BANASTHALI VIDYAPITH

Bachelor of Science and Bachelor of Education

Curriculum Structure

First Semester Examination, December, 2020
Second Semester Examination, April/May, 2021
Third Semester Examination, December, 2021
Fourth Semester Examination, April/May, 2022
Fifth Semester Examination, December, 2022
Sixth Semester Examination, April/May, 2023
Seventh Semester Examination, December, 2023
Eighth Semester Examination, April/May, 2024

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

July, 2020

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

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

New Delhi, the 25th October, 1983

N O T I F I C A T I O N

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

N O T I C E

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.

CONTENTS

Programme Educational Objectives

Department of Education aims to develop human resource in terms of effective School Teachers, Educational Researchers, Teacher Educators and Educational Leaders so as to achieve the excellence in teaching, research and innovation with Indian ethos.

acher Education program at Banasthali Vidyapith intends to develop knowledge of Teaching Learning Process, competencies to transfer the knowledge, development of skills, organization and management of school system as well as to develop subject content and curriculum and maintain professional ethics and attitude towards Teaching as a 'noble profession'.

Department of Education purports to provide comprehensive inputs which are aimed;

* To study the education as a discipline.
* To prepare competent and enlightened teachers for different levels of education in India.
* To develop responsive, reflective and responsible teachers, educational administrators, researchers and academicians who will be able to work in collaboration with parents and community.
* To develop an understanding of focal concerns of education such as language diversity, inclusive education, gender-neutral attitude and education for sustainable development and global citizenship.
* To prepare teachers having an understanding of interact and instruct in class in the context of school organization and school education system at local and global level.
* Develop a sensitivity and appreciation amongst professionals about the larger societal context in which school education operates, the linkages, mutual pressure and influences of other sub systems.
* To provide a deep understanding of educational research and be competent to carry out independent need based quality field researches.
* To create digital competency amongst professionals in order to enhance their teaching, research, innovation and administration.
* To prepare effective teachers by integrating the academic studies with professional understanding, competencies and reflective visions.

* To nurture a temperament in the professionals to work toward self-driven performance goals, entrepreneurship and academic leadership for a noble mission 'Teaching'.
* To increase the sensitivity of professional ethics, code of conduct, social cultural values, human dignity and humanness.

Programme Outcomes

Program Specific Outcomes of Four Year Integrated Program.

Students will be able to-

PO 1: able to integrate theoretical and practical knowledge of their respective subject in classroom practice.

PO-2: apply their knowledge of core content and pedagogy to set goals and objectives for learning based on Curriculum, and design instruction that engages students in meaningful learning activities.

PO-3: appreciate the diversity of learners and create appropriate learning environment to assure a focus on learning of all students.

PO-4: deliver meaningful learning experiences for all students by integrating their knowledge and applying a variety of communication, instructional, and assessment strategies in their teaching.

PO-5: demonstrate their commitment for continuous self-improvement by engaging in professional development activities and collaborative and reflective practices to improve teaching and learning that contribute to the revitalization of the teaching profession.

PO-6: demonstrate leadership qualities by participating in the curriculum initiatives, student support and school management systems.

PO-7: demonstrate their associations with school, family and community to foster student and community progression.

PO-8: integrate ICT in teaching-learning and assessment process to enrich professional practice.

PO-9: engage in value based and culturally responsive teaching practices.

PO-10: use effective and appropriate verbal, nonverbal, written, and media communication techniques in their teaching, professional collaboration, and interactions with students, colleagues, parents, and the community.

PO-11: demonstrate professional ethics and responsibilities as an educational practitioner.

PO-12: recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of knowledge explosion and technological change.

Curriculum Structure

Bachelor of Science and Bachelor of Education

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
EDU 401	Childhood and Growing Up	5	0	0	5
	Discipline 1 – Course - 1	6	0	4	8
	Discipline 2 – Course - 1	6	0	4	8
	Discipline 3 – Course - 1	6	0	4	8
	Semester Total:	**27**	**0**	**12**	**33**

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
EDU 415	Learning and Teaching	5	0	0	5
	Discipline 1 – Course - 2	6	0	4	8
	Discipline 2 – Course - 2	6	0	4	8
	Discipline 3 – Course - 2	6	0	4	8
	Semester Total:	**27**	**0**	**12**	**33**

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
EDU 503	Contemporary Indian Education	5	0	0	5
	Discipline 1 – Course - 3	6	0	4	8
	Discipline 2 – Course - 3	6	0	4	8
	Discipline 3 – Course - 3	6	0	4	8
	Semester Total:	**27**	**0**	**12**	**33**

Semester - IV

Course Code	Course Name	L	T	P	C*
	Core Foundation Course - IV	2	0	0	2
	Elective Foundation Course - II	2	0	0	2
EDU 413	Knowledge and Curriculum	5	0	0	5
	Discipline 1 – Course - 4	6	0	4	8
	Discipline 2 – Course - 4	6	0	4	8
	Discipline 3 – Course - 4	6	0	4	8
	Semester Total:	**27**	**0**	**12**	**33**

Third Year

Semester - V

Course Code	Course Name	L	T	P	C*
	Vocational Course - I	2	0	0	2
	Core Foundation Course - V/ Elective Foundation Course - III	2	0	0	2
	Discipline Elective (Focal area) - I	4	0	0	4
	Discipline 1 – Course - 5	6	0	4	8
	Discipline 2 – Course - 5	6	0	4	8
	Discipline 3 – Course - 5	6	0	4	8
	Semester Total:	**26**	**0**	**12**	**32**

Semester - VI

Course Code	Course Name	L	T	P	C*
	Vocational Course - II	2	0	0	2
	Elective Foundation Course - III/ Core Foundation Course - V	2	0	0	2
	Discipline Elective (Focal area) - II	4	0	0	4
	Discipline 1 – Course - 6	6	0	4	8
	Discipline 2 – Course - 6	6	0	4	8
	Discipline 3 – Course - 6	6	0	4	8
	Semester Total:	**26**	**0**	**12**	**32**

Fourth Year

Semester - VII

Course Code	Course Name	L	T	P	C*
EDU 502	Assessment for Learning	5	0	0	5
	Discipline Elective (Main Pedagogy)-I	4	0	0	4
	Discipline Elective (Main Pedagogy)-II	4	0	0	4
	Discipline Elective (Subsidiary Pedagogy)	4	0	0	4
	Open Elective	0	0	6	3
EDU 450P	Internship-I: Teaching Practice	0	0	24	12
	Semester Total:	**17**	**0**	**30**	**32**

Semester - VIII

Course Code	Course Name	L	T	P	C
EDU 475P	Internship II*	0	0	48	24
	Reading Elective	0	0	4	2
	Semester Total:	**0**	**0**	**52**	**26**

Disciplinary Courses

Course Code	Course Name	L	T	P	C*
Botany					
Semester – I					
BT 102	Cell and Molecular Biology-I	6	0	0	6
BT 104L	Cell and Molecular Biology-I Lab	0	0	4	2
Semester – II					
BOT 103	Introduction to Genetics and Genetic Engineering	6	0	0	6
BOT 103L	Introduction to Genetics and Genetic Engineering Lab	0	0	4	2
Semester – III					
BOT 204	Algae, Fungi, Bryophyta and Pteridophyta	6	0	0	6
BOT 204L	Algae, Fungi, Bryophyta and Pteridophyta Lab	0	0	4	2

Semester – IV					
BOT 205	Gymnosperms and Angiosperms	6	0	0	6
BOT 205L	Gymnosperms and Angiosperms Lab	0	0	4	2
Semester – V					
	Discipline Elective-I	6	0	0	6
	Discipline Elective-I Lab	0	0	4	2
Semester – VI					
	Discipline Elective-II	6	0	0	6
	Discipline Elective-II Lab	0	0	4	2
Zoology					
Semester – I					
ZOO 105	Biosystematics and Evolution	6	0	0	6
ZOO 105L	Biosystematics 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					
BT 212	Biochemistry	6	0	0	6
BT 212L	Biochemistry 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	0	6
	Discipline Elective-I Lab	0	0	4	2
Semester – VI					
	Discipline Elective-I	6	0	0	6
	Discipline Elective-II Lab	0	0	4	2

List of Discipline Elective- Botany/Zoology

BT 320	Microbiology and Immunology	6	0	0	6
BT 320L	Microbiology and Immunology Lab	0	0	4	2
BT 317	Advances in Biotechnology	6	0	0	6

BT 317L	Advances in Biotechnology Lab	0	0	4	2
BT 318	Genomics and Proteomics	6	0	0	6
BT 318L	Genomics and Proteomics Lab	0	0	4	2
BT 319	Medical Biotechnology	6	0	0	6
BT 319L	Medical Biotechnology Lab	0	0	4	2
BOT 306	Angiosperms: Morphology, Anatomy and Embryology	6	0	0	6
BOT 306L	Angiosperms: Morphology, Anatomy and Embryology Lab	0	0	4	2
BOT 309	Plant Physiology	6	0	0	6
BOT 309L	Plant Physiology Lab	0	0	4	2
BOT 308	Plant Pathology	6	0	0	6
BOT 308L	Plant Pathology Lab	0	0	4	2
BOT 307	Economic Botany and Ethnobotany	6	0	0	6
BOT 307L	Economic Botany and Ethnobotany Lab	0	0	4	2
BOT 305	Horticulture	6	0	0	6
BOT 305L	Horticulture Lab	0	0	4	2
ZOO 306	Animal Physiology	6	0	0	6
ZOO 301L	Animal Physiology Lab	0	0	4	2
ZOO 307	Developmental Biology	6	0	0	6
ZOO 307L	Developmental Biology Lab	0	0	4	2
ZOO 309	Economic and Applied Zoology	6	0	0	6
ZOO 309L	Economic and Applied Zoology Lab	0	0	4	2
ZOO 308	Ecology and Biodiversity	6	0	0	6
ZOO 308L	Ecology and Biodiversity Lab	0	0	4	2

Chemistry					
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
Semester - VI					
	Discipline Elective - II	6	0	4	8
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

Computer Science

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
Semester - VI					
CS 309L	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

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	0	0	4	2

	Maps Lab				
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
Semester - VI					
	Discipline Elective - II	6	0	4	8
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
MATH 313	Multivariable Calculus	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
Semester - VI					
	Discipline Elective - II	6	0	4	8
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

Statistics					
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	6	0	0	6

	Distributions				
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
Semester - VI					
	Discipline Elective - II	6	0	4	8
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

Education					
Discipline Elective (Focal area)					
EDU 414	Language Across the Curriculum	4	0	0	4
EDU 508	Understanding Disciplines and Subjects	4	0	0	4
EDU 504	Gender, School and Society	4	0	0	4
EDU 402	Creating an Inclusive School	4	0	0	4
EDU 405	Educational Guidance and Counseling	4	0	0	4
EDU 406	Educational Technology	4	0	0	4
List of Discipline Elective					
Main Pedagogy					
EDU 438	Pedagogy of General Science – I	4	0	0	4
EDU 442	Pedagogy of Mathematics – I	4	0	0	4
EDU 439	Pedagogy of General Science – II	4	0	0	4
EDU 443	Pedagogy of Mathematics – II	4	0	0	4
Subsidiary Pedagogy					
EDU 416	Pedagogy of Biology	4	0	0	4
EDU 417	Pedagogy of Chemistry	4	0	0	4
EDU 419	Pedagogy of Computer Science	4	0	0	4
EDU 423	Pedagogy of Geography	4	0	0	4
EDU 428	Pedagogy of Mathematics	4	0	0	4
EDU 431	Pedagogy of Physics	4	0	0	4
Enhancing Professional Capacity					
EDU 301L	Reading and Reflecting on Texts	0	0	6	3
EDU 459L	Asthetic Appreciation through Art and Drama	0	0	6	3
EDU 467L	Understanding the Self and Yoga	0	0	6	3
List of Reading Elective					
EDU 461R	Disaster Management Education	0	0	4	2
EDU 468R	Women Education	0	0	4	2
EDU 466R	Peace Education	0	0	4	2

List of Core Foundation Course

Course Code	Course Name	L	T	P	C*
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

Course Code	Course Name	L	T	P	C*
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

Course Code	Course Name	L	T	P	C*
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

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.

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

Aesthetic Education I/II		**Physical Education I/II**	
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
Practical Education I/II		BVFF 213	Hockey
BVFF 301	Banasthali Sewa Dal	BVFF 214	Judo
BVFF 302	Extension Programs for Women Empowerment	BVFF 215	Kabaddi
BVFF 303	FM Radio	BVFF 216	Karate - Do
BVFF 304	Informal Education	BVFF 217	Kho-Kho
BVFF 305	National Service Scheme	BVFF 218	Net Ball
BVFF 306	National Cadet Corps	BVFF 219	Rope Mallakhamb
		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

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

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	40	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:

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

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^{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:

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

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

Internship-I: Comprise Internship-I A and Internship-IB

Internship-I A: This component will comprise:

- Skill based Teaching (SBT) practice of atleast 10 skills based lessons. Evaluation of two lessons of integrated skills will be done for duration of 30 minutes.
- Observation and participation in different school activities such as classroom observation, conduction of Examination, day's celebration, co-curricular activities etc.
- Atleast one week engagement in real class room teaching.
- One criticism lesson related to pedagogy of a school subject.

Internship-I B Atleast three days engagement in real class room teaching. One final Test lesson will be given by each candidate.

In Internship-I A, continuous assessment of each student teacher will include participation & performance on components in respect of:

- The clarity and depth of understanding of pedagogy reflected by the lesson plans prepared.
- The perceptiveness and discernment of school based activities and effectiveness reflected in observation and peer observations.

In Internship-IA, semester assessment will be done by the board in consultation with the Head of Department.

In Internship-IB, The Final Test Lesson of each candidate will be assessed as follows:

1. One lesson in a pedagogical school subject by a board of Examiners.
2. The Board will be constituted by the Vice-Chancellor comprising-
    - Two external experts each from the broad subject specialization viz. –Science education, Social Science education and Language education, so that at least one expert is from student's subject specialization.
    - Head of Department.
3. Final lesson will be assessed of 60 Marks. The marks will be finalized by the Head of the Department in Consultation with other members of the Board.

Project Evaluation Scheme

Duration	Course Code	Course Name	L	T	P	C
1 Semester (5 months) 1 Jan - 31 May	EDU 475P	Internship II*	0	0	48	24

Continuous Assessment (40 Marks)

1. Joining report, brief project outlay	- 10 Marks
2. Synopsis	- 10 Marks
3. Mid-term evaluation by Supervisor	- 10 Marks
4. Further evaluation by Supervisor	- 10 Marks
Total	**- 40 Marks**

End Semester Assessment (60 Marks)

1. Project Report	- 20 marks
2. Presentation	- 20 Marks
3. Viva-voce	- 20 Marks
Total	**- 60 Marks**

*** Internship-II**

School Internship: This programme will comprise the following components:

I. One-week observation of regular classroom and school activities with regular school-teachers.

II. At least 30 lessons in respective teaching subjects at upper primary level to Secondary/Senior Secondary level in regular class.

III. Active participation and organization of school activities such as assembly, Attendance recording, lab/library management, timetable preparation, Co-curricular activities, Parent Teacher Meeting (PTM), Guidance & Counselling programme and Examination programme.

IV. Preparation and conduction of one Unit test for Upper Primary and Secondary level and prepare a Result report.

V. Preparation of two Video Lessons

VI. Preparation of Action Research Report

Every student will submit the following documents and reports related to school internship

Continuous Assessment will be on the overall performance during the internship on the following basis -

1. **Joining report, brief school report and project report outlay - 10 Marks**
   a) Joining report of School
   b) School at a glance report
   c) Problem identification for action research
2. **Project proposal, Video Lesson - 10 Marks**
   a) Proposal of Action research
   b) One Video lesson
3. **Midterm evaluation - 10 Marks**
   a) Progress of Action research
   b) Regularity and Discipline
   c) Involvement and active participation in Various School activities and programmes (Report)
4. **Further evaluation - 10 Marks**

Submission of documents and reports

a) Unit plan, Unit test, Lesson Plan diary
b) One video lesson
c) Action research report

Continuous Semester Assessment will be done of 40 Marks

End Semester Assessment will be done by the board.

1. **School report and project report - 20 Marks**
   a) School at a glance: Detail information about the school and participation and organization of school activities
   b) Unit plan, Unit test, Lesson Plan diary
   c) Two video lessons
   d) Action research report
2. **Presentation - 20 Marks**

Presentation of School internship experiences and Action Research report by the students before the board.

3. **Viva-voce - 20 Marks**
   a) School Internship -
   b) Action Research -

End Semester Assessment will be of 60 Marks

Disciplinary Courses

BOTANY

First Semester

BT 102 Cell and Molecular Biology-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain knowledge in the ultrastructural information of cell besides the detailed views of the cell interior
- understand the complex molecular mechanisms occurring in the cell and regulation of gene expression
- describe types, structural organization and packaging of chromosomes

Unit 1

- General introduction to the science of biotechnology, cell biology, molecular biology and their scope.
- Structural and functional organization of prokaryotic and eukaryotic cell, difference between prokaryotic and eukaryotic cell.
- Molecular structure of cell wall and plasma membrane of eukaryotic cell.
- Ultrastructural organization of cilia, flagella and basal bodies.
- Basic idea of different types of cell junctions.

