K. (2018). *General Concepts of Histology & Endocrinology*. Kolkata: New Central Book Agency.
- Russell, P.J. (2009). *iGenetics: A Molecular Approach* (3<sup>rd</sup>ed.). Pearson Education India.
- Satyanarayana, U. & Chakrapani, U. (2017). *Essentials of Biochemistry* (2<sup>nd</sup>ed.). Kolkata: Booka & Allied Ltd.
- Tamarin, R.H. (2004). *Principles of Genetics* (7<sup>th</sup>ed.). USA: McGraw-Hill Higher Education.
- Verma, G. P. (2001). *Fundamentals of Histology*. New Delhi: New Age International (P) Limited Publishers.
- Verma, P.S. & Agarwal, V.K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution & Ecology*. New Delhi: S. Chand Publisher.

### **Suggested e-Resources:**

#### ➤ **Introductory genetics**

[http://depts.washington.edu/genetics/courses/genet371b-aut99/overheads/pdfs/all\\_lect.pdf](http://depts.washington.edu/genetics/courses/genet371b-aut99/overheads/pdfs/all_lect.pdf)

#### ➤ **Cell biology**

<https://nptel.ac.in/courses/102103012/6>

➤ **Cell biology & organelles**

<https://www.nicholls.edu/biol-ds/biol155/Lectures/Cell%20Biology.pdf>

➤ **Biomolecules**

[http://www.biologie.ens.fr/~mthomas/L3/intro\\_biologie/2-sucres-lipides-acides-nucleiques.pdf](http://www.biologie.ens.fr/~mthomas/L3/intro_biologie/2-sucres-lipides-acides-nucleiques.pdf)

➤ **Enzymology**

<https://nptel.ac.in/courses/102102033/14>

➤ **Human genetics**

<https://nptel.ac.in/courses/102104052/>

➤ **Mendelian genetics & deviation**

<https://www.khanacademy.org/science/biology/classical-genetics/variations-on-mendelian-genetics/a/multiple-alleles-incomplete-dominance-and-codominance>

<http://download.nos.org/srsec314newE/PDFBIO.EL21.pdf>

## **ZOO 203L Cell Biology, Molecular Biology, Histology and Genetics Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### **Learning Outcomes:**

On completion of the course, students will be able to:

- Learn the preparation of buffers and different concentration solutions.
  - Demonstrate the practical skills of various biochemical tests of carbohydrates, proteins and lipids.
  - Carry out enzyme assay and salt precipitation of protein from moong seeds.
  - Develop competency in the genetic problems.
1. Preparation of normal and molar solutions.
  2. Preparation of buffers.
  3. Tests for carbohydrates:
    - (i) Molisch's test for general carbohydrates

- (ii) Benedict's test and Fehling's test for reducing sugars (glucose, maltose, lactose)
  - (iii) Tollen's phloroglucinol test for galactose
  - (iv) Tests for non reducing sugar (sucrose)
  - (v) Barfoed's test for monosacharides
  - (vi) Seliwanoff's test for ketoses (fructose)
  - (vii) Iodine tests for polysaccharides-starch and glycogen
4. Tests for proteins:
- (i) Biuret's test
  - (ii) Million's test
  - (iii) Xanthoproteic test
  - (iv) Ninhydrin test
  - (v) Sakaguchi test
  - (vi) Fohl's test (sulfur test)
5. Test for lipids:
- (i) Sudan IV test
  - (ii) Emulsion test
  - (iii) Saponification test
6. To prepare standard curve of ammonium sulfate.
7. Preparation of enzyme extract from mung seeds and measurement of asparaginase activity.
8. Purification of an enzymatic protein by salt precipitation.
9. Demonstration of salivary amylase activity.
10. Acetocarmine preparation from the material available and identifying mitotic or meiotic stages.
11. Study of permanent slides:
12. Study of the prepared slides of nucleic acids proteins and mucopolysaccharides.
13. Study of salivary gland, lampbrush and polytene chromosomes.
14. Genetic problem (Linkage and crossing over).

#### **Suggested Books:**

- Boya, R.F. (2006). *Modern Experimental Biochemistry* (3<sup>rd</sup> ed.). Noida: Pearson Education.