Unit 2

- Transport across cell membrane: Passive transport (simple & facilitated diffusion) and active transport (primary & secondary).
- An elementary idea of autocrine, paracrine and endocrine signaling.
- Basic concept of receptors (GPCR, receptor tyrosine kinase and intracellular receptors) that mediate the response to extra cellular signals.
- Basic concept of signal transduction (adenylate cyclase pathway and inositol lipid pathway).
- Cell division, cell cycle & its regulation.

Unit 3

- A study of ultrastructural organization and functions of eukaryotic cell organelles:
  - Mitochondria.
  - Chloroplast.
  - Endoplasmic reticulum.
  - Golgi complex.
  - Lysosomes.
  - Peroxisomes.

Unit 4

- Ultrastructural organization of nucleus and nucleolus.
- Structural organization of chromosomes including lampbrush and polytene chromosomes. DNA packaging into chromosomes.
- Types of chromosomes based on number and position of centromere. Karyotype.
- Molecular structure and types of DNA, denaturation and renaturation, Tm value, basic idea of Cot curves.
- Molecular structure and types of RNA.
- DNA replication in prokaryotes and eukaryotes.

Unit 5

- Mechanism of transcription in prokaryotes.
- Mechanism of transcription in eukaryotes, RNA processing.
- Genetic code.
- Mechanism of translation in prokaryotes and eukaryotes.
- Regulation of gene expression in prokaryotes: Lac and Trp operons.

Suggested Books:

- Robertis, D., E.D.P., Robertis, D. E.M.F. (1987). *Cell and Molecular Biology* (8th ed.). USA: Lea & Febiger.
- Gupta, P.K. (2005). *Cell and Molecular Biology*. Meerut: Rastogi Publications.
- Hardin, J., Bertoni, G.P. (2016). *Becker's World of the Cell* (9th ed.). USA: Pearson education.
- Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A., Killian, D. (2018). *Concepts of Genetics* (12th ed.). USA: Pearson.
- Krebs, J.E., Goldstein, E.S., Kilpatrick, S.T. (2012). *Lewin's Genes XI* (11th ed.). USA: Jones and Bartlett Publishers.

- Lodish, H., Berk, A. Kaiser, C.A., Krieger, M. Scott, M.P. (2007). *Molecular Cell Biology* (6th ed.). USA: W H Freeman.
- Malacinski, G.M. (2015). *Freifelders Essentials of Molecular Biology* (4th ed.). USA: Jones & Bartlett.
- Paul, A. (2011). *Textbook of Cell & Molecular Biology*. Kolkata: Books & Allied Ltd.
- 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.
- Singh, B.D. (2015). *Biotechnology*. New Delhi: Kalyani Publishers.
- Tamarin, R.H. (2004). *Principles of Genetics* (7th ed.). USA: McGraw-Hill Higher Education.
- Verma, P.S., Agarwal, V.K. (2004). *Cell Biology, Genetics, Molecular Biology, Evolution & Ecology*. New Delhi: S. Chand Publisher.
- Weaver, R.F. (2011). *Molecular Biology* (5th ed.). USA: McGraw-Hill Education.

Suggested e-Resources:

- **Cell organelles**

  https://www.khanacademy.org/test-prep/mcat/cells/eukaryotic-cells/a/organelles-article

  https://www.ncbi.nlm.nih.gov/books/NBK21743/

- **DNA packaging**

  https://www.nature.com/scitable/topicpage/dna-packaging-nucleosomes-and-chromatin-310

- **Replication, transcription, translation**

  https://www.atdbio.com/content/14/Transcription-Translation-and-Replication

- **Signal transduction pathway**

  https://www.ncbi.nlm.nih.gov/books/NBK9870/

- **Cell biology**

  https://nptel.ac.in/courses/102103012/6

- **Cell biology & organelles**

  https://www.nicholls.edu/biol-ds/biol155/Lectures/Cell%20Biology.pdf

- **Molecular cell biology**
  https://nptel.ac.in/courses/102106025/
  https://nptel.ac.in/courses/122103039/22

BT 104L Cell and Molecular Biology-I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the structure of cells and its organelles with the help of permanent slides
- gain hands-on training for operating microscope for cell analysis
- use relevant tools and techniques for the analysis of chromosomes and cell size determination using micrometry

1. Organization and working of optical microscope: Dissecting and compound microscopes.
2. To examine the phenomenon of cell permeability using hypotonic, isotonic and hypertonic solutions.
3. Microscopic study of giant chromosomes (Polytene and Lampbrush) with the help of permanent slides.
4. To study the prokaryotic (bacterial) and eukaryotic cells (plant & animal) with the help of microscope.
5. To study the cell organelles (mitochondria, nucleus and chloroplast) with the help of permanent slide.
6. To observe the different stages of mitosis and meiosis using permanent slides.
7. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
8. Squash preparation of onion bud/grasshopper testis and study of the various stages of meiosis.
9. Calibration of microscope followed by determination of cell size using stage and ocular micrometer.
10. To determine the λ_{max} for given DNA sample.

11. Double staining of *Calotropis* sp. stem and leaf material.

Suggested Books:

- Ghose, K., & Manna, B. (2016). *Practical Zoology* (4th ed.). Kolkata: New Central Book Agency.
- Lal, S.S. (2016). *A Textbook of Practical Zoology* Vol-III (2nd ed.). Meerut: Rastogi Publication.

Second Semester

BOT 103 Introduction to Genetics and Genetic Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain in-depth knowledge about principles of genetics, its approaches and methodology at the molecular, cellular, organismal and population levels
- gain knowledge of various tools and techniques in recombinant DNA technology
- translate learned concepts in genetic engineering to their own research

Unit 1

- Mendel's experiments: Laws of inheritance.
- Deviation from Mendel's laws, multiple alleles.
- Extra chromosomal inheritance.
- Linkage and crossing over.
- Sex determination, dosage compensation, barr body and sex linked inheritance.

Unit 2

- Chromosomal aberrations- Structural and numerical.
- Gene mutations: Types, significance; brief idea about mutagens.
- Eugenics, genetic counseling and pedigree analysis.

- Population genetics: Hardy Weinberg law.

Unit 3

- Introduction of genetic engineering and an overview of steps involved in gene cloning.
- Restriction endonucleases, Dam and Dcm methylases, demethylases, ligases, S1 nucleases, DNA polymerases, reverse transcriptase, terminal transferase, polynucleotide kinase and alkaline phosphatases.
- Linkers, adaptors, blunt end ligation, homopolymer tailing.
- Isolation of DNA from bacterial, plant and animal cells.
- Cloning vectors: Plasmids, phages (M13 & λ), cosmids, phagemids, shuttle vectors, BAC and YAC.

Unit 4

- Screening and selection of recombinant clones in prokaryotes.
- Expression of cloned genes in prokaryotes (*E. coli*) using pET vector as an example.
- Genomic library: Construction and screening.
- cDNA synthesis and cDNA library.

Unit 5

- *Agrobacterium tumefaciens:* Ti plasmid, mechanism of T-DNA transfer in plant cells. Brief idea of using Ti plasimd as an experimental gene vector.
- Brief idea of gene cloning and expression of cloned gene in insect cells (Baculovirus).
- Gene transfer methods: Electroporation, liposome, microinjection, microprojectile, and calcium phosphate precipitation.
- Molecular markers: RFLP, RAPD, AFLP, and SNP.

Suggested Books:

- Borem, A., Santos, F.R., & Bowen, D.E. (2003). *Understanding Biotechnology* (1st d.). USA: Prentice Hall.
- Brown, T. (2011). *Introduction to Genetics –A molecular approach* (1st ed.). USA: Garland Science.
- Brown, T.A. (2010). *Gene Cloning and DNA Analysis: An Introduction* (6th ed.). USA: Wiley-Blackwell.
- Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2005). *Principles of Genetics* (8th ed.). New Jersey, USA: John Wiley & Sons Ltd.

- Glick, B.R., & Patten, C.L. (2017). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (5th 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* (7th 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* (9th ed.). Canada: Jones and Barlett Publishers.
- Hartwell, L., Hood., Goldberg, M., Reynolds, A.E., & Silver, L. (2010). *Genetics: From Genes to Genomes* (4th ed.). New York: McGraw-Hill Education.
- Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A., Killian, D. (2018). *Concepts of Genetics* (12th ed.). USA: Pearson Education.
- Krebs, J.E., Goldstein, E.S., & Kilpatrick, S.T. (2012). *Lewin's Genes XI* (11th ed.). USA: Jones and Bartlett Publishers.
- Maloy, S.R., Cronan, J.E., & Friefelder, D. (1994). *Microbial Genetics* (2nd ed.). USA: Jones and Bartlett.
- Primrose, S.B., & Twyman, R. (2006). *Principles of Gene Manipulation and Genomics* (7th ed.) UK: Oxford University Press.
- Rastogi, V.B. (2018). *Genetics* (4th ed.). Medtech.
- Singh, B.D. (2015). Biotechnology. New Delhi: Kalyani Publishers.
- Singh, B.D. (2014). *Fundamentals of Genetics* (332nd ed.). New Delhi: Kalyani Publishers.
- Strickberger, M.W. (1995). Genetics (3rd ed.). New Delhi: Prentice Hall India Learning Private Limited.
- Tamarin, R.H. (2004). *Principles of Genetics* (7th ed.). USA: McGraw-Hill Higher Education.
- Watson, J.D., Tania, A.B., & Stephen, P.B. (2017). *Molecular Biology of the Gene* (7th ed.). USA: Pearson Education.
- Winnacker, E.L. (1987). *From Genes to Clones: Introduction to Gene Technology*. Germany: Wiley VCH.

Suggested e-Resources:

- **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

- **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

  https://sci-hub.tw/10.1038/nbt0483-175

BOT 103L Introduction to Genetics and Genetic Engineering Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should 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 based on Mendel's laws, gene interaction multiple alleles, sex linked inheritence and pedigree analysis.
2. Human genetics: Tongue rolling, widow's peak, ear lobes and little finger.

3. Preparation of permanent slide to show the presence of barr body in human female blood cells/buccal epithelium cells.
4. Isolation of genomic DNA from *E.coli*.
5. Determination of purity of DNA.
6. Analysis of isolated DNA by Agarose gel electrophoresis.
7. Estimation of DNA by DPA method.
8. To determine the melting curve and base composition of DNA.
9. Estimation of RNA by Orcinol method.

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.

Third Semester

BOT 204 Algae, Fungi, Bryophyta and Pteridophyta

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- acquaint with the general characterstics and classification of cryptogams
- gain fundamental knowledge of evolutionary relationships among lower plant groups with differentiating characteristics
- understand economic importance and application of lower plant groups

Unit-I

- **Algae:** Classification (F.E. Fritsch, 1935) and characteristics upto classes.
- General account with special reference to:
  - *Anabaena*
  - *Oscillatoria*
  - *Volvox*
  - *Oedogonium*

- *Chara*
- *Ectocarpus*
- *Polysiphonia*

- Economic importance of algae.

Unit 2

- **Fungi**: Classification (Hawksworth et al., 1995).
- General account with special reference to:
  - *Albugo*
  - *Aspergillus*
  - *Puccinia*
  - *Ustilago*
  - *Alternaria.*
- Economic importance of fungi.

Unit 3

- **Bryophytes**: Classification (According to the latest recommendations of ICBN).
- General account with special reference to important features in the life cycles of
  - Liverworts: *Marchantia*
  - Hornworts: *Anthoceros*
  - Mosses: *Funaria and Sphagnum.*
- Ecological importance of Bryophytes.

Unit 4

- **Pteridophytes**: Classification (Zimmerman, 1959).
- General account with special reference to important features in the life cycles of
  - *Selaginella*
  - *Equisetum*
  - *Marsilea*

Unit 5

- Evolution of Stelar systems.
- Apospory, Apogamy.
- Parthenogenesis.
- Evolution of Heterospory seed habit.
- Telome Theory.

Suggested Books:

- Alam, A. (2015). *Text book of Bryophyta*. New Delhi: I K International Publishers.

- Alexopoulus, 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
- Chamberlian, 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.
- 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. (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

- **Pteridophytes**

  http://nsdl.niscair.res.in/jspui/bitstream/123456789/556/1/PTERIDOPHYTES%20april609%20-%20formatted.pdf

BOT 204L Algae, Fungi, Bryophyta and Pteridophyta Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- identify and characterize different organisms belonging to algae, fungi, bryophyte and pteridophyte groups
- gain practical understanding of various stages in the life cycles of lower plant groups
- gain in-depth knowledge of morphology, anatomy and reproduction in representative members of lower plant groups

1. Study of algae as mentioned in the syllabus (museum specimen of the affected plants and permanent prepared slides).
2. Study of fungi as mentioned in the syllabus (museum specimen of the affected plants and permanent prepared slides).
3. Study of vegetative and reproductive parts in *Marchantia, Anthoceros* and *Funaria* by the preparation of temporary slides.
4. Study of vegetative and reproductive parts in *Selaginella, Equisetum* and *Marsilea*.

Suggested Books:

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

Fourth Semester

BOT 205 Gymnosperms and Angiosperms

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand characteristic features, evolutionary relationships and life cycle of gymnosperms
- gain fundamental knowledge of plant taxonomy and different classification systems
- identify characteristic features of angiospermic plant families and their interdisciplinary approaches

Unit-1

- Gymnosperms: Classification and evolution, distribution with special reference to the Indian subcontinent.
- Special features in life cycle of *Cycas, Pinus* and *Ephedra*.
- Economic importance.
- Introduction to palaeobotany.
- Contribution of Prof. Birbal Sahni in Indian palaeobotany.

Unit-2

- Important Systems of Classification: Hutchinson and Takhtajan and APG, merits and demerits.
- Numerical taxonomy and chemical taxonomy (brief ideas only).
- A brief account of National Herbaria and Botanical Gardens of India.

Unit-3

- Study of selected families of Dicotyledons with emphasis on their diagnostic features:
  - Rananculaceae
  - Amaranthaceae
  - Apocynaceae
  - Asclepiadaceae
  - Asteraceae
  - Brassicaceae

- Cucurbitaceae
- Euphorbiaceae

Unit 4

- Study of selected families of Dicotyledons with emphasis on their diagnostic features:
  - Fabaceae
  - Lamiaceae
  - Myrtaceae
  - Malvaceae
  - Papaveraceae
  - Rutaceae
  - Solanaceae
  - Apiaceae

Unit 5

- Study of Monocotyledons families with emphasis on their diagnostic features:
  - Poaceae
  - Arecaceae
  - Liliaceae
  - Orhidaceae
  - Cannaceae
  - Cyperaceae

Suggested Books:

- Dutta, S. (2009). *A Hand Book of Systematic Botany*. New Delhi: New Age International (P) Limited.
- Dutta, S.C. (1967). *Introduction to Gymnosperms*. Asia Publishing House.
- 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.
- Vashistha, B.R., Sinha, A.K., & Kumar, A. (1987). *Botany for Degree classes- Gymnosperms*. New Delhi: S. Chand 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/

BOT 205L Gymnosperms and Angiosperms Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain in-depth knowledge of identification, characterization and life cycle of gymnospermic plants families
- develop skills for plant identification, with reference to their systematic position
- acquire skills required to identify the morphological characters and floral diagrams of angiospermic plant families

1. Study of *Cycas, Pinus* and *Ephedra*.
2. Study of locally available plants of the families mentioned in the syllabus.
3. Preparation of herbarium.

Suggested Books:

- Dutta, S.C. (1967). *Introduction to Gymnosperms*. Asia Publishing House.

- Sahu, A.C. (2015). *Text book of Practical Botany*. New Delhi: Kalyani Publishers.
- Singh, V., Pande, P.C. & Jain D.K. (2016). *A text Book of Botany*. Meerut: Rastogi Publications
- Vashistha, B.R., Sinha, A.K., & Kumar, A. (1987). *Botany for Degree classes- Gymnosperms*. New Delhi: S. Chand Publication.

ZOOLOGY

First Semester

ZOO 105 Biosystematics and Evolution

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain fundamental knowledge of the origin of life and its evolution
- describe basic concepts of systematics and classification of plants and animals
- gain knowledge about the fossils and the distribution of organisms in different geological time scale

Unit-1

- Origin of life on earth.
- Introduction to evolutionary theories: Lamarckism, Darwinism and Neo Darwinism, Theory of mutation, Modern synthetic theory of evolution.
- Role of variations, adaptive colouration and mimicry, speciation (sympatric and allopatric) and isolation in the process of evolution.
- Centers of origins.

Unit-2

- Basic concept of systematics: Terminology, definition, and significance.
- Botanical classification: International code of Botanical nomenclature, principles of nomenclature, kinds of classification (Natural- Bentham and Hooker and Phylogenetic- Engler and Prantl).
- Zoological classification: International code of zoological nomenclature, principles of nomenclature, kinds of classification (phenetic and cladistic), Linnaean hierarchy.

Unit-3

Plant Kingdom

- General characteristics and systematic position of Cryptogams and Phanerogams.
  - **Algae** (Chlorophyta, Xanthop.hyta, Phaeophyta and Rhodophyta). Life cycle of *Chlamydomonos.*

- **Bryophytes** (Hepaticopsida, Anthocerotopsida and Bryopsida). Life cycle of *Riccia.*
- **Pteridophytes** (Psilophyta, Lycophyta, Sphenophyta and Filicophyta). Life cycle of *Lycopodium.*
- **Gymnosperms**-Life cycle of Gymnosperms (*Thuja*).
- **Angiosperms**- Life cycle of Angiosperms (*Asters*).

Unit-4

Animal Kingdom

- General characters and systematic position (excluding extinct forms) of the following upto classes: Lower non-chordates (protozoa, porifera, coelenterata, platyhelminthes & nematods). Higher non-chordates (annelida, arthropoda, mollusca and echinodermata).
- General characters and classification upto sub –classes of hemichordates and protochordates (urochordates and cephalochordates).
- Chordates: General characters and classification of the following upto sub-classes cyclostomes, fishes, amphibians, reptiles, birds and mammals.

Unit-5

- Fossils: Formation of fossils, kinds of fossils, significance of the study of fossils.
- Geological time scale and the distribution of organisms in time and space.
- Evolution of humans.

Suggested Books:

- Alam, A. (2015). *Text book of Bryophyta*. New Delhi: I K International Publishers.
- Alexopoulus, C. (1979). *Introductory Mycology*. New York: John Wiley Sons.
- Arora, M.P., & Arora, H. (2013). *A Textbook of Organic Evolution*. New Delhi: Himalaya Publishing House.
- 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
- Chaki, K.K., Kundu, G., & Sarkar, S. (2016). *Introduction to General Zoology* Vol-II. Kolkata: New Central Book Agency.

- Chamberlian, C.J. (1919). *Morphology of Gymnosperms*. Allahabad: Central Book Depot.
- 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.
- 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* (8th ed.). New Delhi: CBS Publishers & Distributors.
- Kotpal, R.L. (2014). *Modern Textbook of Zoology: Invertebrates* (11th ed.). Meerut: Rastogi Publications.
- Kotpal, R.L. (2018). *Modern Text book of Zoology: Vertebrates* (4th ed.). Meerut: Rastogi Publications.
- Kumar, H.D. (1999). *Introductory Phycology*. New Delhi: Affiliated East-West.
- 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.
- Pandey, B.P. (2018). *A Text Book of Botany: Angiosperms Taxonomy, Anatomy and embryology*. New Delhi: S Chand and Company Ltd.
- Parihar, N.S. (1956). *Bryophyta Pteridophyta*. Allahabad: Central Book Depot.
- Prasad, S.N., & Kashyap, V. (2012). *A text book of Invertebrate Zoology* (14th ed.). New Delhi: New Age International (P) Limited.
- Rashid, A. (1999). *An Introduction to Pteridophyta*. New Delhi: Vikas publications.
- Rastogi, V.B. (2016). *Organic Evolution* (1st ed.). Medtech.
- 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
- **Taxonomy & classification**
  http://www.austincc.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

ZOO 105L Biosystematics and Evolution Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- identify selected algae, fungi, bryophytes, pteridophytes, gymnosperms and angiosperms
- identify selected non chordates and chordates based on external features

- prepare slides of selected invertebrates and develop an understanding of internal features

1. **Morphotaxonomical study and preparation of permanent slides of**
   - *Chlamydomonos* sp.
   - *Riccia* sp.
   - *Lycopodium* sp.
   - *Thuja* sp.
   - *Verbesina encelioides*
2. **Study of museum specimens**
   - Porifera: *Sycon*, *Hyalonema* and *Euspongia*.
   - Coelenterata: *Porpita, Velella, Gorgonia, Pennatula, Alcyonium,* and *Adamsia*.
   - Platyhelminthes: *Fasciola* and *Echinococcus*.
   - Nemathelminthes: *Dracunculus* and *Enterobius.*
   - Annelida: *Pheretima, Aphrodite, Terebella* and *Pontobdella.*
   - Arthropoda: *Lepus*, *Sacculina,* Crab, Hermit crab, *Melanopus*, Queen-termite, *Limulus* and *Peripatus.*
   - Mollusca: *Chiton, Aplysia, Dentalium, Mytilus, Teredo, Sepia* and *Loligo.*
   - Echinodermata: *Asterias, Holothuria, Echinus* and *Clypeaster.*
   - Protochordata: *Ascidia* and *Botryllus.*
   - Cyclostomata: *Petromyzon.*
   - Pisces: *Torpedo, Labeo* and *Hippocampus.*
   - Amphibia: *Ichthyophis, Salamandra* and *Pipa.*
   - Reptilia: Turtle, *Chaemeleon, Calotes* and *Python.*
   - Aves: *Archaeopteryx,* and *Passer.*
   - Mammalia: *Funambulus* and *Hedgehog.*
3. **Study the evidences of evolution (Analogy and homology) through charts/ models.**
4. **Survey of pond water**
5. **Preparation of permanents slides of**
   - *Euglena*
   - *Hydra*
   - *Cyclops*
   - *Mysis*
   - *Daphnia*

Suggested Books:

- Bendre, A., & Kumar, A. (2009). *A Textbook of Practical Botany- I.* Meerut: Rastogi Publications.
- Lal, S.S. (2015). *Practical Zoology: Invertebrates* (11th ed.). Meerut: Rastogi Publication.
- Lal, S.S. (2015). *Practical Zoology: Vertebrates* (11th ed.). Meerut: Rastogi Publication.
- Verma, P.S. (2010). *A Manual of Practical Zoology: Invertebrates* (11th ed.). New Delhi: S Chand Publishing.

Second Semester

ZOO 101 Non-Chordates and Proto - Chordates

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain fundamental understanding of the non chordates and protochordates
- understand the salient features and systems of different major phyla of invertebrates and lower chordates
- 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 *Palaemone.*
- 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.
- Dhami P.S. & Dhami, J.K. (2015). *Invertebrate Zoology.* New Delhi: R. Chand and Co.
- Hyman, L.H. *The Invertebrtaes*. 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* (11th ed.). Meerut: Rastogi Publications.
- Kotpal, R.L. (2018). *Modern Text book of Zoology: Vertebrates* (4th ed.). Meerut: Rastogi Publications.
- Lahiri, B.K. (2013). *College Zoology* Vol-I. Mumbai: Himalaya Publishing House.
- Majupuria, T.C. (1962). *A textbook of invertebrate Zoology* (1st 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* (7th 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* (5th 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
- **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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- identify and characterize different organisms of invertebrate based on the external features
- learn the preparation of permanent slide and study of internal structures of higher invertebrate animals
- understand the collection and preservation 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) and *Fungia* (mushroom coral).
   - Platyhelminthes: *Schistosoma* and *Taenia*.

- Nemathelminthes: Male and female *Ascaris*.
- Annelida: *Nereis*, *Chaetopterus, Sabella, Arenicola* and *Hirudinaria*.
- Arthropoda: *Balanus, Squilla*, *Julus, Scolopendra*, Locust, Butterfly, *Cimex,* Scorpion and Spider.
- Mollusca: *Patella, Cyprea, Pecten, Octopus* and *Nautilus*.
- Echinodermata: *Antedon, Clypeaster* and *Ophiothrix.*
- Hemichordata: *Balanoglossus*.
- Protochordata: *Ciona* and *Salpa*.

2. Study of microscopic slides:

- Protozoa: *Monocystis*, Binary fission and conjugation in *Paramecium*.
- Porifera: T.S. and L.S. of *Sycon*, Spicules of sponge.
- Coelenterata: *Obelia.*
- Platyhelminthes: W.M. of miracidium, sporocyst, redia, cercaria and metacercaria larva of *Fasciola*. W.M. of *Planaria*, W.M. of scolex, gravid proglottid, onchosphere and bladder worm of *Taenia*.
- Nemathelminthes: T.S. through the body of male and female *Ascaris*.
- Annelida: T.S. of *Pheretima posthuma* through gizzard, typhlosolar region, prostrate glands and seminal vesicles.
- Arthropoda: V.S. of compound eye.
- Echinodermata: T.S. through the arm of *Asterias*.
- Mollusca: V.S. of molluscan shell, T.S. of gill of *Unio* and Glochidium larva.
- Hemichordata: T.S. of *Balanoglossus* through proboscis, collar and trunk region.
- Protochordata: W.M. Velum, pharyngeal wall of *Amphioxus* and tadpole larva of *Ascidia*.

3. Anatomy:

- Anatomical study of various systems with the help of chart/model/CD.

Pheretima posthuma

1. Digestive system
2. Nervous system

Palaemon

1. Appendages
2. Digestive system
3. Nervous system

Pila globosa

1. Digestive system
2. Nervous system

4. To study methods of preservation of museum specimens.

5. Preparation of permanent slides

- Protozoa: *Paramecium*.
- Porifera: Sponge spicules, Spongin fibers and gemmule.
- Coelenterata: *Obelia* colony.
- Annelida: Parapodium of *Nereis* and heteronereis.
- Arthropoda: Crustacean larva (nauplius, and 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, and mosquitoes.

(ii) Culture of *Pheretima*.

7. Preparation of permanent mount of mouth parts of mosquito.

Suggested Books:

- Lal, S.S. (2015). *Practical Zoology: Invertebrates* (11th ed.). Meerut: Rastogi Publication.
- Lal, S.S. (2015). *Practical Zoology: Vertebrates* (11th ed.). Meerut: Rastogi Publication.
- Verma, P.S. (2010). *A Manual of Practical Zoology: Invertebrates* (11th ed.). New Delhi: S Chand Publishing.

Third Semester

BT 212 Biochemistry

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	6	0	0	6

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain fundamental knowledge of structure and function of biomolecules, metabolic pathways and the regulation of biochemical processes
- gain knowledge of basic energy metabolism of cells and identify some of common reaction mechanisms in biochemical processes
- describe structure, functions, kinetics, regulation and the mechanisms of action of enzymes

Unit-1

- Structure and colligative properties of water.
- pH, pKa, acids, bases and buffers. Ionic product of water, Henderson-Hasselbalch equation.
- Carbohydrates-Classification, structure, properties and functions.
- Lipids-Classification, structure, properties and functions.

Unit-2

- Amino acids and proteins-Classification, structure, properties and functions.
- Various levels of structural organization of proteins.
- Bioenergetics: Energy and its forms, principles of thermodynamics.
- Energy rich biomolecules: ATP, NADP and other phosphorylated compounds.

Unit-3

- Glycolysis, citric acid cycle and pentose phosphate pathway. Shuttle mechanisms (malate-aspartate and glycerol-phosphate), glycogenolysis and glycogenesis; gluconeogenesis.
- Mechanism of ATP synthesis: Oxidative phosphorylation, chemiosmotic hypothesis and photophosphorylation.

- Fat Metabolism: Mechanism of synthesis and break down of fats (Palmitic acid), fate of Acetyl CoA.

Unit-4

- Protein metabolism: Biosynthesis of amino acids (tryptophan). Oxidative deamination, transamination and decarboxylation of amino acids, fate of glucogenic and ketogenic amino acids.
- Metabolism of purine and pyrimidines.
- Classification, nomenclature and general properties of enzymes.

Unit-5

- Introduction to mechanism of enzyme action (lock and key hypothesis, induced fit hypothesis).
- Kinetics of enzyme catalyzed reaction (Michaelis-Menten law), double reciprocal plot.
- Enzyme inhibition: competitive, non- competitive and uncompetitive.
- Coenzymes: Classification, structure and functions.

Suggested Books:

- Berg, J.M., Stryer, L., Tymoczko, J.L. & Gatto, G.J. (2015). *Biochemistry* (8th ed.). New York, USA: WH Freeman.
- Conn, E.E., Stumpf, P.K., & Bruening, G. (2006). *Outlines of Biochemistry* (5th ed.). New Jersey: Wiley-Blackwell.
- Copeland, R.A. (2008). *Enzymes: A Practical Introduction to Structure, Mechanism & Data Analysis* (2nd ed.). India: Wiley-VCH.
- Gupta, S.N. (2015). *Biochemistry* (2nd ed.). Meerut: Rastogi Publication.
- Jain, J.L., Jain, S., & Jain, N. (2016). *Fundamentals of Biochemistry* (7th ed.). New Delhi: S Chand.
- Mathews, C.K., Van Holde, K.E., Appling, D.R., & Anthony-Cahill, S.J. (2012). *Biochemistry* (4th ed.). London, UK: Pearson Education.
- Nelson, D.L., & Cox, M.M. (2017). *Lehninger Principles of Biochemistry* (7th ed.). USA: W H Freeman & Co.
- Palmer, T. (2001). *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry* (5th ed.). Cambridge: Horwood Publishing Ltd.
- Rodwell, V., Bender, D., Kennelly, P., & Weil, P.A. (2015). *Harpers Illustrated Biochemistry* (30th ed.). New York, USA: McGraw-Hill Education / Medical.
- Satyanarayana, U., & Chakrapani, U. (2017). *Essentials of Biochemistry* (end ed.). Kolkata: Booka & Allied Ltd.

- Voet, D., & Voet, J.G. (2010). *Biochemistry* (4th ed.). New York, USA: John Wiley & Sons Inc.
- Zubay, G., Parson, W.W., & Vance, D.E. (1995). *Principles of Biochemistry*. USA: Brown (William C.) Co.

Suggested e-Resources:

- **Enzymology**
  https://nptel.ac.in/courses/102102033/14
- **Biomolecules**
  http://www.biologie.ens.fr/~mthomas/L3/intro_biologie/2-sucres-lipides-acides-nucleiques.pdf
- **ETC**
  https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/oxidative-phosphorylation/a/oxidative-phosphorylation-etc
  http://courses.chem.indiana.edu/c483/documents/lecture23.pdf
- **Biochemistry**
  https://nptel.ac.in/courses/102105034/3

BT 212L Biochemistry Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- apply various tools and techniques to understand different biochemical processes of experimentation and hypothesis testing
- identify and distinguish the carbohydrates, proteins and lipids based on specific biochemical tests
- apply the gained knowledge to develop enterpreunership skills in both academics and industries

1. To find out the λ_{max} of protein (BSA).
2. Qualitative analysis of carbohydrates (reducing and non-reducing): Molisch's test, Benedict's test, Fehling's test, Barfoed's test, Seliwanoff's test and acidic hydrolysis test for sucrose.
3. Qualitative test for proteins: Biuret test, Ninhydrin test, Xanthoproteic test, Million's test, Sakaguchi test and Fohl's test.

4. Qualitative analysis of lipids: Solubility test, Grease spot test, Emulsification test, Saponification test, Unsaturation test, Acrolein test, and Salkowski test.
5. Determination of iodine number.
6. Determination of the acid value of lipid.
7. Determination of saponification value of fats and oil.
8. Titration curve of glycine (determination of isoelectric point).
9. To prepare a standard curve of ammonium sulfate.
10. Preparation of enzyme (Urease) extract from horse gram seeds.
11. Determination of urease activity using standard curve of ammonium sulfate.
12. To check time linearity of urease catalyzed reaction.
13. To check protein linearity of urease catalyzed reaction.
14. Preparation and precipitation of casein from buffalo milk.

Suggested Books:

- Deb, A.C. (2013). *Comprehensible Viva & Practical Biochemistry* (2nd 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* (2nd ed.). New Delhi: New Age International Publishers.
- Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers.
- Sharma, S. (2007). *Experiments and Techniques in Biochemistry* (1st ed.). New Delhi: Galgotia Publication.

Fourth Semester

ZOO 202 Comparative Anatomy and Embryology of Chordates

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the comparative anatomy of some representative choradate animals
- gain an elementary idea about reproductive biology
- gain the fundamental knowledge about the embryological development in chick and frog

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 Urinogential 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* (5th 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.
- Dhami P.S., & Dhami, J.K. (2015). *Chordate Zoology.* New Delhi: R. Chand and Co.
- Dhami, P.S. & Dhami, J.K. (2014) *A text book of Zoology: Chordates (Comparative anatomy)*. India: Pradeep's Publication.
- Jain, P.C. (2013). *Elements of Developmental Biology* (Chordate Embryology) (7th ed.). New Delhi: Vishal Publishing Co.
- Kardong, K.V. (2011). *Vertebrates: Comparative Anatomy, Function, Evolution* (6th ed.). McGraw-Hill Education**.**
- Kent, G. C., & Carr, R. K. (2000). *Comparative Anatomy of the Vertebrates* (9th ed.). Europe: McGraw-Hill Science.
- Kotpal, R.L. (2019). *Modern Text book of Zoology: Vertebrates* (5th 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.
- Nigam, H.C. (2017). *Biology of Chordates* (25th ed.). Vishal Publishing Co.
- Prasad, S.N., & Kashyap, V. (2010). *A text book of* V*ertebrate Zoology* (14th 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* (2nd 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.
- Kardong, K.V. (2009). *Vertebrates: Comparative Anatomy, function, Evolution* (5th ed.). The McGraw−Hill Companies.