- Deb, A.C. (2013). *Comprehensible Viva & Practical Biochemistry* (2<sup>nd</sup>ed.). Kolkata: New Central Book Agency.
- Kumar, A., Grg, S. & Garg, N. (2017). *Biochemical Tests: Principles & Protocols*. New Delhi: Viva Books.
- Rao, B.S. & Deshpande, V. (2012). *Experimental Biochemistry*. New Delhi: I.K. International Publisher.
- Sadasivam, S. & Manickam, A. (1996). *Biochemical Methods* (2<sup>nd</sup>ed.). New Delhi: New Age International Publishers.
- Sharma, S. (2007). *Experiments and Techniques in Biochemistry* (1<sup>st</sup>ed.). New Delhi: Galgotia Publication

## ZOOLOGY

### Fourth Semester

#### ZOO 202 Comparative Anatomy and Embryology of Chordates

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Understand the comparative anatomy of various organ systems with special reference to *Scoliodon*, *Rana*, *Uromastix*, *Columba* and *Oryctolagus*.
- Gain the fundamental knowledge about the development of frog, Hen's egg and chick to understand the principles of developmental biology.
- Gain an elementary idea about reproductive biology.

#### **Unit 1**

Comparative anatomy with special reference to *Scoliodon*, *Rana*, *Uromastix*, *Columba* and *Oryctolagus*:

- Integumentary system: Skin and its derivatives.
- Skeleton System: Development of chondrocranium and Vertebra; Jaw suspension.
- Digestive system: Alimentary canal and associated glands.

**Unit 2**

Comparative anatomy with special reference to *Scoliodon*, *Rana*, *Uromastix*, *Columba* and *Oryctolagus*:

- Respiratory system: Respiratory organs.
- Circulatory system: Evolution of heart and aortic arches.
- Urinogenital system: Evolution of kidney and Urinogenital ducts.

**Unit 3**

Comparative anatomy with special reference to *Scoliodon*, *Rana*, *Uromastix*, *Columba* and *Oryctolagus*:

- Nervous system: Brain and Spinal Cord.
- Eye.
- Ear.

**Unit 4**

- Elementary idea about the formation of egg and sperm.
- Fertilization, parthenogenesis, induction and regeneration.
- Development of Frog upto the end of neurulation, Tadpole larva and its metamorphosis.

**Unit 5**

- Detailed structure of Hen's egg and its development upto 4th somite stage.
- Structure, development and functions of extra embryonic membranes in chick.
- Definition of placenta, types and functions of mammalian placenta.

**Suggested Books:**

- Balinsky, B.I. (2012). *An Introduction to Embryology* (5<sup>th</sup>ed.). New Delhi: Cengage Learning India.
- Chaki, K.K., Kundu, G. & Sarkar, S. (2016). *Introduction to General Zoology* Vol-II. Kolkata: New Central Book Agency.
- Dhama P.S. & Dhama, J.K. (2015). *Chordate Zoology*. New Delhi: R. Chand and Co.
- Jain, P.C. (2013). *Elements of Developmental Biology* (Chordate Embryology) (7<sup>th</sup>ed.). New Delhi: Vishal Publishing Co.

- Kardong, K.V. (2011). *Vertebrates: Comparative Anatomy, Function, Evolution* (6<sup>th</sup>ed.). McGraw-Hill Education.
- Kent, G. C. & Carr, R. K. (2000). *Comparative Anatomy of the Vertebrates* (9<sup>th</sup>ed.). Europe: McGraw-Hill Science.
- Kotpal, R.L. (2018). *Modern Text book of Zoology: Vertebrates* (4<sup>th</sup> ed.). Meerut: Rastogi Publications.
- Kotpal, R.L., Sastry, K.V. & Shukla, V. (2017). *Comparative Anatomy & Developmental Biology*. Meerut: Rastogi Publication.
- Lahiri, B.K. (2014). *College Zoology Vol-II*. Mumbai: Himalaya Publishing House.
- Prasad, S.N. & Kashyap, V. (2010). *A text book of Vertebrate Zoology* (14<sup>th</sup>ed.). New Delhi: New Age International (P) Limited.
- Sastry, K.V. & Shukla, V. (2017). *Developmental Biology*. Meerut: Rastogi Publications.
- Saxena, R.K. & Saxena, S. (2016). *Comparative Anatomy of Vertebrates* (2<sup>nd</sup>ed.). Viva Books Private Limited.
- Srivastava, M.L. (1985). *An Introduction to the Comparative Anatomy of Vertebrates*. Allahabad: Central Book Depot.
- Verma, P.S. & Agrawal, V.K. (2017). *Chordate Embryology: Developmental Biology*. New Delhi: S Chand.

### **Suggested e-Resources:**

- **Comparative anatomy**  
<http://www.iaszoology.com/category/comparative-anatomy/>
- **Chick development**  
<http://www.notesonzooology.com/vertebrates/chick/development-of-chick-with-diagram-vertebrates-chordata-zoology/8645>  
[http://www.macollege.in/app/webroot/uploads/department\\_materials/doc\\_139.pdf](http://www.macollege.in/app/webroot/uploads/department_materials/doc_139.pdf)
- **Developmental biology**  
<https://www.shomusbiology.com/developmental-biology.html>
- **Frog development**  
<http://www.notesonzooology.com/frog/development-of-frog-with-diagram-vertebrates-chordata-zoology/8626>

## ZOO 202L Comparative Anatomy and Embryology of Chordates Lab

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

### Learning Outcomes:

On completion of the course, students will be able to:

- Identify higher chordate animals based on the external features.
  - Identify and distinguish bones of *Rana*, *Varanus*, Fowl and *Oryctolagus*.
  - Understand histology of organs and endocrine glands through microscopic study of slides.
  - Understand the development of frog and chick through microscopic slides.
1. Permanent mountings:
    - i. Placoid and ctenoid scales
    - ii. Cartilage and striated muscle fibres of amphibian.
    - iii. Filoplumes.
    - iv. Blood film of mammal.
  2. Osteology: A comparative study of articulated and disarticulated bones of *Rana*, *Varanus*, Fowl and *Oryctolagus*.
  3. Comparative study of microscopic slides with special reference to amphibian and mammal:
    - i. V.S. of skin, oesophagus, stomach, intestine, liver, pancreas, lung, kidney, testis, ovary, spinal cord.
    - ii. T.S. of endocrine glands of a mammal (pituitary, thyroid, parathyroid, adrenal).
  4. Study of museum specimens:
    - i. Cyclostomata: Amnocoete larva, *Petromyzon*, *Myxine* and *Bdellostoma*.
    - ii. Pisces: *Sphyrna*, *Torpedo*, *Pristis*, Stingray, *Chimaera*, *Acipensor*, *Amia*, *Labeo*, *Wallago*, *Saccobranclus*, *Anguilla*, *Exocoetus*, *Belone*, *Hippocampus*, *Syngnathus*, *Echeries*, *Porcupine* and *Protopterus*.

- iii. Amphibia: *Ichthyophis*, *Ambystoma*, Axolotal larva, *Salamandra*, *Necturus*, *Siren*, *Alytes*, *Pipa*, *Hyla* and *Rhacophorus*.
  - iv. Reptilia: *Chelone*, Turtle, *Testudo*, *Sphenodon*, *Phrynosoma*, *Chaemeleon*, *Calotes*, *Hemidactylus*, *Draco*, *Hydrophis*, *Eryx*, *Python*, *Naja*, *Viper*, *Bungarus* and *Crocodilus*.
  - v. Aves: *Archaeopteryx*, *Psittacula*, *Passer*, *Columba* and *Pavo*.
  - vi. Mammalia: *Ornithorynchus*, *Tachyglossus*, *Pteropus*, *Funambulus*, *Hedgehog*, Mongoose and *Oryctolagus*.
5. Development of Chordates:
- i. Study of the development and metamorphosis of frog with the aid of permanent prepared slides.
  - ii. W.M. of primitive steak, head folds, 18hrs, 24hrs and 33hrs of chick embryo, T.S. of chick embryo through various regions upto 4th somite state with aid of permanent prepared slides.

#### **Suggested Books:**

- Ghose, K. & Manna, B. (2016). *Practical Zoology* (4<sup>th</sup>ed.). Kolkata: New Central Book Agency.
- Lal, S.S. (2015). *Practical Zoology: Vertebrates* (11<sup>th</sup>ed.). Meerut: Rastogi Publication.
- Poddar, T., Mukhopadhyay, S. & Das, S.K. (2003). *An advanced Laboratory Manual of Zoology*. Kolkata: Macmillan India Limited.
- Verma, P.S. (2010). *A Manual of Practical Zoology: Chordates* (11<sup>th</sup>ed.). New Delhi: S Chand Publishing.

# V Semester and VI Semester

## Discipline Elective

## ZOOLOGY

### ZOO 301 Animal Physiology

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Gain basic understanding of structure and functions of each physiological system of human.
- Describe principles and pathway of metabolism of carbohydrate, protein and lipids.
- Develop an understanding about principles of human anatomy and physiology.

#### **Unit 1**

- Physiology of Digestion: Various kinds of digestive enzymes (carbohydrases, proteinases and lipases) and their digestive action to corresponding food stuffs in the alimentary canal of mammals; hormonal control of digestive functions; mechanism of absorption of various end-products of digestion and other materials such as vitamins, minerals and trace elements.
- Physiology of respiration in mammals: Mechanism and control of breathing; transport of oxygen and carbon dioxide; oxygen dissociation curves of hemoglobin, Bohr effect, chloride shift, Haldane effect, lung volumes and capacities, regulation of respiration, respiration at cellular level.

#### **Unit 2**

- Metabolism: (structure formula of metabolites not essential) Carbohydrate metabolism oxidation of glucose (glycolysis); Embden–Meyerhof-Parnas pathway, tricarboxylic acid cycle and oxidative phosphorylation, shuttle mechanisms (malate-aspartate and glycerol-phosphate), glycogenolysis and glycogenesis; gluconeogenesis and the role of dicarboxylic acid shuttle, role of insulin and glucagons on carbohydrate metabolism.