Suggested e-Resources:

- **Comparative anatomy**

  http://www.iaszoology.com/category/comparative-anatomy/

- **Chick development**

  http://www.notesonzoology.com/vertebrates/chick/development-of-chick-with-diagram-vertebrates-chordata-zoology/8645

  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.notesonzoology.com/frog/development-of-frog-with-diagram-vertebrates-chordata-zoology/8626

ZOO 202L Comparative Anatomy and Embryology of Chordates Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- perform the permanent mounting, identify and differentiate the bones based on external features
- identify and characterize different organisms of vertebrate based on the morphological features

- understand histology of organs, endocrine glands in a comparative manner and embryological development of frog and chick through permanent slides

1. Permanent mountings:
   i. Placoid and ctenoid scales.
   ii. Cartilage and striated muscle fibres of amphibian.
   iii. 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 and adrenal).
4. Study of museum specimens:
   i. Cyclostomata: Amnocoete larva, *Myxine* and *Bdellostoma*.
   ii. Pisces: *Sphyrna, Pristis*, Stingray, *Chimaera, Acipensor, Amia, Wallago, Saccobranchus, Anguilla, Exocoetus, Belone, Syngnathus, Echeries, Porcupine and Protopterus*.
   iii. Amphibia: *Ambystoma*, Axolotal larva, *Necturus, Siren, Alytes, Hyla* and *Rhacophorus*.
   iv. Reptilia: *Chelone*, *Testudo*, *Sphenodon, Phrynosoma, Hemidactylus, Draco, Hydrophis, Eryx, Naja, Viper, Bungarus* and *Crocodilus*.
   v. Aves: *Archaeopteryx, Psittacula, Columba* and *Pavo*.
   vi. Mammalia: *Ornithorhynchus, Tachyglossus, Pteropus,* 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, 18 hrs, 24 hrs and 33 hrs, 48 hrs and 72 hrs of chick embryo.

Suggested Books:

- Ghose, K. & Manna, B. (2016). *Practical Zoology* (4thed.). Kolkata: New Central Book Agency.
- Lal, S.S. (2015). *Practical Zoology: Vertebrates* (11thed.). 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* (11thed.). New Delhi: S Chand Publishing.

Fifth Semester & Sixth Semester

Discipline Elective Courses-I & II

(Botany & Zoology)

BT 320 Microbiology and Immunology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- identify the characteristics of bacteria and viruses
- understand various tools and techniques used for culturing and preservation of microbes
- develop an understanding of the different viral infections and basic concepts of immune system

Unit 1

- Overview of history of Microbiology - Biogenesis and abiogenesis. Contributions of Pasteur, Koch, Edward Jenner and Flemming.
- Ultrastructure of bacteria. General account of different groups: Mycoplasma, cyanobacteria and archaebacteria.
- Microbial growth and reproduction: Binary fission, growth curve, methods of growth determination and factors affecting growth of bacteria.

- Bacterial nutrition: Nutritional categories of bacteria, culture media and types.

Unit 2

- Techniques for sterilization. Isolation of pure culture and preservation of cultures.
- Staining procedures: Gram staining, acid fast staining, flagella staining and endospore staining.
- Mechanism of genetic exchange: Transformation, transduction and conjugation. Brief idea of transposable elements.
- A brief idea of controlling microorganisms using chemotherapeutic agents (antibiotics).

Unit 3

- Basic concepts of virology: General characteristics of viruses. Classification of viruses (Baltimore). A brief idea of viroid and prion.
- Structures of different viruses on the basis of capsid symmetry- enveloped (Herpes virus, SARS-CoV-2), helical (TMV) and icosahedral (Polyoma viruses) and complex (Bacteriophage).
- Virus replication strategies: HIV, TMV and bacteriophages (T_4 and λ).
- Introduction to immune system- organs and cells of immune system.

Unit 4

- Innate and acquired immune system, active and passive immunity.
- Antigen, antigenicity, factors affecting immunogenicity.
- Antibody structure and classes. Generation of antibody diversity.
- Major Histocompatibility complex – class I & class II MHC antigens, antigen processing and presentation.

Unit 5

- Humoral and Cellular immune responses and their effector mechanisms.
- Tools in diagnostic immunology- RIA, ELISA, Western blotting, Immunoprecipitation.
- Hybridoma technology: Monoclonal antibodies and their applications.
- Brief idea about autoimmunity, factors contributing development of autoimmune diseases.

Suggested Books:

➢ Khan, F. H. (2009). *Elements of Immunology* (1st ed.). Pearson Education India.

- Kindt, T.J., Osborne, B.A., & Goldsby, R.A. (2006). *Kuby Immunology* (6th ed.). New York, USA: W. H. Freeman & Company.
- Madigan, M. T., Martinko, J. M., Dunlap, P. V., & Clark, D. P. (2005). *Brock Biology of Microorganisms* (12th ed.). San Fransisco: Benjamin Cummings.
- Maloy, S.R., Cronan, J.E., & Friefelder, D. (1994). *Microbial Genetics* (2nd ed.). USA: Jones and Bartlett.
- Owen, J., Punt, J., Stranford, S., & Jones, P. (2018). *Kuby Immunology* (7th ed.). USA: W. H. Freeman and Company.
- Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. (2007). *Microbiology* (5th ed.). New York, U.S.: Tata McGraw-Hill Inc.
- Shetty, N. (2005). *Immunology: Introductory Textbook*. New Delhi: New Age International Publishers.
- Tizard, I.R. (1995). *Immunology: Introduction* (4th ed.). Philadelphia: Saunders College Publishing.
- Tortora, G.J., Funke, B.R., & Case, C.L. (2016) *Microbiology: An Introduction* (12th ed.). London, UK: Pearson.
- Weaver, R.F. (2011). *Molecular Biology* (5th ed.). New York, USA: McGraw-Hill Education.
- Willey, J.M., Sherwood, L., & Woolverton, C.J. (2007). *Prescott, Harley and Klein's Microbiology,* (7th ed.). USA: Mc Graw Hill Higher Education.

Suggested e- Resources:

- **Immunology**

  https://nptel.ac.in/courses/102103038/3

- **Immunity**

  https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-the-immune-system/a/hs-the-immune-system-review

- **Microbiology**

  https://nptel.ac.in/courses/102103015/

- **Structure of bacteria & viruses**

  https://instruct.uwo.ca/biology/090b/1290b%201-7.pdf

  http://ocw.jhsph.edu/courses/EpiInfectiousDisease/PDFs/EID_lec2_Dick.pdf

BT 320L Microbiology and Immunology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- learn techniques of different culture media preparation and their sterilization
- perform the microbial isolation, culture, maintenance and their enumeration
- develop an understanding of immunological techniques

1. To prepare basic liquid media, solid media, agar slants and agar deep tube for the routine cultivation of bacteria.
2. Isolation of pure culture by streak plate method.
3. Isolation of microorganisms from soil by serial dilution and determination of CFU.
4. To perform the spread plate method and pour plate method for enumeration of microorganisms.
5. Isolation of microorganisms from air by direct plate exposure method.
6. To perform Gram's staining and endospore staining of bacteria.
7. Testing of blood groups including Rh factors to observe the phenomenon of agglutination.
8. To study the various lymphoid glands (spleen and thymus).
9. To study different type of cells participating in non-specific immunity (Blood film preparation).
10. Immunoprecipitation by double diffusion technique.

Suggested Books:

- Aneja, K.R. (1996). *Experiments in Microbiology, Plant Pathology, Tissue Culture and Mushroom Cultivation* (2nd ed.). New Delhi: Wishwa Prakashan.
- Ghose, K., & Manna, B. (2016). *Practical Zoology* (4th ed.). Kolkata: New Central Book Agency.
- Kumar, V. (2011). *Laboratory Manual of Microbiology*. New Delhi: Scientific Publishers.
- Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (1st ed.). New Delhi: Vayu Education of India.

BT 317 Advances in Biotechnology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand the different techniques of DNA sequencing, gene synthesis, gene silencing, PCR and blotting
- Understand the basic concepts of recent techniques of genome editing
- Gain an understanding of the introductory nanobiotechnology: Synthesis, characterization and applications of nanoparticles

Unit 1

- DNA sequencing methods: Maxam & Gilbert, Sangers method and automated sequencing.
- Chemical synthesis of oligonucleotides: Solid phase automated synthesis using phosphoramidite.
- Molecular probes: Preparation, labeling and applications.
- Blotting techniques: Principles and applications of Southern, Northern and Western blotting and hybridization.

Unit 2

- PCR and its applications.
- Molecular techniques for identification of organism: Nucleic acid hybridization, Ribotyping and ARDRA.
- DNA fingerprinting: Principle, procedure and applications.
- DNA microarray: Principle, procedure and applications.

Unit 3

- Gene silencing techniques: Antisense gene approach, antisense oligonucleotides, aptamers and RNA interference.
- Genome editing: Meganucleases, zinc finger nucleases (ZFNs) and transcription activator-like effector-based nucleases (TALEN).
- Clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system.

Unit 4

- Gene therapy: An overview of its types and vectors used.
- Terminator seed technology.
- Gene Targeting: Knock-ins and Knock-outs.
- Molecular priming.

Unit 5

- An introduction of nanobiotechnology.
- Brief idea of carbon based nanomaterials: Quantum dots, nanowires, nanotubes, dendrimers, 2D films and 3D nanomaterials.
- Synthesis of nanomaterials: Bottom up and top down approach; physical, chemical and biological methods.
- Applications of nanotechnology.

Suggested Books:

- Balasubramanian, D., Bryce, C.F.A., Dharmalingam, K., Green, J., & Jayaraman, K. (2004). *Concepts in Biotechnology*. Hyderabad: University Press.
- Borem, A., Santos, F.R., & Bowen, D.E. (2003). *Understanding Biotechnology* (1st ed.). USA: Prentice Hall.
- Brown, T.A. (2010). *Gene Cloning and DNA Analysis: An Introduction* (6th ed.). USA: Wiley-Blackwell.
- Crueger, W., & Crueger, A. (2017). *Biotechnology: A Textbook of Industrial Microbiology* (3rd ed.). New York: Medtech.
- Gupta, P.K. (2005). *Biotechnology and Genomics*. Meerut: Rastogi Publication.
- Kumar, H.D. (1998). *Modern Concept of Biotechnology*. New Delhi: Vikas Publishing House.
- Niemeyer, C.M., & Mirkin, C.A. (2013). *Nanobiotechnology: Concepts, Applications and Perspectives*. India: Wiley.
- Shah, M.A., & Shah, K.A. (2013). *Nanotechnology: The Science of Small*. India: Wiley.
- Shrivastava, S. (2012). *Molecular Techniques in Biochemistry & Biotechnology*. Kolkata: New Central Book Agency.
- Srivastava, S. (2013). *Introductory Nanobiotechnology*. Kolkata: New Central Book Agency.
- Sudbery, P. (2010). *Human Molecular Genetics* (3rd ed.). USA: Pearson Education.

Suggested e- Resources:

- **Gene therapy**

  https://nptel.ac.in/courses/102103041/

- **PCR, hybridization & blotting technique**

  http://www.tulane.edu/~wiser/methods/notes.pdf

- **RNA interference**

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC309050/

- **Genome editing**

  https://www.nature.com/articles/nprot.2013.143

- **Synthetic Biology**

  https://www.sciencedirect.com/science/article/abs/pii/S0734975019301466

  https://www.sciencedirect.com/science/article/abs/pii/S0734975019301521

BT 317L Advances in Biotechnology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- develop the skills in the experimental part of advanced biotechnology
- understand the advanced biotechnology by easy to run experiments such as DNA isolation, restriction digestion, electrophoresis, PCR etc
- apply acquired skills of nanotechnological techniques in the field of biotechnology

1. Isolation and quantification of plasmid DNA from *E.coli*.
2. Restriction digestion of the DNA.
3. Agarose gel electrophoresis for analysis of DNA.
4. Preparation of competent *E.coli.* cells.
5. Demonstration of PCR.
6. To prepare the melting curve of DNA.
7. To find out absorption spectrum of the oxidized and reduced form of a molecular species (NAD and NADH).
8. Synthesis of nanoparticles (iron).
9. To study the effect of synthesized nanoparticles on mung seeds germination.
10. Demonstration of DNA quantification using NANO-DROP.

Suggested Books:

- Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers.
- Sharma, R.K., & Sangha, S.P.S. (2009). *Basic Techniques in Biochemistry & Molecular Biology*. New Delhi: I.K. International Publisher.
- Swamy, P.M. (2008). *Laboratory Manual on Biotechnology* (1st ed.). Meerut: Rastogi Publication.
- Vats, S. (2015). *A laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag.

BT 318 Genomics and Proteomics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning outcomes:

After successful completion of the course, students should be able to:

- develop an understanding of basic principles of functional genomics
- learn the usage of different techniques in the field of genomics and proteomics
- explain different applications of genomics and proteomics

Unit 1:

- Introduction to Genomics, origin of genomes. Acquisition of new genes. DNA sequencing methods: Maxam and Gilbert and Sanger's method.
- Genome Sequencing: Shotgun and Hierarchical (clone contigs) methods. Restriction mapping. DNA and RNA fingerprinting. DNA footprinting.
- Basic concept of Gene networks.

Unit 2:

- Prediction of genes, promoters, splices sites, regulatory regions: basic principles, application of methods to prokaryotic & eukaryotic genomes.
- Concept of DNA microarray.

- Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, UCSC Genome Browser, NCBI genome.

Unit 3:

- Genome assembly and annotation. Genome databases of plants, animals and pathogens.
- Introduction to protein structure. Determination of sizes (Sedimentation analysis, gel filteration, SDS-PAGE); Native PAGE, Determination of covalent structures –Edman degradation.
- Introduction to Proteomics. 2D-PAGE. Sample preparation, solubilization, reduction and resolution.

Unit 4:

- Reproducibility of 2D-PAGE. Mass spectrometry based methods (MALDI – TOF, electospray ionization coupled tandem Mass spectrometry and triple quadrupole mass analyzer) for protein identification.
- *De novo* sequencing using mass spectrometric data.
- Applications of proteomics.

Unit 5:

- Modeling of three-dimensional structure of a protein from amino acid sequence.
- Evaluating protein structure.
- Protein-protein interactions: databases such as MIPS, STRINGS, PPI server and tools for analysis of protein-protein interactions.

Suggested Readings

- Brown, S.M. (2015). *Next-generation DNA sequencing Informatics* (2nd ed.). Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
- Lesk, A.M. (2015). *Introduction to Genomics* (2nd ed.). Oxford, UK: Oxford University Press.
- Liebler, D.C. (2001). *Introduction to proteomics tools for the new biology*. US: Humana Press.
- Pennington, S. R. & Dunn, M. J. (Eds.). (2000). *Proteomics: From protein sequence to function*. Oxford, UK: Bios Scientific Pub Ltd.
- Pevsner, J. (2017). *Bioinformatics and Functional Genomics* (3rd ed.). New Jersey, USA: John Wiley & Sons Ltd.

- Primrose, S.B. (1987). *Modern Biotechnology*. 2nd Edition, Blackwell Publishing.
- Thangadurai, D. & Sangeetha, J. (2015). *Genomics and Proteomics: Principles, Technologies, and Applications*. USA: CRC Press.
- Twyman, R.M. (2004). *Principles of Proteomics*. New Delhi, India: CBS Publishers.

Suggested e- Resources:

- **Proteomics**

  https://nptel.ac.in/courses/102101055/4

- **Genomics**

  https://edu.t-bio.info/learn-to-analyze-omics-data/

BT 318L Genomics and Proteomics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning outcomes:

After successful completion of the course, students should be able to:

- develop understanding of various tools and databases for genomics and proteomic studies
- perform computational analysis of genomes
- perform proteome analysis

1. Accessing UCSC Genome browser and ENSEMBL genome browser.
2. Use of SNP, and OMIM databases.
3. Detection of Open Reading Frames using ORF Finder.
4. The 2-D PAGE database.
5. Construction and Analysis of biological networks (Gene-gene interactions, Protein-protein interactions).
6. Hydropathy plots.
7. To perform a native-PAGE.
8. To perform a SDS-PAGE.
9. To perform Ion exchange chromatography.
10. Sample preparation for 2D-PAGE.

Suggested Books:

- Twyman, R.M. (2004). *Principles of Proteomics*. New Delhi, India: CBS Publishers.

BT 319 Medical Biotechnology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning outcomes:

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

- understand various diagnostic techniques used in medical biotechnology
- gain knowledge about gene therapy and regenerative medicine techniques used for the treatment of diseases
- learn the applications of stem cells and tissue engineering

Unit 1

- An overview of medical biotechnology.
- Diagnosis using protein and enzyme markers, monoclonal antibodies: ELISA, DNA/RNA based diagnosis; Hepatitis, SARS-CoV-2 and HIV-CD 4 receptor.
- Karyotyping of human chromosomes and pedigree analysis. Chromosome banding: G banding and R-banding technique.

Unit 2

- Microarray technology: genomic and cDNA arrays; application to diseases.
- Prenatal diagnosis, invasive techniques: Amniocentesis, fetoscopy and chorionic villi sampling (CVS).
- Noninvasive techniques: Ultrasonography, X-ray, maternal serum and fetal cells in maternal blood.

Unit 3

- Gene therapy: *Ex-vivo*, *in-vivo*, *in-situ* gene therapy, vectors used in gene therapy: viral (retroviruses, adenoviruses and adeno-associated viruses) and non-viral vectors.
- Gene therapy trials, familial hypercholesterolemia, cystic fibrosis and solid tumors. Strategies of gene therapy: gene augmentation–ADA deficiency; Prodrug therapy/ suicide gene – glioma.
- Synthetic therapy: Brief idea of synthetic DNAs, therapeutic ribozymes, synthetic drugs.

Unit 4

- Production of insulin and erythropoietin using recombinant DNA technology.
- Animal cell products: Growth factors, interferons, enzymes, recombinant proteins, hormones, monoclonal antibodies and vaccines.

- DNA based vaccines, subunit vaccines: Herpes Simplex Virus, recombinant attenuated vaccines– Cholera.