- Protein metabolism: Essential and non-essential amino-acids, oxidative deamination, transamination and decarboxylation of amino acids, fate of glucogenic and ketogenic amino acids, role of hormones in protein metabolism.
- Fat metabolism: Oxidation of fatty acids ( $\beta$ -oxidation), glycerol, and unsaturated fatty acids; fate of Acetyl CoA; synthesis of fatty acids & lipids; role of hormones in fat metabolism.

### Unit 3

- Physiology of excretion: Kinds of nitrogenous excretory products, structure of kidney, role of liver in the formation of urea; composition and formation of urine; role of hormones in urine formation; micturition.
- Physiology of vascular system: Composition and functions of blood; lymph & lymphatic system; blood groups, Rh factor; platelet plug formation; blood clotting mechanism and its significance; structure and functions of hemoglobin. Blood pressure & its regulation; origin, conduction and regulation of heart beat; nervous and hormonal regulation of heart beat; cardiac cycle.

### Unit 4

- Physiology of muscle contraction: Functional architecture of smooth, skeletal and cardiac muscles; mechanism of muscle contractions (skeletal muscle). Fuel for muscle contraction, mechanical properties of muscle: simple muscle twitch; wave summation, tetanus and muscle fatigue.
- Physiology of nerve impulse and reflex action: Functional architecture and classification of neuron; nature, origin and propagation of nerve impulse along a neuron (myelinated and unmyelinated), synapse; reflex arc, reflex action and its central control.

### Unit 5

- Physiology of endocrine glands: Structure and functions of hypothalamus; pituitary; thyroid; parathyroid; adrenal and pancreas.
- An elementary idea about neuro-secretion.

- Physiology of reproduction: Structure and physiology of human male and female reproductive system; spermatogenesis and oogenesis; reproductive cycles- estrous and menstrual cycle.
- Hormonal regulation of ovulation, fertilization, implantation, abortion, gestation, parturition and lactation.

### **Suggested Books:**

- Chatterjee, C.C. (2005). *Human Physiology* Vol-II (11<sup>th</sup>ed.).
- Chatterjee, C.C. (2018). *Human Physiology* Vol-I (12<sup>th</sup>ed.). New Delhi: CBS Publishers & Distributors.
- Guyton, A.C. & Hall, J.E. (2015). *Textbook of Medical Physiology* (13<sup>th</sup>ed.). USA: Saunders.
- Jurd, R.D. (2003). *Instant notes in Animal Biology*. New Delhi: Viva Books Pvt. Ltd.
- Kumar, N. (2016). *Animal Physiology*. Jaipur: RSBA Publishers.
- Pandey, K. & Shukla, J.P. (2005). *Regulatory Mechanism in Vertebrates*. Meerut: Rastogi Publications.
- Randall, D., Burggren, W., & French, K. (2001). *Eckert Animal Physiology* (5<sup>th</sup>ed.). W. H. Freeman.
- Roy, R.N. (2018). *Textbook of Physiology: with Biochemistry & Biophysics* Vol-I. Kolkata: New Central Book Agency.
- Tortora, G.J. & Grabowski. (2003). *Principles of Anatomy & Physiology* (10<sup>th</sup>ed.). New Jersey, USA: John Wiley & Sons.
- Verma, P.S., Tyagi, B.S. & Agarwal, V.K. (2000). *Animal Physiology*. New Delhi: S. Chand publisher.

### **Suggested e-Resources:**

- **Digestive system**  
<https://www2.estrellamountain.edu/faculty/farabee/biobk/BioBookDIGEST.html>
- **Unsaturated fatty acid oxidation**  
<https://pharmaxchange.info/2013/10/oxidation-of-unsaturated-fatty-acids/>
- **Urine formation**  
<http://medschool.slu.edu/gpbs/syllabus/2008/renal2/Kidney%20Lecture-2%20Core%202008.pdf>



➤ **Muscles**

<http://www.onlinebiologynotes.com/muscular-tissue-skeletal-smooth-cardiac-muscle/>

➤ **Endocrine glands**

<http://what-when-how.com/nursing/the-endocrine-system-structure-and-function-nursing-part-1/>

➤ **Physiological systems**

<https://nptel.ac.in/courses/102104042/>

<https://nptel.ac.in/courses/122103039/18>

## **ZOO 301L Animal Physiology Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
0	0	4	2

**Learning Outcomes:**

On completion of the course, students will be able to:

- Gain hands on experience in hematological tests such as counting of RBCs, WBCs, preparation of haemin crystals, determination of blood haemoglobin, calcium, cholesterol, sugar, protein, clotting time.
  - Demonstrate the skills of pathological analysis of urine through the detection glucose and albumin.
1. To prepare Haemin Crystals.
  2. Estimation of Haemoglobin percentage by Haemometer.
  3. Enumeration of the total number of red blood corpuscles (R.B.C.)
  4. Enumeration of the total number for white blood corpuscles (W.B.C.)
  5. Determination of ABO blood groups and Rh factor.
  6. Study of effect of isotonic, hypotonic and hypertonic solutions on R.B.C.
  7. Determination of the presence of sugar and albumin in the urine sample.
  8. Determination of blood sugar content.
  9. Estimation of total protein from blood.
  10. Estimation of total calcium from blood.

11. Estimation of total cholesterol from blood.

12. Determination of the clotting time of blood.

### **Suggested Books:**

- Poddar, T., Mukhopadhyay, S. & Das, S.K. (2003). *An advanced Laboratory Manual of Zoology*. Kolkata: Macmillan India Limited.
- Sharma, S. (2007). *Experiments and Techniques in Biochemistry* (1<sup>st</sup>ed.). New Delhi: Galgotia Publication.
- Sharma, S. & Sharma, R. (2016). *Practical Manual of Biochemistry* (2<sup>nd</sup>ed.). New Delhi: Medtech.
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## **ZOO 305 Environmental Biology and Biostatistics**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

### **Learning Outcomes:**

On completion of the course, students will be able to:

- Understand the physical and biological characters of the environment and the interrelationship between biotic and abiotic components of nature as well as relationship among the individuals of the biotic components.
- Realize the importance of ecosystem and biodiversity for maintaining ecological balance.
- Understand the basic principles of population and community ecology.
- Understand the fundamental principles of biostatistics and its role in the data analysis generated by scientific research.

### **Unit 1**

- Terminology and scope of ecology.
- Environment:
  - i. Biosphere -Lithosphere, hydrosphere and atmosphere.
  - ii. Physical factors-with special reference to temperature, light and water.
  - iii. Biotic factors -Intra and inter specific relationship among animals.

- iv. Principles of limiting factors-Leibig's law of minimum, Shelford's law of tolerance, combined concept of limiting factors.
- Biogeochemical cycles: Carbon, oxygen, nitrogen and phosphorus cycles.

## **Unit 2**

- Ecosystem ecology: Structure and dynamics of the ecosystem including food chain, food webs trophic levels, productivity and energetics.
- Fresh water ecosystem: Physiochemical factors, biotic communities and lake eutrophication.
- Marine ecosystem: Zonation factors and biotic communities of deep sea only.
- Terrestrial ecosystem: Salient features of grass land, forest and desert ecosystem.

## **Unit 3**

- Population ecology:
  - i. Definition and attributes of animal population: Population density and its measurement, natality, mortality, growth form, age distribution, age pyramids, sex ratio, dispersal and dispersion.
  - ii. Regulation of population density: Population fluctuations and interactions.
- Community ecology:
  - i. Definition of types of communities (micro and macro communities).
  - ii. Community dominance and species diversity.
  - iii. Ecotone, edge effect and ecological niche.
  - iv. Succession and climax.

## **Unit 4**

- Applied ecology:
  - i. Conservation of natural resources.
  - ii. Wild life management.
  - iii. National parks and wild life sanctuaries in India.
  - iv. Extinction in animals.
  - v. Zoogeographical regions of the world along with the boundaries and fauna.

## Unit 5

- Biostatistics:
  - i. Introduction, scope and applications.
  - ii. Sampling, data collection and presentation.
  - iii. Types of data, methods of collection of primary and secondary data, data presentation-Histogram, polygon, bar diagram, pie diagram.
  - iv. Frequency distribution. Measures of central tendency-Mean, median, mode.
  - v. Measures of variability-Standard deviation, standard error.