Unit 5

- Nanomedicine, drug designing, drug delivery (Conventional & new approaches) and drug targeting.
- Stem cell (Mesenchymal stem cell, adult stem cells & embryonic stem cells) and their therapeutic applications.
- Tissue engineering (Use of cells, scaffolds and biomaterials) in bone, cartilage and skin regeneration.

Suggested Books

- Aschengrau, A., & Seage, G. R. (2014). *Essentials of epidemiology in public health*.
- Bongso, Ariff. & Lee, EngHin. (2005). *Stem cells: from bench to bedside*. Singapore: World Scientific Publishing.
- George, A.J., & Urch, C.E. (Eds.). (2000). *Diagnostic and therapeutic antibodies* (Vol. 40). Springer Science & Business Media.
- Pagano, M., & Gauvreau, K. (2000). *Principles of biostatistics*. Australia: Duxbury.
- Strachan, T., Read, A.P., & Strachan, T. (2011). *Human molecular genetics*. New York: Garland Science.

Suggested e- Resources:

- **Prenatal Diagnosis**
  http://semmelweis.hu/noi1/files/2017/02/Prenatal-diagnostic-methods.pdf
  https://www.health.wa.gov.au/docreg/Education/Prevention/Genetics/HP3131_prenatal.pdf
- **Gene Therapy**
  https://nptel.ac.in/courses/102103013/pdf/mod8.pdf
  http://uniqure.com/patients/Gene-Therapy-Information.pdf
- **Nanomedicine**
  https://noharm-europe.org/sites/default/files/documents-files/2462/HCWH%20Europe%20Nanoreport.pdf
- **Stem cells and Tissue Engineering**
  https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/113108071/lec18.pdf
  https://nptel.ac.in/courses/102106036/

BT 319L Medical Biotechnology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning outcomes:

After successful completion of the course, students should be able to:

- develop the practical understanding of various diagnostic techniques used in medical biotechnology
- learn various tools and techniques of animal cell culture
- apply the gained knowledge to initiate a start-up venture in the field of medical biotechnology

1. Introduction to animal cell culture techniques.
2. Karyotyping of normal and abnormal human chromosome sets.
3. Human pedigree analysis.
4. Study of preparation of nanoparticles and coating.
5. To perform Dot ELISA.
6. Estimation of glucose and ketone bodies using diagnostic kits.
7. Detection of pregnancy using kit.
8. Estimation of progesterone using ELISA kit.
9. Genotyping by RFLP.
10. Blood group and Rh factor determination by slide agglutination test.

Suggested Books:

- George, A. J., & Urch, C. E. (Eds.). (2000). *Diagnostic and therapeutic antibodies* (Vol. 40). Springer Science & Business Media.
- Strachan, T., Read, A. P., & Strachan, T. (2011). *Human molecular genetics*. New York: Garland Science.

Suggested e-Resources:

- https://nptel.ac.in/content/storage2/nptel_data3/html/mhrd/ict/text/102107028/lec41.pdf
- https://nptel.ac.in/content/storage2/courses/102103012/pdf/mod2.pdf

BOT 306 Angiosperms: Morphology, Anatomy and Embryology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning outcomes:

After successful completion of the course, students should be able to:

- understand structure and functions of plant cells and tissues
- identify and compare structural differences among different taxa of vascular plants with ecological adaptations
- gain fundamental knowledge of plant embryology

Unit-I

- Habit and habitat of plants.
- Characteristics functions and types of root system: Modification for storage, support and vital functions- (Respiratory, photosynthetic, haustorial and epipyhtic).
- Stem: Characteristics and functions, types of underground, Aerial and Sub-Aerial and modifications.
- Leaf: Structure and functions, types of leaves, phyllotaxy, venation, modifications in leaves.
- Types of inflorescence (in brief), Flower parts, types of aestivation, types of placentation.
- Fruits: Structure and types (in brief).

Unit-2

- Angiosperm tissues types: structure and function of meristematic and permanent tissues, simple, complex and secretory tissue.
- Root and shoot apex organization, apical cell theory, histogen theory, tunica: Carpous theory, Korper-Kappe theory, concept of quiscent zone.
- Anatomy of dicot and monocot, root and stem.
- Secondary growth in dicot root and stem.
- Anomalous secondary growth in stem/roots: *Boerhaavia, Bignonia, Salvadora, Nycatanthes, Dracaena* and *Aristolochia.*

Unit-3

- Ecological anatomy: General adaptations of hydrophytes, xerophytes and halophytes.
- Anatomical adaptations of Hydrophytes: *Hydrilla,* and *Nymphaea.*

- Anatomical adaptation of Xerophytes: *Calotropis, Nerium,* and *Capparis.*
- Halophytes: Mangrove plants- *Rhizophora*

Unit-4

- Angiosperm embryology: Structure and development of male gametophyte and ovule.
- Monosporic, bisporic and tetrasporic types of embryo sacs (one example each of *Polygonum, Allium* and *Adoxa*).
- Pollination, fertilization, sexual incompatibility, embryo development (monocot and dicot) and Polyembryony.

Unit-5

- Experimental embryology: Apomixis, agamospermy and apospory, Parthenocarpy.
- Adventive embryony.
- Control of fertilization.
- Endosperm and embryo development.

Suggested Books:

- Bhojwani, S.S. & Bhatnagar (1979). *Embryology of Angiosperms*. Vikas Publications.
- Bhojwani, S.S. & Razdan, M.K. (1996) *Plant Tissue Culture*.
- 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://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

BOT 306L Angiosperms: Morphology, Anatomy and Embryology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning outcomes:

After successful completion of the course, students should be able to:

- gain practical knowledge of identification and characterization of morphological and anatomical structures of angiospermic plants
- understand different types of anomalous secondary growth and anatomical differences in plants with ecological adaptations with the help of slides preparation and study
- gain fundamental knowledge of plant embryology by studying models and permanent slides

1. Study of habit and habitat of plants.
2. Study of modified angiospermic plant parts.
3. Study of inflorescence types.

4. Study of fruit types.
5. Anatomical studies of dicot and monocot's roots and stems.
6. Anamolous secondary growth in stem/root of angiosperms (*Boerhaavia, Bignonia, Salvadora, Aristolochia, Nyctanthes* and *Dracaena*).
7. Vegetative structure of hydrophytes and xerophytes (ecological anatomy of *Calotropis, Capparis, Nerium, Hydrilla* and *Nymphaea*).
8. Slides and models on embryology.

Suggested Books:

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

BOT 309 Plant Physiology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- comprehend about life processes of plants and their adaptation in various stress conditions
- understand the various plant growth hormones and their significance
- gain in-depth knowledge of biochemical mechanisms of various metabolic pathways

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.

Unit 2

- Translocation of organic substances: General principle and mechanism.
- Photosynthesis: Structure of chloroplast and photosynthetic pigments.
- Mechanism of photosynthesis, Light reaction: Noncyclic and cyclic photophosphorylation.

- Carbon dioxide assimilation in dark reactions, C3 and C4 plants, photorespiration.

Unit 3

- Respiration: Aerobic and anaerobic respiration. Respiratory quotient, factors affecting respiration.
- Seed germination and dormancy.
- Plant movements.

Unit 4

- Plant growth regulators:- Auxins, gibberellins, cytokinins, ethylene and abscissic acid, their physiological importance.
- Flowering: Photoperiodism.
- Vernalization.

Unit 5

- Nitrogen cycle: Ammonification, nitrification and denitrfication.
- Nitrogen fixation: symbiotic and non-symbiotic.
- Assimilation of nitrate and ammonia.

Suggested Books:

- 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.
- Jain V. K., (2018) Fundamentals of Plant Physiology. New Delhi S. Chand and company limited.
- 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.
- 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.
- Srivastava, H.S. (2005). *Plant Physiology*: Meerut: Rastogi Publications.
- Stiles, W. (2006). Principals of Plant Physiology, Discovering Publishing House.
- Taiz, L., & Zeiger, E. (2010). *Plant Physiology*. London: Sinauer Associates.
- Verma V. Text book of Plant Physiology. Ane's student edition.

Suggested e- Resources:

- **Plant Physiology**

  https://www.udemy.com/plant-physiology/?siteID=zOCYiUhWwNM-1RExiYvhsJfnMd_rZR_ivg&LSNPUBID=zOCYiUhWwNM

BOT 309L Plant Physiology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the physiological details of plant photosynthesis and respiration
- design the experiments, collect and critically evaluate data related to plant physiology
- gain basic skills of laboratory practices and field studies

1. Osmosis
   a. To demonstrate the process of imbibitions by using raisins.
   b. To demonstrate osmosis in living plant cells by potato osmoscope.
   c. To demonstrate the process of plasmolysis in onion cells.
2. Root pressure
   a. To demonstrate root pressure in plants.
   b. To demonstrate that ascent of sap takes place by xylem (ringing experiment).
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. Study of stomata.
4. Photosynthesis
   a. Separation of plant pigments (chlorophyll) by chromatography.
   b. To demonstrate that oxygen is liberated in the process of photosynthesis.

c. To demonstrate that light and CO_2 are essential for photosynthesis (Moll's half leaf experiment).
d. To demonstrate that chlorophyll is necessary for photosynthesis.

5. Respiration
   a. To demonstrate that some energy is released in the form of heat during respiration.
   b. To demonstrate that CO_2 is produced during respiration.
   c. To demonstrate anaerobic respiration.
   d. To determine the Respiratory quotient (R.Q) of different types of respiratory substrates (starch, proteins and fats).
6. Plant Movement
   a. To determine following types of movements**:**
      I. Phototropism
      II. Geotropism

Suggested Books:

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

BOT 308 Plant Pathology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the concept of pathogenesis, disease cycles and the role of various factors impacting pathogenecity
- gain knowledge of plant resistance development towards pathogens
- identify the disease symptoms and control measures for plant diseases

Unit 1

- History of plant pathology and geographical distribution of plant diseases.
- Types of plant pathogens, host pathogen relationship.
- Concept of plant disease-definitions of disease, disease cycle, pathogenticity and symptoms.
- Stages in disease development, plant disease epidemiology, role of environment in disease cycle.

Unit 2

- Concepts of constitutive defense mechanisms in plants.
- Concepts of inducible structural defenses (histological-cork layer, abscission layer, tyloses and gums), inducible biochemical defenses [hypersensitive response (HR), systemic acquired resistance (SAR), phytoalexins, pathogenesis related (PR) proteins, plantibodies, phenolics, quinines and oxidative bursts].

Unit 3

- Bacterial diseases: General symptoms and types of bacterial diseases.
  (i) Soft rot of vegetable
  (ii) Stewart's wilt of maize
  (iii) Brown rot of potato
  (iv) Citrus canker
  (v) Common scab of potato

Unit 4

- Fungal diseases: General symptoms and disease cycle.
  (i) Wart disease of potato
  (ii) Black rust
  (iii) Smut - Wheat
  (iv) White rust of crucifers
  (v) Early blight of potato

Unit 5

- Viral diseases: General symptoms, survival and transmission of plant viruses.
  (i) Tungro disease of rice
  (ii) Tobacco Mosaic disease
  (iii) Yellow vein Mosaic of Bhindi
- Diseases caused by parasitic higher plant: Dodder, dwarf mistletoe of conifers and kudzu vine.
- Control of plant disease: Physical, chemical and biological.

Suggested Books:

- Agrios, G.N. (2005). *Plant Pathology* (5th ed.). Elsevier Science.
- Biswas, S.B. (2009). *An Introduction to Viruses*. New Delhi: Vani Education.
- Butler, E.J. *Plant Pathology- Fungi & Diseases in Plants.* Kolkata: Thanker 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.
- Mehrotra R.S. (2006). *Plant Pathology*. New Delhi: Tata McGraw-Hill.
- 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.

Suggested e- Resources:

- **Plant diseases: Identification and control**

  https://www.planetnatural.com/pest-problem-solver/plant-disease/

BOT 308L Plant Pathology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- perform isolation of various plant pathogens for study
- identification of plant diseases and disease symptoms
- develop an understanding of pathogenesis in plants through slides and other assays

1. Study of bacterial and viral diseases of plants mentioned in the syllabus with help of specimens and charts.
2. Study of fungal and nematode diseases in plants mentioned in the syllabus by museum specimens.
3. Screening for antagonistic activity of *Trichoderma* against *Aspergillus* and *Fusarium* strains.
4. Isolation of fungal pathogen from infected plant part.
5. Isolation of bacterial pathogen from infected plant part.
6. Preparation of temporary mount of
   a) *Alternaria solani* (early blight of potato)
   b) *Ustilago tritici* (loose smut of wheat)
7. Induction of pathogenesis in mung seedlings by *Macrophomina phaseolina* and study of pathogenesis through temporary slides.

8. Extraction of cellulase from diseased plant and its estimation.
9. Comparative of uninfected and infected plant on the basis of polyphenol/salicylic acid content.

Suggested Books:

- Aneja, K.R. (2003). *Experiments in microbiology, plant pathology and biotechnology*. New Age International Publishers.

BOT 307 Economic Botany and Ethnobotany

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning outcomes:

After successful completion of the course, students should be able to:

- gain awareness about importance of traditional and modern uses of native flora
- understand the distribution and life style of ethnic plant groups in India along with their applications
- cain an understanding of commercial products such as beverages, herbs and spices derived from plants and its economic value

Unit 1: Ethnobotany

- Introduction, concept, scope and objectives of ethnobotany.
- The relevance of ethnobotany in the present context.
- Major and minor ethnic groups, tribals of India and their life styles.
- Plants of mythological and religious.
- Plants mentioned in folklore and folk songs.

Unit 2: Ethnobotanical uses

- Plants as totems, taboos and superstition.
- Major centers of ethnobotany in India.
- 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.

Unit 3: 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) *Azadirachta indica* (b) *Ocimum sanctum* (c) *Vitex*

negundo (d) *Gloriosa superba* (e) *Tribulus terrestris* (f) *Pongamia pinnata* (g) *Cassia auriculata* (h) *Indigofera tinctoria*.

- Role of ethnic groups in conservation of plant genetic resources.
- The relevance of ethnobotany in the present context.

Unit 4: Economic Botany

- Origin of cultivated plants, concept of centres of origin and their importance.
- Cereals: Wheat, maize and Bajra -Origin, morphology and uses.
- Legumes: General account with special reference to gram and soybean
- Spices: General account with special reference to coriander, turmeric, chillies, fennel, green cardamom, *Asafoetida*, cumin clove and black pepper (Botanical name, family, part used, morphology and uses).

Unit 5:

- Beverages: Tea and coffee.
- Oils and fats: General description with special reference to mustard, groundnut and coconut.
- Fibre yielding plants: General description with special reference to cotton, coir and jute.
- Drug plants: *Cinchona, Rauwolfia* and *Papaver.*
- Timber plants: *Tectona, Dalbergia* and *Pinus.*
- Rubber: *Hevea brasiliensis.*

Suggested Readings

- Alam, A., & Sharma, V. (2012). *Economic Botany*. Jaipur: Pointer Publishers.
- Colton C.M. (1997). *Ethnobotany – Principles and applications*. John Wiley and sons, Chichester
- Sharma, V., & Alam, A. (2017). *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.
- 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.
- 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.
- Verma, V. (2010). *A text book of economic botany.* New Delhi: Emkay publications.

Suggested e- Resources:

- **Economic botany**

  http://nsdl.niscair.res.in/jspui/bitstream/123456789/130/1/beverages.pdf

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

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

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

BOT 307L Economic Botany and Ethnobotany Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning outcomes:

After successful completion of the course, students should be able to:

- identify and collect plants of ethnic importance from the local regions
- gain basic skills of herbarium preparation
- identify and study economically important plant and their products along with their usefulness

Ethnobotany

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.

Economic Botany

7. Study of economically important plant products as mentioned in the syllabus.
8. Cereals: Wheat, Maize and Bajra; Legumes: Gram and soybean.
9. Spices: Coriander, turmeric, chillies, fennel, green cardamom, *Asafoetida*, cumin clove and black pepper.
10. Beverages: Tea and coffee; Oils and fats: Mustard, groundnut & coconut.
11. Fibre plants: Cotton, coir and jute. Drug plants: *Cinchona, Rauwolfia* and *Papaver*. Timber plants: *Tectona, Dalbergia* and *Pinus*.

Suggested Books:

- Alam, A., & Sharma, V. (2012). *Economic Botany*. Jaipur: Pointer Publishers.
- Colton C.M. (1997). *Ethnobotany – Principles and applications*. John Wiley and sons, Chichester
- Jain S.K. (1995). *Manual of Ethnobotany*, Scientific Publishers, Jodhpur, 1995.

BOT 305 Horticulture

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning outcomes:

After successful completion of the course, students should be able to:

- develop skills in the basic and advanced techniques of plant propagation
- gain fundamental knowledge of various aspects of green house technology
- understand commercially important plants and their cultivation techniques

Unit 1

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

Unit 2

- Soil less culture (hydroponic and 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 and carnations).
- Study of foliage plants (*Ficus,* croton and coleus).
- Study of one locally available vegetables (Root, leafy and cole crops).

Unit 5

- Study of tropical fruits (Mango, amla, and 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

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.longdom.org/horticulture.html

BOT 305L Horticulture Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning outcomes:

After successful completion of the course, students should be able to:

- explore the commercial cultivation practices of vegetables and plants
- apply acquired knowledge for compost preparation and its use for crop improvement
- propagate, grow and maintain plants through vegetative propagation

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 and hybridization.
6. Preparation of compost.