### Suggested Books:

- Alllee W.C., Emerson, A.E., Park, O., Parl, T. & Schmidt, K.P. (1967). *Principles of Animal Ecology*. USA: W.B. Saunders Company.
- Banerjee, P.K. (2007). *Introduction to Biostatistics* (3<sup>rd</sup>ed.). New Delhi: S Chand and company Pvt. Ltd.
- Bhuyan, K.C. (2017). *Advanced Biostatistics*. Kolkata: New Central Book Agency.
- Chaudhary, B.L. & Pandey, J. (2007). *Fundamentals of Ecology & Environment*. Jaipur: Apex Publishing House.
- Clarke, G.L. (1965). *Elements of Ecology*. New Jersey: John Wiley & Sons Inc.
- Datta, A.K. (2014). *Basic Biostatistics and Application*. Kolkata: New Central Book Agency.
- Hillary, E. (1984). *Ecology 2000: The Changing Face of Earth*. Michael Joseph Ltd.
- Kendeigh, S.C. (1974). *Ecology with special reference to animal and man*. New Jersey: Prentice Hall.
- Krebs, C.J. (2001). *Ecology* (5<sup>th</sup>ed.). San Francisco, USA: Benjamin Cummings.
- Kumar, A. (2015). *Biodiversity & Conservation*. New Delhi: APH Publishing Corporation.
- Miller, G.T. (2004). *Environmental Science: Working with the Earth* (10<sup>th</sup> ed.). Singapore: Thomson Asia.
- Misra, S.P. & Pandey, S.N. (2016). *Essentials of Environmental Sciences* (4<sup>th</sup>ed.). New Delhi: Ane Books Pvt. Ltd.
- Odum, E.P. (1965). *Ecology*, New Delhi: Amerind Publishing.

- Pandey, M. (2015). *Biostatistics: Basic and Advanced*. New Delhi: MV Learning.
- Saxena, M.M. (1990). *Environmental Analysis*: Bikaner: Agro Botanical.
- Sharma, P.D. (2011). *Ecology and Environment*. Meerut: Rastogi Publication.
- Singh, S.P. (2005.). *Animal Ecology*. Meerut: Rastogi Publications.
- Tripathi, G. (2002). *Modern Trends in Environmental Biology*. New Delhi: CBS Publishers & Distributors.

#### **Suggested e-Resources:**

- **Aquatic ecology**  
<https://nptel.ac.in/courses/120108002/>
- **Ecosystem**  
<https://nptel.ac.in/courses/122103039/38>
- **Biostatistics**  
<https://nptel.ac.in/courses/102101056/>
- **Measures of central tendency**  
[https://www.tutorialspoint.com/statistics/arithmetic\\_mean.htm](https://www.tutorialspoint.com/statistics/arithmetic_mean.htm)
- **Population characteristics**  
<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.534.5462&rep=rep1&type=pdf>

### **ZOO 305L Environmental Biology and Biostatistics Lab**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**0 0 4 2**

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Demonstrate skills in the quality assessment of water through testing of water for CO<sub>2</sub>, O<sub>2</sub>, chloride and hardness.
- Gain an understanding of parasitic, aquatic, desert and aerial adaptations of animals with the help of charts and specimens.
- Describe symbiosis, commensalism and socialization among organisms with the help of charts and specimens.
- Understand analysis of data by solving biostatistical problems.

1. To find the depth and visibility in a pond by Sachi disc method.
2. To determine the pH of water sample.
3. To determine the content of dissolved oxygen in the water sample.
4. To determine the chemical oxygen demand in the water sample.
5. To determine free CO<sub>2</sub> content in the water sample.
6. To determine the chloride content of the water sample.
7. To determine the total hardness of water.
8. To study the effect of environmental stimulation on *Paramecium*.
9. To study parasitic, desert, aquatic and aerial adaptations in animals:
  - i. Parasite: *Hirudinaria*, *Taenia*, *Ascaris*, *Schistosoma*, *Fasciola*, *Pediculus*.
  - ii. Desert: *Phrynosoma*, *Uromastix*, Camel, *Heloderma*, Rattle snake, Golden mole.
  - iii. Aquatic: *Pleuronectus*, *Exocoetus*, Turtle, *Hippocampus*, Dolphin, *Hydrophis*, Duck, Crocodile.
  - iv. Aerial: Any bird, *Draco*, bat.
10. To study different types of associations existing among living organisms.
  - i. Symbiosis: *Chlorohydra*, termite and aphid.
  - ii. Commensalism: Harmit-crab, sea anemone and gastropod shell, *Euplectella* and shrimps.
  - iii. Socialization: Ants, termites and honey bees.
11. Draw a map of world and identify the Zoogeographical regions of the world along with their major fauna.
12. Biostatistics exercise-mean, median, mode, standard deviation and standard error.
13. Report on any current topic related to environmental biology.

#### **Suggested books:**

- Lal, S.S. (2015). *Practical Zoology: Invertebrates* (11<sup>th</sup>ed.). Meerut: Rastogi Publication.
- Lal, S.S. (2015). *Practical Zoology: Vertebrates* (11<sup>th</sup>ed.). Meerut: Rastogi Publication.
- Lal, S.S. (2016). *A Textbook of Practical Zoology Vol-III* (2<sup>nd</sup>ed.). Meerut: Rastogi Publication.

- Poddar, T., Mukhopadhyay, S. & Das, S.K. (2003). *An advanced Laboratory Manual of Zoology*. Kolkata: Macmillan India Limited.
- Verma, P.S. (2010). *A Manual of Practical Zoology: Chordates* (11<sup>th</sup>ed.). New Delhi: S Chand Publishing.