Suggested Books

- Chadha, K.L. 2019. *Handbook of Horticulture*. ICAR Publications, Govt. Of India.
- Gupta, S. N. 2018. *Instant Horticulture*. Jain Brothers, India
- Singh, J. 2018. *Fundamentals of Horticulture*. Kalyani Publishers, India
- Muthukumar, P. 2013. *Glaustas Horticulture*. New Vishal Publications, India
- Raj, D. 2017. *Floriculture At A Glance*. Kalyani Publishers, India

Suggested e- Resources:

- http://www.agrimoon.com/horticulture-icar-ecourse-pdf-books/
- https://www.scribd.com/doc/4678612/Handbook-of-Horticulture

ZOO 306 Animal Physiology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- acquire in-depth knowledge of structure and functions of various physiological systems of human
- apply the gained knowledge for research work in the field of animal science
- understand the mechanism of thermoregulation

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 and respiration at cellular level.

Unit 2

- 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 and lymphatic system; blood groups, Rh factor; platelet plug formation; blood clotting mechanism and its significance; structure and functions of hemoglobin. Blood pressure and its regulation; origin, conduction and regulation of heart beat; nervous and hormonal regulation of heart beat; cardiac cycle.

Unit 3

- 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 4

- Thermoregulation: Heat balance in animals, Adaptations to temperature extremes, torpor, aestivation and hibernation, counter and current heat exchangers.
- Physiology of sensory organs: Eye: Retinal components, photoreceptors, mechanism of image formation. Ear-Cochlea, basilar membrane, and organ of corti, mechanism of hearing and equilibrium.

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; reproductive cycles- estrous and menstrual cycle.
- Hormonal regulation of ovulation, fertilization, implantation, abortion, gestation, parturition and lactation.

Suggested Books:

- Chaterjee, C.C. (2005). *Human Physiology* Vol-II (11^{th}ed.).
- Chaterjee, C.C. (2018). *Human Physiology* Vol-I (12^{th}ed.). New Delhi: CBS Publishers & Distributors.
- Guyton, A.C. & Hall, J.E. (2015). *Textbook of Medical Physiology* (13^{th}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* (5th 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* (10th 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
- **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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- acquire hands-on experience in hematological parameters such as counting of RBCs, WBCs, preparation of haemin crystals and determination of blood haemoglobin
- gain expertise in qualitative estimation of calcium, cholesterol, sugar and protein in blood
- develop practical understanding 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.
13. Demonstrate the activity of salivary amylase enzyme.

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* (1st ed.). New Delhi: Galgotia Publication.

➢ Sharma, S. & Sharma, R. (2016). *Practical Manual of Biochemistry* (2nd ed.). New Delhi: Medtech.

ZOO 307 Developmental Biology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain in- depth knowledge of developmental biology
- acquire knowledge about the understanding of early and late embryonic development
- gain fundamental understanding of reproductive techniques and reproductive disorder

Unit 1 Introduction to developmental biology

- History and scope of developmental biology.
- Gametogenesis: Spermatogenesis, (Spermeiogenesis, spermateoleosis and structure of mammalian sperm).
- Oogenesis: (Previtellogenesis, vitellogenesis and structure of ovum).
- Fertilization and Implantation in mammals.

Unit 2 Early embryonic development with respect to mammals

- Cleavage.
- Morulation, blastulation and gastrulation.
- Fate maps and their significance.
- Organizers.

Unit 3 Late embryonic development with respect to mammals

- The embryonic period.
- The fetus, fetal membranes and placenta.
- Development of male reproductive system (Gonads, genital ducts, and glands).
- Development of female reproductive system (Gonads, genital ducts and glands).

Unit 4 Reproductive disorders

- Birth defects and principles of teratology.
- Menstrual disorders: Precocious, delayed or absent puberty; Amenorrhea.
- Fertility disorders: Sexual dysfunction; Infertility; Spontaneous pregnancy loss.
- Pregnancy disorders: Pre-eclampsia, IUGR, labour abnormalities.

Unit 5 Reproductive Techniques

- Super-ovulation, *In-vitro* fertilization (IVF) and embryo transfer.
- Intra-Cytoplasmic Sperm Injection (ICSI)/ micromanipulation.
- Cryopreservation of gametes and embryos; Vitrification.
- Prenatal diagnosis: Amniocentesis and CVS.
- Pre-implantation genetic diagnosis (PGD).

Suggested Books

- Balinsky, B.I. & Fabian, B.C. (1981). *An Introduction to Embryology* (5th ed.). International Thompson Computer Press.
- Carlson, B. (2013). *Human Embryology and Development Biology* .5th Ed. Saunders.
- Carlson, B.M. (1999). *Patten's foundations in embryology*. (6th ed.). New York, USA: McGraw Hill.
- Chattopadhyay, S. (2017). *An introduction to developmental Biology*. Kolkata, India: Books and Allied.
- Gilbert, S.F. (2000). Developmental Biology (6th ed). Sinauer Associates.
- Gilbert, S.F. (2010). *Developmental Biology* (9th ed.). Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Kalthoff, (2008). *Analysis of Biological Development* (2nd ed.). McGraw-Hill Publishers.
- Lewis, Wolpert (2002). *Principles of Development* (2nd ed.). Oxford University Press.
- Rastogi, V.B. & Jayaraj, M.S. (2005). *Developmental Biology (A Text book of embryology*). Kedar Nath Ram Nath Publisher, Meerut.
- Richard, E. Jones & Kristin, H Lopez. (2014). *Human Reproductive Biology*. 4th Ed. Academic press
- Singh, I. & G.P. *Human Embryology*. Pal Press Jaypee Brothers Pub

Suggested e-Resources:

- Developmental Biology
  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 307L Developmental Biology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand and identify different stages of development of mammalian embryo
- learn the basic concept of qualitative detection of pregnancy in urine sample
- lain practical understanding of the female reproductive cycle-estrous cycle

1. Specimens of different developmental stages of mammalian embryos.
2. Study of different developmental stages of mammals using slides/ charts/CD's.
3. Qualitative detection of pregnancy in urine sample.
4. Demonstration of estrous cycle.

Suggested Books

- Lal, S.S. (2015). *Practical Zoology: Vertebrates* (11thed.). Meerut: Rastogi Publication.
- Verma, P.S. (2010). *A Manual of Practical Zoology: Chordates* (11thed.). New Delhi: S Chand Publishing.

ZOO 309 Economic and Applied Zoology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- explore the importance of earthworms in agro-ecosystems and utilize gained knowledge for production of vermicompost in small scale for garden/household plant
- apply acquired knowledge for setting up poultry farm, sericulture, apiculture, lacculture plant
- understand biology, life cycle and control measures of insect pests of crops and stored grains

Unit-1

- **Introduction to host-parasite relationship:** Host, definitive host, intermediate host, parasitism, symbiosis, commensalism, reservoir, zoonosis.
- **Parasitic protozoans:** Life history and pathogenicity of *Plasmodium vivax,* and *Trypanosoma gambiense.*
- **Parasitic helminthes:** Life history and pathogenicity of *Ancylostoma duodenale* and *Wuchereria bancrofti*.

Unit-2

- Life history and economic importance of ticks and mites.
- **Insects of medical importance and their control**: *Pediculus humanus, Anopheles, Culex* and *Aedes.*
- **Insects of agriculture importance and their control**: Biology and damage caused by crop pests (*Helicoverpa armigera, Pyrilla perpusilla*) and stored grain pests (*Callosobruchus chinensis, Sitophilus oryzae* and *Tribolium castaneum*).

Unit-3

- **Apiculture:** Different species of honey bees, pollen calendar, bee keeping and management practices, honey extraction techniques, bee products, diseases of honey bees and their control.
- **Sericulture:** Different silkworm species and their host plants, silkworm rearing and management practices, diseases of silkworms and their control.
- **Lac culture:** Lac insect, culture practices, diseases of lac insect and their control.

Unit-4

- **Fisheries:** Types of fishery: Marine, inland. Composite fish culture, induced breeding and hybridization. Transportation of fish seed. Fish diseases and their control.
- **Prawn culture:** Life history and culture practices of fresh water prawn.

- **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* (2nd 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 309L Economic and Applied Zoology Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should 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 knowledge of plant parasitic nematodes & control of insect pests of stored grains and crops

1. Study of life cycle of *Plasmodium vivax, Leishmania, Trypanosoma gambiense, Ancylostoma duodenale* and *Wuchereria bancrofti* through permanent slides/photomicrographs or specimens.
2. Study of arthropod vectors associated with human diseases: *Pediculus* and *Xenopsylla* through permanent slides.
3. Study of permanent slides of eggs, larvae, pupae and adults of *Culex, Anopheles* and *Aedes*.
4. Study of some stored grains insect pests through damaged products/photographs.
5. Study of life cycle of honey bee through photographs/specimens/models.
6. Study of life cycle of silk moth through photographs /specimens/models.
7. Study of life cycle of lac insect through photographs /specimens/models.
8. Study of different types of pearls through photomicrographs or specimens.
9. Aquarium design and maintenance.
10. Demonstration of vermicomposting.
11. Demonstration of insect culture.
12. Isolation of plant parasitic nematodes from soil using decanting and sieving method**.**
13. Population dynamics of plant parasitic and free living nematodes.

Suggested Books:

- Kotpal, R.L. (2014). *Modern Textbook of Zoology: Invertebrates* (11th ed.). Meerut: Rastogi Publications.
- Lal, S.S. (2015). *Practical Zoology: Invertebrates* (11th ed.). Meerut: Rastogi Publication.
- Verma, P.S. (2010). *A Manual of Practical Zoology: Invertebrates* (11th ed.). New Delhi: S Chand Publishing.

ZOO 308 Ecology and Biodiversity

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- acquire in-depth knowledge about the physical and biological inter-relationship
- gain knowledge of biodiversity for maintaining ecological balance
- understand the various methods of conservation of biodiversity

Unit 1

- Definition, branches and significance of ecology.
- Biosphere, biomes, ecosystem and its components (abiotic and biotic).
- 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: Definition and attributes of population: Population density and its measurement, natality, mortality, growth form, age distribution, age pyramids, sex ratio, dispersal and dispersion.
- Regulation of population density: Population fluctuations and interactions.

- Community ecology: Definition of types of communities (micro and macro communities), community dominance and species diversity, ecotone, edge effect and ecological niche.
- Ecological succession: types and concept of climax.

Unit 4

- Biodiversity: Basic concepts, importance and conservation needs. Levels of biodiversity-genetic, species and ecosystem.
- Significance of biodiversity: consumptive use, productive use, social, ethical, aesthetic and option values.
- Brief idea on biodiversity at global, National and local levels. India as a mega diversity nation; phytogeographic and zoogeographic zones of the country.
- Biodiversity hotspots, endangered and threatened species of plants and animals in India.

Unit 5

- Threats to biodiversity: habitat loss, poaching of wildlife, man-wildlife conflicts.
- IUCN Red List categorization: guidelines, practice and application; Red Data book.
- Biodiversity conservation: *In-situ* conservation (Biosphere reserves, national parks, wildlife sanctuaries); *Ex-situ* conservation (Botanical gardens, zoological gardens, gene banks, seed and seedling banks, pollen culture, tissue culture and DNA banks).
- Indian biodiversity act, Man and the Biosphere Programme (MAB).
- Environmental pollution: Sources, impacts and control measures of air, water and land pollution.

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.
- 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.
- 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* (5th 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* (10th ed.). Singapore: Thomson Asia.
- Misra, S.P., & Pandey, S.N. (2016). *Essentials of Environmental Sciences* (4th ed.). New Delhi: Ane Books Pvt. Ltd.
- Odum, E.P. (1965). *Ecology*, New Delhi: Amerind Publishing.
- 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

- **Population characteristics**

  http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.534.5462&rep=rep1&type=pdf

ZOO 308L Ecology and Biodiversity Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain hands-on skills in the quality assessment of water
- understand the physical and chemical characteristics of soil with easy to run experiments

- gain knowledge about plant community and zoogeographical distribution

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_2 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 determine the soil temperature by soil thermometer.
9. To measure relative humidity of the atmosphere by wet and dry–bulb thermometer or psychrometer.
10. To determine soil texture.
11. To test the presence of carbonate, nitrate, pH value and base deficiency in soil.
12. To measure the light intensity.
13. To study the structure of the plant community of an area by quadrat method and to determine the plant density, abundance and frequency.
14. To determine the water holding capacity of different soils.
15. Draw a map of world and identify the phytogeographical and zoogeographical regions of the world along with their major fauna.

Suggested books:

- Lal, S.S. (2015). *Practical Zoology: Invertebrates* (11th ed.). Meerut: Rastogi Publication.
- Lal, S.S. (2015). *Practical Zoology: Vertebrates* (11th ed.). Meerut: Rastogi Publication.
- Lal, S.S. (2016). *A Textbook of Practical Zoology* Vol-III (2nd 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* (11th ed.). New Delhi: S Chand Publishing.

CHEMISTRY

First Semester

CHEM 102 Inorganic Chemistry-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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_{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 it's 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 Ψ and Ψ^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-field 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 BF_3, BF_4^-, NH_3, H_2O, H_3O^+, PCl_5, SF_4, ClF_3, I_3^-, SF_6, IF_7, ICl_2^-, and $POCl_3$; MO theory, simple LCAO theory; sigma and pi 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 alkalides and electrides, alkyls and aryls of *s*-block elements

p-Block Elements:

Comparative study (including diagonal realtionship) of groups 13 to17 elements, compounds like hydrides, oxides, oxyacids and halides of groups 13 to 16, hydrides of boron-diboranes and higher boranes, borazine, borohydride; fullerenes, carbides, flourocarbons, 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 3*d*-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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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**
   (a) Determination of acetic acid in commercial vinegar using NaOH.
   (b) Determination of alkali content in antacid tablet using HCl.
   (c) Estimation of calcium content in chalk as calcium oxalate by permanganometry.
   (d) Estimation of copper using thiosulphate.

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.

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

Second Semester

CHEM 103 Organic Chemistry-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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.

Organomatellic Compound:

Structure, synthesis and applications of Grignard reagent.

Unit 2 Setereochemistry 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.

Confomational 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: Nomenclature, methods of preparation, chemical reactions, Baeyer's strain theory and its limitation, cyclopropane- Banana Bond.

Alkenes:

Nomenclature, isomerism, relative stabilities, methods of preparation: dehydration of alcohols, dehydrohalogenation of alkyl halides, dehalogenation of vic-dihalides, pyrolysis of quarternary ammonium hydroxides; physical properties, chemical reactions: - catalytic hydrogenation, addition of hydrogen halides, hydroboration-oxidation, oxymercuration-reduction, epoxidation, ozonolysis, hydration, hydroxylation with $KMnO_4$, 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 σ-and π-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 [$Pb(OAc)_4$ and 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, decrboxylation and halogenation (Hell-Volhard-Zelinsky reaction).

Recommended Books

1. Clayden, J., Greeves, N., Warren, S., & Wothers, P., (2001). *Organic Chemistry.* (2nd ed.).Oxford University Press.
2. Sykes, P. (1986). *A guide book to mechanism in organic chemistry* (6th 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* (6th ed.). PrentlceHall: Englewood Cliffs, NJ.
5. Nasipuri, D. (1994). *Stereochemistry of organic compounds.* (2nd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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	L	T	P	C
(CA: 40 + ESA: 60)	6	0	0	6

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, Eular 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 ΔH 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, structural differences between solids, liquids and gases, thermography and seven-segment cell.

Surface tension :

Basic concept, effect of temperature , Surface energy

Viscosity:

Basic concept, effect of temperature and Pressure

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, co-ordination 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: Addision-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 Physcial 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
   https://www.edx.org/learn/chemistry
3. Free Online Education SWAYAM
   https://swayam.gov.in

CHEM 202L Physical Chemistry-I Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 $CaCl_2$ 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 HCl and H_2SO_4 by studying the kinetics of ethyl acetate.
4. To study the reaction rate of decomposition of iodide by H_2O_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. $MnCl_2.4H_2O$/ $SrBr_2.2H_2O$).

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 it's 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). *Avanced Physical Chemistry*, India: Pragati Prakashan .
2. Sindhu, P.S. (2005). *Practicals in Physical Chemistry*, India: Macmillan Publishers.

Suggested e-Sources

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Fourth Semester

CHEM 201 Inorganic Chemistry-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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 μ_S and μ_{eff} values, orbital contribution to magnetic moments, applications of magnetic data for 3*d*-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 $[Ti(H_2O)_6]^{3+}$ 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 NH_3 liquid HF and liquid 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 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
2. Online Chemistry Courses
   https://www.edx.org/learn/chemistry
3. Free Online Education SWAYAM
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CHEM 201L Inorganic Chemistry - II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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:

1. Estimation of Barium (as sulphate)
2. Estimation of Lead (as sulphate)
3. Estimation of Zinc (as ammonium sulphate)
4. Estimation of Magnesium (as magnesium hydrogen phosphate)
5. Estimation of Copper (as thiocynate)
6. Estimation of Nickel (as nickel dimethyl glyoximate)

Complexometric Titrations using Disodium Salt of EDTA:

1. Estimation of Mg^{2+} and Zn^{2+}
2. Estimation of Ca^{2+} by substitution method

Preparation and Purification of following Complexes:

1. Sodium trioxalatoferrate (III)
2. Tetraamminecopper (II) sulphate
3. Sodium trioxalatochromate (III)
4. cis- and trans-diaquadioxalatochromate (III) ion

Colorimetric Estimation:

1. Job's method
2. 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
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3. Free Online Education SWAYAM
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Fifth Semester & Sixth Semester

Discipline Electives (Theory)

CHEM 302 Organic Chemistry-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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:

(a) Amino acids: Classification, structure, acid-base behaviour, isoelectric point; preparation, physical properties and chemical reactions of α-amino acids.

(b) Peptides and Proteins: Classification, structure determination, and end group analysis, selective hydrolysis of peptides, solid-phase peptide synthesis.

(c) 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 λ_{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_2, CN and aryl group; synthetic applications.

Unit 4 Heterocyclic Compounds:

Introduction, classification, nomenclature of five and six-membered rings, molecular orbital picture and aromatic characterstics 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 Bischier-Napieralski synthesis; mechanism of electrophilic substitution reactions of indole, quinoline and isoquinoline.

Unit 5 Organic Synthesis via Enolates:

Introduction, acidity of α-hydrogens, reactive methylene group-alkylation of diethyl malonate and ethyl acetoacetate, synthesis

and reaction of ethyl acetoacetate, Keto-enol tautomerism of ethyl aectoacetate, 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.* (2nd ed.). Oxford University Press.
2. Sykes, P. (1986). *A guide book to mechanism in organic chemistry* (6th 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* (6th ed.). Prentlce Hall.
5. Nasipuri, D. (1994). *Stereochemistry of organic compounds.* (2nd 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*. (3rd 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*. (7th ed.). New Age International Publishers, New Delhi
12. Silverstein, R. M., Webster, F. X. & Kiemle, D., (2005). *Spectrometric Identification of Organic Compounds*. (7th ed.). John Wiley & Sons.

Suggested e-Sources

1. National Programme on Technology Enhanced Learning
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CHEM 305 Molecular Modeling and Drug Design

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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, Roult'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 Haff 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 (ΔG, ΔH 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_2O and ethanol-water systems; partially miscible liquids: -phenol-water, trimethylamine-water, nicotine-water systems; lower and upper consulate temperature, effect of impurity on consulate temperature.

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

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: Addision-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 Physcial Chemistry* (47th Ed). India: Vishal Publishing Company.
5. Arniker, H. J. (2005). *Essentials of Nuclear Chemistry* (4th 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 it's 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 streingth of unknown acids (Strong, Weak and mixture), potentiometric: principle, instrumentation and application (determination of transport number. Detternimation 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, Rf 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.

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

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

Discipline Electives (Lab)

CHEM 302L Organic Chemistry-II Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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, benzoylation, diazotization or coupling reaction and electrophilic substitution.

Steam Distillation (any one of the following)

1. 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, $NaHCO_3$, NaOH for separation and preparation of suitable derivatives.

Synthesis of Organic Compounds (any two of the following)

(i) Acetylation

- Salicyclic 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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 σ bonds and ethene, ethyne, benzene and pyridine π 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_2, 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 ºC, 100 ºC, 108 ºC, 82 ºC, 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_2O, H_2S, H_2Se. (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), TINKER 6.2 (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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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 $KMnO_4/K_2Cr_2O_7$ 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 conducotometrically.
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 $KMnO_4/K_2Cr_2O_7$ as titrant and calculate the redox-potential of Fe^{2+} / 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 determine the concentration of a given unknown solution of optically active compound cane sugar and tartaric acid.
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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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 Fe^{3+}, Al^{3+}, and 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 Ni^{2+} & Fe^{2+} by complexation with DMG and extracting the Ni^{2+}- DMG complex in chloroform, and determine its concentration by spectrophotometry.

(b) Solvent extraction of zisconium 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 fame 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_a 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
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3. Free Online Education SWAYAM
   https://swayam.gov.in

COMPUTER SCIENCE

First Semester

CS 107 Computer Fundamentals and Programming

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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, Cache Memory, Secondary Memory devices and their characteristics.

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. VenugopalK.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. Kergnighan 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 scant'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 ofGCD, LCM.
v. Sum of various series, Fibonacci series, sin, cos, exp etc.

vi. Printing patterns with digits/albabets/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	L	T	P	C
(CA: 40 + ESA: 60)	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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 ofGCD, 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.

Third Semester

CS 210 Data Structures

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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-Ω, Big-O, Big-θ notation) Searching and Sorting: Linear search and Binary Search, Bubble sort, Selection sort, Insertion sort, Quick sort, Radix sort.

Unit 2 Liner 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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.

Fourth Semester

CS 208 Computer Oriented Numerical and Statistical Method

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 quardrature 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, Chebysheve 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 sankhyatmakReetiyan*, 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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 309L Project Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 (Arithmatic, Logical, Relational etc.)

L6-L8 Joins(Self join, inner join, outer join, equi join)

CS 301 Communication and Networking

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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
2. Data Communication
   https://nptel.ac.in/courses/106105082/

CS 215 Systems Programming

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 I, 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
2. Object Oriented Programming in Java Specialization
   https://www.coursera.org/specializations/object-oriented-programming

CS 320L Programming in Java Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Lab Number	**Problems**
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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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

GEOGRAPHY
First Semester

GEOG 103 Physical Geography

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (7th 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.* (2nded.). Patna, India: Shukla Book Depot.
4. Garrison, T. (1998). *Oceanography*. (3rded.). 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*. (4th ed.). New Jersey, NJ: John Wiley & Sons.
11. चौहान, वी.एस. (1996). *भौतिक भूगोल.* मेरठ, भारतः रस्तोगी.
12. शर्मा, एच. एस. (2014). *भौतिक भूगोल.* जयपुर, भारतः पंचशील.
13. सिंह, एस. (2005*). भौतिक भूगोल.* गोरखपुर भारतः 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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 gauze 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* (2nd ed.). New Delhi, India: Concept.

2. Robinson, A.R. (2011). *Elements of Cartography* (6th ed.). London, UK: Chapman & Hall.
3. Saha, P. & Basu, P. (2011). *Advanced Practical Geography* (7th ed.). Kolkatta, India: Books & Allied.
4. Singh, R.L. (2011). *Elements of Practical Geography* (8th ed.). New Delhi, India: Kalyani.
5. खुल्लर, डी.आर. (2015). *प्रयोगात्मक भूगोल.* लुधियाना, भारतः कल्याणी.
6. दयाल, पी. (2006). *प्रयोगात्मक भूगोल की रूपरेखा.* नई दिल्ली, भारतः राजेश.
7. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारतः रस्तोगी.
8. सिंह, आर.एल. (2013). *प्रायोगिक भूगोल के सिद्धान्त* (तृतीय सं.). इलाहाबाद, भारतः 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
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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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: Forms, Causes and Types; General laws of migration- E.G. Ravenstein's laws, Lee's model, Zelinskey'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* (2nd ed.). New York, NY: John Wiley & Sons.
2. Husain, M. (2014). *Human Geography* (4th ed.). Jaipur, India: Rawat.
3. Leong, G. C. & Morgan, G. C. (2010). *Human and Economic Geography* (2nd 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 Aproach*. Meerut, India: Kedarnath Ramnath.
6. Rubenstein, J. M. (2003). *An Introduction to Human Geography* (7thed.). New Jersey, NJ: Prentice Hall.
7. Singh, L. R. (2005). *Fundamentals of Human Geography* (2nded.). 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/Bushmen

GEOG 104L Statistical Techniques and Data Representation Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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.

Course Content:

1. Meaning and definition of statistics, data and sampling.
2. Statistical series and their types
3. Frequency distribution and its presentation
4. Measures of Central tendency : Arithmetic Mean, Mode & Median (Direct Method)
5. Measure of Dispersion: Standard deviation
6. Representation of statistical data through diagrams :- Multiple Bar diagram, Simple Pyramid diagram, Rectangular diagram (Simple and Divided), Wheel or pie diagram, Spherical diagram
7. Representation of statistical data through graphs: - Poly Linear graph, Climograph, Triangular graph.

Scientific calculators are allowed during the examination.

Recommended Books:

1. Alvi, Z. (2005). *Statistical Geography Methods and Applications* (2nd 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* (4th ed.). New Delhi, India: Sultan Chand and Sons.
4. Mahmood, A. (2017). *Statistical Methods in Geographical Studies* (6th ed.). New Delhi, India: Rajesh.
5. Saha, P. & Basu, P. (2011). *Advanced Practical Geography* (7th ed.). Kolkatta, India: Books & Allied.
6. Singh, R. L. (2011). *Elements of Practical Geography* (8th ed.). New Delhi, India: Kalyani.
7. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल.* लुधियाना, भारतः कल्याणी.
8. नागर, के. एन. (2013). *सांख्यिकीय के मूलतत्व* (चतुर्थ सं.). मेरठ, भारतः मीनाक्षी.

9. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारतः 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/~cll/lskills/WN/NumeracyDiagrms.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
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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 Rate.

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 & Density, 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* (12th ed.). Jaipur, India: Kuldeep.
2. Khullar, D. R. (2014). *India, A Comprehensive Geography* (3rd 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* (9th 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: पचंशील.

8. शर्मा, एच. एस. एवं शर्मा, एम. एल. (2017). *भारत का नूतन भूगोल.* जयपुर, भारत: आर. बी. डी.

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., एवंसक्सैना, 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 मैक्ग्राहिल.

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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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, Simple Shading Method, Naming Method, Choroschematic Method- Geometrical Symbol, Pictorial Symbol and Literal Symbol 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* (2nd ed.). New Delhi, India: Concept.
2. Raize, E. (1948). *General Cartography*. London, UK: McGraw Hill.
3. Sarkar, A. (2015). *Practical Geography*: *A Systematic Approch* (3rd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (9th ed.). Kolkata, India: The World Press.
2. Gurjar, R., & Jat, B. C. (2010). *Resources and Environment* (7th 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* (2nd ed.). New York. NY: Oxford Press.

5. Maurya, S. D. (2018). *Economic Geography*. Allahabad, India: Pravalika.
6. Shelar, S. K. (2013). *Priciples of Economic Geography*. Kanpur, India: Chandralok.
7. Siddhartha, K. (2006). *Economic Geography Theories, Processes and Patterns* (2nd ed.). Delhi, India: Kisalaya.
8. Siddhartha, K. (2016). *Economic Geography* (3rd ed.). Delhi, India: KitabMahal.
9. गौतम, ए. (2015). *आर्थिक भूगोल के मूलतत्त्व.* इलाहाबाद, भारतः शारदा पुस्तक भवन.
10. जाट, बी. सी. (2016). *आर्थिक भूगोल* (चतुर्थ सं.). जयपुर, भारतः पंचशील.
11. मामोरिया, सी. (2012). *आर्थिक भूगोल* (द्वितीय सं.). आगरा, भारतः साहित्य भवन.
12. राव. एस. (2013). *आर्थिक भूगोल.* गोरखपुर, भारतः वसुन्धरा.
13. सिंह, के. एन., एवं सिंह, जे. (2010). *आर्थिक भूगोल के मूलतत्त्व* (11वीँ सं.). गोरखपुर, भारतः ज्ञानोदय.
14. सिंह, जे. (2009). *संसाधन भूगोल.* नई दिल्ली, भारतः 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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* (2nd ed.). New Delhi, India: Concept.
2. Raize, E. (1948). *General Cartography*. London, UK: McGraw Hill.
3. Singh, G. (2009). *Map work and Practical Geography* (4th 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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* (7th ed.). Kolkatta, India: Books & Allied.
2. Singh, G. (2009). *Map work and Practical Geography* (4th ed.). Delhi, India: Vikas.
3. खुल्लर, डी. आर. (2015). *प्रयोगात्मक भूगोल.* लुधियाना, भारत, कल्याणी.
4. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल* (पंचम् सं.). मेरठ, भारत, रस्तोगी.
5. सिंह, आर. एल. (2013). *प्रायोगिक भूगोल के सिद्धान्त* (तृतीय सं.). इलाहाबाद, भारतः 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 (2nd 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 (2nd 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* (8th ed.). New Delhi, India: Kalyani.
6. चौनियाल, डी. डी. (2010). *सुदूर संवेदन एवं भौगोलिक सूचना प्रणाली*. इलाहाबाद, भारत: शारदा पुस्तक भवन.
7. शर्मा, जे. पी. (2011). *प्रायोगिक भूगोल (पंचम् 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
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

Discipline Electives

GEOG 305 Environment and Disaster Management

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (4th 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 (4th ed.). New York, NY: Pearson.
7. Keller, E.A. (1978). *Environmental Geology* (9th ed.). North Carolina, NC: Bell & Howell.

8. Montgomery, C.W. (2013). *Environmental Geology* (10th 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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, Varenius 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* (3rd ed.). London, UK: Prentice Hall.
2. Dikshit, R. D. (2018). *A Contextual History of Ideas* (2nd ed.). New Delhi, India: PHI.
3. Hussain, M. (2014). *Evolution of Geographical thought* (6th 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* (4th 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, भारतः साहित्य भवन.

11. प्रसाद, जी. (2006). *भौगोलिक संकल्पनाएँ.* नई दिल्ली, भारतः डिसकवरी.

12. मौर्य, एस. डी. (2015). *भौगोलिक चिन्तन का इतिहास.* इलाहाबाद, भारतः प्रयाग पुस्तक भवन.

13. सिंह, जे. (2009). *भौगोलिक चिन्तन के मूल आधार.* नई दिल्ली, भारतः वसुन्धरा.

14. हुसैन, एम. (2006). *भौगोलिक चिन्तन का इतिहास.* जयपुर, भारतः 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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* (2nd 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* (2nd ed.). New Delhi, India: Concept.

6. Singh, R. Y. (2014). *Geography of Settlements* (2nd ed.). Jaipur, India: Rawat.
7. तिवारी, आर. सी. (2016). *अधिवास भूगोल* (अष्ट सं.). इलाहबाद, भारतः प्रयाग पुस्तक भवन.
8. बंसल, एस. सी. (2016). *ग्रामीण बस्ती भूगोल* (संशोधित सं.). मेरठ, भारतः मीनाक्षी.
9. मौर्य, एस. डी. (2017). *अधिवास भूगोल* (षष्ठ सं.). इलाहबाद, भारतः शारदा पुस्तक भवन.
10. सिंह, आई. (2008). *अधिवास भूगोल.* नई दिल्ली, भारतः यूनिवर्सिटी.
11. सिंह, आर. वाई. (2005). *अधिवास भूगोल.* नई दिल्ली, भारतः 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
3. Origin and evolution of towns
   http://www4.brandonu.ca/ebertsd/281/281f17unit02.pdf

GEOG 304 World Regional Geography

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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* (5th ed.).London, UK: Longman.
4. Hussain, M. (2012). *World Geography* (4th 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* (6th ed.). Ludhiana, India: Kalyani.
7. Minshull, G. N. (1984). *Western Europe*. New York, NY: Hoddard & 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, भारतः इशिका.
11. राव, बी. पी., एवं सत्यपति, डी.पी. (2010). *एशिया की भौगोलिक समीक्षा* (द्वितीय सं.). गोरखपुर, भारतः वसुन्धरा.
12. लोढा, आर. एम. (2010). *औद्योगिक भूगोल* (चतुर्थ सं.). जयपुर, भारतः राजस्थान हिन्दी ग्रंथ अकादमी.
13. सक्सेना, एच.एम. (2011). *विश्व का प्रादेशिक भूगोल.* मेरठ, भारतः रस्तोगी.
14. सिंह, जे., एवं राव, बी. पी. (2007). *तीन दक्षिणी महाद्वीप* (सप्तम् सं.). गोरखपुर, भारतः 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
4. Climate, natural vegetation

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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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* (2nded.). *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* (11th 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (3rd ed.). New York, NY: Prentice Hall.
2. Condie, K. C. (1984). *Plate Tectonics & crustal Evolution*. (4th ed.). London, UK: Pergamon Press.
3. Condie, K. C. (2016). *Earth as an Evolving Planetary System* (3rd 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* (2nd ed.). Cambridge, UK: Cambridge University Press.
6. George, H. D., Stephen J. R. & Charles F. K. (2013). *Structural Geology of Rocks and Region* (3rd 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* (3rd ed.). New York, NY: Chapman & Hall.
11. Pluijm B. A., & Marshak, S. (2004). *Earth Structure An Introduction to Structural Geology and Tectonics (2nd 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* (2nd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (5th 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* (3rd ed.). Victoria, Australia: Blackwell.

Suggested e-learning materials:

1. Online stereonet software https://app.visiblegeology.com/stereonet App.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/Field Trips/BrokenHillOlary/Mapping.html
4. Geologic structures
   https://nptel.ac.in/courses/105105106/

Third Semester

GEOL 203 Mineralogy, Crystallography and Geochemistry

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (3rd ed.). New York, NY: John Wiley & Sons.
3. Gribble, C. D. (1991). *Rutley's Element of Mineralogy* (27th 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* (3rd 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

GEOL 203L Mineralogy, Crystallography and Geochemistry Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (3rd ed.) New York, NY: John Wiley & Sons.
3. Gribble, C. D. (1991). *Rutley's Element of Mineralogy* (27th 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* (3rd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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. Phaserule, Unicomponent system, Bowen's reaction series.