## **ZOO 304 Developmental Biology**

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

**L T P C**

**6 0 0 6**

### **Learning Outcomes:**

On completion of the course, students will be able to:

- Gain expertise in explaining how a variety of interacting processes generate an organism's heterogeneous shapes, size and structural features that arise on the trajectory from embryo to adult or more generally throughout a life cycle.
- Gain an understanding of systematic and organized learning about the knowledge and concepts of growth and development of organisms.
- Demonstrate a rich array of material and conceptual practices that could be analysed to better understand the scientific reasoning exhibited in experimental life sciences.

### **Unit 1** Introduction to developmental biology

- History, scope and applications of developmental biology.
- Basic concepts: Phases of development, cell-cell interaction, pattern formation, differentiation and growth, differential gene expression, cytoplasmic determinants and asymmetric cell division.
- Gametogenesis: spermatogenesis and oogenesis. Polarity and gradients.
- Fertilization: Types, mechanism and theories.

### **Unit 2** Early embryonic development

- Cleavage: Definition, planes and patterns of cleavage, classification of cleavage based on distribution and amount of yolk.
- Morulation, blastulation and gastrulation in ambhibia and birds.

- Morphogenetic movements, embryonic induction and competence, primary organizers.

### **Unit 3** Late embryonic development

- Differentiation of germinal layers.
- Method of organ formation: an overview of neural tube formation, types of mesoderm, somite formation, endoderm and its derivatives in amphibians and birds.
- Extra-embryonic membranes in birds, their development and functions.
- Paedogenesis and neoteny in amphibians.

### **Unit 4** Post embryonic development

- Metamorphic events and its hormonal regulations in amphibians.
- Regeneration: types, regeneration of limbs in salamanders, regeneration of lost tail in lizard.
- Introduction to senescence and apoptosis.

### **Unit 5** Implications of developmental biology

- Teratogenesis: Teratogenic agents and their effects on embryonic development.
- Embryonic stem cells and their applications.
- Cloning of animals: Nuclear transfer technique and embryo transfer technique.
- *In vitro* fertilization, artificial insemination in cattle, amniocentesis.

### **Suggested Books**

- Balinsky, B.I. & Fabian, B.C. (1981). *An Introduction to Embryology* (5<sup>th</sup>ed.). International Thompson Computer Press.
- Carlson, B.M. (1999). *Patten's foundations in embryology*. (6<sup>th</sup>ed.). New York, USA: McGraw Hill.
- Chattopadhyay, S. (2017). *An introduction to developmental Biology*. Kolkata, India: Books and Allied.
- Gilbert, S.F. (2010). *Developmental Biology* (9<sup>th</sup>ed.). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Kalthoff (2008). *Analysis of Biological Development* (2<sup>nd</sup>ed.). McGraw-Hill Publishers.



- Lewis, Wolpert (2002). *Principles of Development* (2<sup>nd</sup>ed.). Oxford University Press.
- Rastogi, V.B. & Jayaraj, M.S. (2005). *Developmental Biology (A Text book of embryology)*. Kedar Nath Ram Nath Publisher, Meerut.

#### **Suggested e-Resources:**

- Developmental Biology  
[https://nptel.ac.in/courses/nptel\\_download.php?subjectid=102101068](https://nptel.ac.in/courses/nptel_download.php?subjectid=102101068)  
<http://cmb.i-learn.unito.it/mod/book/tool/print/index.php?id=3288>

### **ZOO 304L Developmental Biology Lab**

**Max. Marks : 100**  
**(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

#### **Learning Outcomes:**

On completion of the course, students will be able to:

- Understand the different stages of development of frog and chick through microscopic slides.
  - Understand the development and life cycle of *Drosophila* through microscopic slides.
1. Study of whole mounts and sections of developmental stages of frog through permanent slides/charts/models: Eggs, 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/charts/models: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages).
  3. Study of the developmental stages and life cycle of *Drosophila* with the help of chart/specimen/models.

#### **Suggested Books**

- Lal, S.S. (2015). *Practical Zoology: Vertebrates* (11<sup>th</sup>ed.). Meerut: Rastogi Publication.
- Verma, P.S. (2010). *A Manual of Practical Zoology: Chordates* (11<sup>th</sup>ed.). New Delhi: S Chand Publishing.

## ZOO 303 Applied Zoology

**Max. Marks : 100**

**(CA: 40 + ESA: 60)**

L	T	P	C
6	0	0	6

### Learning Outcomes:

On completion of the course, students will be able to:

- Explore the important of earthworms in agro-ecosystems and utilize gained knowledge for production of vermicompost in small scale for garden/household plant.
- Demonstrate their knowledge for setting up poultry farm, sericulture, apiculture, lac culture plant.
- Understand biology, life cycle and control measures of crop pests, stored grain pests and insects serve as vectors for human diseases.

### Unit-1

- Parasitic protozoans: Life history and pathogenicity of *Entamoeba histolytica*, *Plasmodium vivax*, *Giardia*, *Leishmania* and *Trypanosoma gambiense*.
- Parasitic helminthes: Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*.

### Unit-2

- Insects of agriculture importance: Biology, control and damage caused by crop pests (*Helicoverpa armigera*, *Pyrilla perpusilla*, *Papilio demoleus*) and stored grain pests (*Callosobruchus chinensis*, *Sitophilus oryzae* and *Tribolium castaneum*).
- Insects of medical importance and their control: *Pediculus humanus corporis*, *Anopheles*, *Culex*, *Aedes*, *Xenopsylla cheopis*.

### Unit 3

- Apiculture: Different species of honey bees, pollen calendar, bee keeping and management practices, honey extraction techniques, bee products, pests of honey bees and their control.
- Sericulture: Different silkworm species and their host plants, silkworm rearing and management practices, pests of silkworms and their control.
- Lac culture: Lac insect, culture practices, pests of lac insect and their control.

## Unit 4

- Aquaculture: Types of fishery: Marine, inland. Composite fish culture, induced breeding and hybridization. Transportation of fish seed. Fish diseases and their control.
- Prawn culture: Culture practices of giant fresh water prawn (*Macrobrachium rosenbergii*), biology and life history.
- Pearl culture, pearl formation, composition, colour, size and quality of pearl.

## Unit 5

- Vermiculture: Definition, scope and importance, culture methods: indoors and out door, monoculture and polyculture, vermicomposting.
- Poultry farming: Principles of poultry breeding, management of breeding stock and broilers, processing and preservation of eggs, diseases of poultry and their control.
- Animal husbandry: Preservation and artificial insemination in cattle, induction of early puberty and synchronization of estrus in cattle.

## Suggested Books:

- Arora, D.R & Arora, B. (2001). *Medical Parasitology* (2<sup>nd</sup> ed.). CBS Publications and Distributors.
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
- Dennis, H. (2009). *Agricultural Entomology*. Timber Press (OR).
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approaches*. CABI publications, U.K.
- Hafez, E.S.E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher.
- Kumar and Corton. *Pathological Basis of Diseases*.
- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.
- Sarkar, S., Kundu, G. & Chaki, K.K. (2014). *Introduction to Economic Zoology*. Kolkata: New Central Book Agency (P) Ltd.
- Shukla & Upadhyaya (1999-2000). *Economic Zoology*. Meerut: Rastogi Publishers.
- Venkitaraman (1983). *Economic Zoology*. Sudarsana Publishers.

**Suggested e-Resources:****➤ Sericulture**

<https://swayam.gov.in/courses/152-silkworm-crop-protection>

**ZOO 303L Applied Zoology Lab****Max. Marks : 100****(CA: 40 + ESA: 60)**

<b>L</b>	<b>T</b>	<b>P</b>	<b>C</b>
<b>0</b>	<b>0</b>	<b>4</b>	<b>2</b>

**Learning Outcomes:**

On completion of the course, the students will be able to:

- Understand the life cycle of protozoan and helminthes parasites through microscopic slides.
  - Explore the knowledge of life cycle of honey bees, silk moths and lac insects for setting up apiculture, sericulture and lac culture farm.
  - Gain an understanding of biology, life cycle and control of stored grain pests, crop pests and insect of medical importance.
1. Study of life cycle of *Plasmodium vivax*, *Entamoeba histolytica*, *Giardia*, *Leishmania*, *Trypanosoma gambiense*, *Ancylostoma duodenale* and *Wuchereria bancrofti* through permanent slides/photomicrographs or specimens.
  2. Study of different types of bees (Queens, drones and worker bees) permanent slides/photomicrographs or specimens.
  3. Study of different types of silk moths (*Bombyx*, *Samia* and *Antheraea*) through permanent slides/photomicrographs or specimens.
  4. Study of *Tachardia lacca* through permanent slides/photomicrographs or specimens.
  5. Study of different types of pearls through photomicrographs or specimens.
  6. Study of arthropod vectors associated with human diseases: *Pediculus*, *Culex*, *Anopheles*, *Aedes* and *Xenopsylla* through permanent slides/photomicrographs or specimens.
  7. Study of some stored grains insect pests through damaged products/photographs.
  8. Identifying feature and economic importance of *Helicoverpa (Heliothis) armigera*, *Papilio demoleus*, *Pyrilla perpusilla* and *Callosobruchus chinensis*.
  9. Aquarium design and maintenance.