Unit II Sediments and sedimentary rock: Origin of clasticand 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* (2nd ed.). New York, NY: John Willy & Sons.
2. Best, M. G. (2002). *Igneous and Metamorphic Petrology* (2nd ed.). Oxford, UK: Blackwell Science.
3. Blatt, H. & Tracy, R.J. (1996). *Petrology: Igneous, Sedimentary, Metamorphic* (2nd 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 lndia: 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* (3rd ed.). New Delhi, India: Harper and Row.

11. Prasad, U. (2015). *Economic Geology: Economic Mineral Deposits* (2nd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 lndia: 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 fiducialmarks. 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 photogeologyand 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). F*undamentals 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* (9th 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* (3rd 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* (3rd 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* (3rd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (3rd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (3rd 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* (6th 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* (3rd 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* (3rd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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* (3rd 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* (6th 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* (3rd 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* (3rd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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
2. International Commission on stratigraphy
   http://www.stratigraphy.org/
3. Petroleum basin in Rajasthan
   http://petroleum.rajasthan.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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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
2. International Commission on stratigraphy
   http://www.stratigraphy.org/
3. Petroleum basin in Rajasthan
   http://petroleum.rajasthan.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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 Echinodea)

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 Supergroupand its flora. Introduction to Micropaleontology: forminifera.

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 Dharwars, Aravallis, Cuddapah and Vindhyans.

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 Cretateous-Tertiary

Recommended Books:

1. Black, R. M. (1988). *The Elements of Palaeontology* (2nd ed.). Cambridge, UK: Cambridge University Press.

2. Boggs, S. (2001). *Principles of Sedimentology and Stratigraphy* (3rd 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* (6th 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* (2nd 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* (3rd 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* (8th 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (2nd ed.). Cambridge, UK: Cambridge University Press
2. Boggs, S. (2001). *Principles of Sedimentology and Stratigraphy* (3rd 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* (6th 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* (2nd 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* (3rd ed.). London, UK: English.
14. Weller, J. M. (1960). *Stratigraphic Principles and Practices*. New Delhi, India: Universal Book.
15. Woods, H. (2004). *Palaeontology Invertebrate* (8th 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

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* (30thed.). New Delhi, Sultan Chand & Sons.

2. Narayan S. & Mittal P. K. (2007). *Integral Calculus* (36th ed.). New Delhi, Sultan Chand & Sons.

Reference Books:

1. Kishan H. (2007). *Differential Calculus*, New Delhi, Atlantic Publishers.
2. Ram Babu (2010). *Engineering Mathematics*, Pearson Education.
3. Kreyszig E. (2007). *Advanced Engineering Mathematics* (9th ed.), John Wiley.

Suggested E-learning material:

1. Single Variable Calculus
   https://ocw.mit.edu/courses/mathematics/18-01sc-single-variable-calculus-fall-2010/
2. Differentiation of two variables
   https://nptel.ac.in/courses/111104085/21
3. Multiple Integral
   https://nptel.ac.in/courses/111104085/29

STAT 104 Introduction to Probability and Statistics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

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.* (2nd 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*), (3rded.), John Wiley & Sons.
4. Gupta, S. C. & Kapoor, V. K. (2013). *Fundamental of Mathematical Statistics* (11thed.). Sultan Chand Publication, New Delhi.
5. Gupta, S. P. (2017). *Statistical Methods* (17thed.). 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

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, parabolids, 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
3. Math handbook of formulas, Process & Trics: 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 apply the appropriate analytical technique for finding the solution.
- 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*. (2nded.). 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 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* (8th Ed.). Cenage Learning.

Reference Books:

1. Hillman, A. P. & Alexandersor, G. L. (2015). *Abstract Algebra: A First Undergraduate Course* (5th Ed.) CBS Publishers & Distributors Pvt. Ltd.
2. Fraleigh, J. B. (2003). *A First Course in Abstract Algebra* (7th Ed.). Pearson.
3. Sen, M. K., Ghosh, S., Mukhopadhyay, P. & Maity, S. K. (2019). *Topics in Abstract Algebra* (3rd 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* (2nd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 Morgon'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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

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* (2nd 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*. (4th Ed.). Noida (U.P.), India Pearson.
2. Halmos, P. R. (2013). *Finite dimensional vector spaces*. (2nd ed.). S.l.: 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

MATH 301 Complex Analysis

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

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 of complex functions.
- Understand problem-solving using complex analysis techniques.
- Enjoy the roll of complex functions in analysis 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* (6th ed.). New York: McGraw-Hill.

Suggested E-learning material

1. Complex Analysis; NPTL https://nptel.ac.in/courses/111103070/

Fifth Semester

Core Paper (Mathematics)

MATH 302 Introduction to Discrete Mathematics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 the validity of an argument.
- Demonstrate the ability to write and evaluate a proof or outline the basic discrete structure.
- Understand the basic principles of sets and operations on sets.
- Apply counting techniques to solve the problems.
- Demonstrate an understanding of relations and functions and their properties.
- Demonstrate an understanding of core ideas and basic concepts of graph theory.
- Model problems and solve them using graph algorithms.
- Understand the numeric functions, generating functions and linear reoccurrence relation.
- Understand the basic principle of lattice and Boolean algebra.

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 it's Applications. McGraw Hil.
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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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: Nptelhttps://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
3. Computational Error; Platform: Nptelhttps://nptel.ac.in/courses/111107062/

Discipline Electives (Mathematics)

MATH 203 Introduction to Mechanics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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* (2nd ed.). CBS Publishers and Distributors.
2. Ramsay, A. S. (2002). *Dynamics* (2nd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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
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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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, substraction, 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^{th}ed.). Pearson Education.

2. Grewal, B. S. & Grewal, J. S. (2005). *Higher Engineering Mathematics (* 37th ed.). New Delhi: Khanna Publishers.
3. Davis, H. F. & Snider, A. D. (1998). *Introduction to Vector Analysis(* 7th 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

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, congurences with prime power modulai. linear Diophantine equations.

Unit 3 Arithmetic fuction, Euler's Theorem, Fermat's little theorem, Wilson's theorem, primality testing and pseudoprimes and Carmichael numbers.

Unit 4 Group of units, Euler's fuction, primitive root, the group U_p^e and U_2^e. 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

MATH 313 Multivariable Calculus

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

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

- Locate points in R^3 given in rectangular, cylindrical and spherical coordinates.
- Recognize and find equations of cylindrical surfaces, quadric surfaces and surfaces.
- Use the method of Lagrange multipliers to solve constrained optimization problems.
- Evaluate triple integrals and use them to find volumes in rectangular, cylindrical and spherical coordinates.
- Use a Jacobin to make a change of variables in a double integral.
- Use Green's theorem to evaluate line integrals.
- Solve applied optimization problems involving functions of two or three variables.

Unit 1 Three-Dimensional coordinate system, Vectors, The dot product, The Cross product, Equations of lines and Planes, Cylinders and Quadric surfaces, Cylindrical and Spherical coordinates, Vector function and Space curves, Derivatives and Integrals of vector functions , Arc length and Curvature.

Unit 2 Function of several variables, Level curves, Limits and Continuity, Partial derivatives, Tangent planes and linear approximation, The Chain rule, Directional derivatives and gradient vector.

Unit 3 Maximum and minimum, Lagrange multipliers, Double Integrals over rectangles, Double Integral over general regions, Double Integral in polar coordinates, Surface area.

Unit 4 Triple integral, Triple Integral in cylindrical and spherical coordinates, Change of variable in multiple integral, Vector fields, line integrals, The Fundamental theorem for line integrals.

Unit 5 Green's Theorem, Curl and Divergence, Parametric surfaces and their Areas, Surface Integrals, Stokes Theorem.

Text Books:

1. Stewart, J. (2007). Calculus: *Early transcendentals*. Belmont, CA: Thomson Higher Education.

Reference Books:

1. Hass, J., & Weir, M. D. (2008). *Thomas' calculus*: Early transcendentals. Boston: Pearson Addison-Wesley.

PHYSICS

First semester

PHY 103 Electricity and Electronics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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: Interinsic & 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 Transitstor 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 vegu lator 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	**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:

- 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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, aplantic 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, colur of thin films in transmission and reflection, Newton's rings, Michelson's interferometer, fringes of different shapes Determination of λ 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 Polorisation: 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. Shivlal Darwal, Agra.
2. Lal, B. & Subramanium (2006), Optics by Brij Lal and Subrahmanium, 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	**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:

- 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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	**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:

- 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

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**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 (α) of the given sample. Compare and verification of (α_{copper})< (α_{brass})< ($\alpha_{aluminum}$).
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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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 thier 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 Statitics: 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 Jean's (No derivation) laws, postulates of quantum statistics, Bose-Einstein's statistics- Plank'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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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 **Black Body radiation**, Planck's quantum theory, photo electric effect, Einstein's explanation, Compton effect, Ritz combination principle in spectra, Bohr's quantizaion 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 Hermition 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 Garlach 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 anamalous) and Paschen back effect for one electron atom.

Unit 5 Molecular bonding: ionic and covalent bonding, molecular spectra, rotational energy levels of diatomic molecules, rotational 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 Spectera, 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-utokyox-utokyo003x-1

PHY 306L Quantum Mechanics and Spectroscopy 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:

- 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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	**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:

- 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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. p 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 zaw, X-ray and neutron diffraction, rotating crystal and powder methods, reciprocal lattice, Brilloin 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	**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:

- 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 hysterisis 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 α- absorption in aluminium foil using G.M counter.
10. Determine the g- factor by ESR- set up.
11. Study of variation of modulus of rigidity of a given specimen as a function of temperature.
12. Study the Compton scattering of α - ray and verify the Compton shift formula.

PHY 305 Advanced Semiconductor Devices

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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, P-N 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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. Sheppared'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. 1*. 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

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

- Represent data sets using some diagrams and graphs.
- 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

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

- Find association between two attributes/variables.
- Fit the linear regression equation for real data sets arising in various fields of the populations.
- Understand the concept of multiple and partial correlation.
- Apply selected probability distributions to solve problems.
- Fit the Binomial, Poisson and Normal distribution for real life data.

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*. (11th ed.). Sultan Chand & Sons.
3. Gupta, S. P. (2010). *Statistical Methods* (39th ed.). New Delhi, Himalaya Publication.
4. Mood, A. M., Graybill, F. A. & Boes, D. C. (2001). *Introduction to the theory of Statistics.* (3rd ed.). Tata McGraw Hill.
5. Meyer, P. L. (1970). *Introductory probability and Statistical Applications.* (2nd 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	**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:

- 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

On completion of the course, 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 t, F and $\chi 2$ distribution and their applications on real life situations

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* (11th ed.). New Delhi: Sultan Chand Publication.
3. Gupta, S.P. (2014). *Statistical Methods* (44th ed.). Sultan Chand & Sons.
4. Freund, J. E. (2004). *Modern Elementary Statistics* (12th 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

STAT 209L Sampling Distributions 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:

- Compute and understand testing of significance and confidence intervals for Single mean, Standard deviation/variance and proportion in the context of large as well as small samples effectively
- Formulate and draw valid conclusion for testing equality of two
  - Means
  - Standard deviations/variances
  - Proportions

  in the context oflarge as well as small samples.
- Understand and establish the test for goodness of fit and independence of attributes.

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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

On completion of this course the students will be able to-

- Understand the concept of statistical inference and criteria for a good estimator.
- Apply various basic parametric, non-parametric and sequential estimation techniques and testing procedures on the real life problems.
- Understand the concept of confidence interval,Neyman-Pearson fundamental lemma, MP test, UMP test, etc.
- Understand the concepts of quality control, control charts, SPRT, OC and ASN function.
- Understand the non-parametric techniques such as sign, median and run test and the problems based on these tests.

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 *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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

On 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**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*. (2nd 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*. (3rd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

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

- Learn the basic principles underlying survey design and estimation.
- Draw a random sample by using with and without 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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, Marshel-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^{th}ed.). Macmillan India Ltd.
2. Croxton, F.E. & Cowden, D. J. (1955). Applied General Statistics. (2^{nd}ed.). New York, Prentice-Hall.

STAT 301L Applied Statistics 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:

- 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

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 entrophy. 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*, (3rd 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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

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	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**6**	**0**	**0**	**6**

Learning Outcomes:

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

- Understand different measures related to health statistic,
- 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.
- Calculate and interpret 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* (2nd 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* (19th 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	**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:

- 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

Education

First Semester

EDU 401 Childhood and Growing Up

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**5**	**0**	**0**	**5**

Learning Outcomes:

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

- clarify development as a continuous process.
- explain childhood development in various aspects.
- describe the adolescent stage in reference to characteristics & problems.
- describe the causes of the problems in adolescent learner and imply the suitable solutions.
- recognize and appriciate adolescent learner's uniqueness and enshape them.
- illustrate the impact of social context upon growing child

Course Outline:

Unit I : Learner's Development: A Continuous Process

- Concepts of Growth, Development and Maturity
- Difference between Growth and Development
- Different Stages of Development
- Genetic and Non-Genetic factors affecting Learner's Development

Activity: Identification of cases in which Development is affected by Genetic/Non Genetic Factors

Unit II : Childhood: As a Foundation Stage

- Late Childhood: An Elementary School age with its unique name
- Major Developmental Characteristics in different aspects: Physical, Cognitive, Emotional, Social and Moral.
- Interest and Hazards
- Dealing of late Childhood in reference to Characteristics and Hazards.

Activity: School Visit to observe developmental features and hazards among Children.

Unit III : Adolescent Stage: Transition to Maturity

- A Period of Secondary Schooling
- Development of Adolescent: Physical, Cognitive, Emotional, Social and Moral
- Problems Facing by Adolescents- (concept, features and providing help for solutions)
  - Identity Crisis
  - Physical Abuse (Bullies and Violence)
  - Depression

Activity: Presentation and Discussion on Adolescent's Problems

Unit IV : Adolescents: A Unique Learner

- Adolescent as Unique Learner: Inter and Intra individual Differences
- Differences in Intelligence, Aptitude, Interest and Personality. (Concept, Features, Identification and dealing of above traits among Adolescents)

Activity: Observation of Adolescent in reference to Uniqueness

Unit V : Growing Child in Social Context

- Child in the Family:
  - Child-Family Relationship
  - Blended Family
  - Expectation of Parents
- Child in the School:
  - Influence of Peer Relationship and Peer Culture
  - Relationship with Teachers
- Child in the Society:
  - Impact of Rural/Urban Community
  - Influence of Media

Activity: Study of an Adolescent in relation to Family/School /Society.

Practicum: Any Two of the following

1. To observe a class and describe the developmental characteristics of student in various aspects.
2. Identification of Adolescent's traits through a Psychological test.
3. Presentation of a problem-facing by Adolescent with supports of data and provide helping suggestions.

4. To prepare a term paper on the role of social context and growing child.
5. On the classroom teaching experiences present children problems.

References:

- Barnard, H. W. (1965). *Psychology of Learning Teaching*. New York : Mc.Graw Hill.
- Borich, G. D., & Tombari, M. L. (1997). *Educational Psychology A Contemporary Approach*. New York: Longman.
- Chauhan, S.S. (1998). *Advance Educational Psychology*. New Delhi: Vikas Publication.
- Cronbach, L.J. (1963). *Educational Psychology.* London: Staples Press.
- Crow, L.D., & Crow, A.D. (1964). *Educational Psychology.* Delhi: Eurasia Publishing House.
- Hurlock, E.(1959). *Developmental Psychology*. New York,: Tata Mc Graw Hill Publication Company.
- Kolesnic, W. B. (1953). *Educational Psychology*. New York: Mc. Graw Hill.
- Lindgren, H. C. (1962). *Educational Psychology*. New York:: John Wiley.
- Mangal, S.K.(2009). *Advance Educational Psycholog.* New Delhi: PHI Learning Private Limited..
- Morris, C. G. (1979). *Psychology: An Introduction.*. New Jersey: Prentice Hall.
- Woolfolk, A. E. (1995.) *Educational Psychology*. Bostan, USA: Allyn & Bacon.

Web Resources:

- Stages of Development- http://www.psychologydiscussion.net /psychology/stages-of-development-of-psychology-of-people-at-different-ages-from-infancy-to-old-age/732
- Individual differences- http://www.psychologydiscussion.net/ psychology/individual-differences-psychology/individual-differences-types-causes-and-role-psychology/2557
- Depression- https://www.healthline.com/health/adolescent-depression Differences between growth and development- http://www.preserve articles.com/201102244162/differences-between-growth-and-development.html

Second Semester

EDU 415 Learning and Teaching

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**5**	**0**	**0**	**5**

Learning Outcome:

- differentiate between types of learner while teaching.
- analyze the different factors influencing teaching learning process during class interaction.
- apply different type of methods and media.
- plan according to Phases, level and maxims of teaching.
- manage the classroom as a professional.

Course Outline:

Unit 1 Learner and Learning

- Learning-a natural tendency
- Learning-connotation in education
- Learning inside and outside the school
- Socio-cultural background of Learner

Activity: Report on learning inside or outside schools.

Unit II Teaching process-basic understanding

- Concept of Teaching, Instruction and Training
- Complex nature of Teaching
- Factors influencing Teaching Learning process

Activity: Discussion on factors influencing Teaching Learning Process.

Unit III Modes of Transaction

- Methods in teaching (Concept, Procedure, Advantages and Limitations)
  - Team Teaching, Debate, Workshop, Seminar.
- Instructional Media
  - Type of Media
  - Criteria of Selection

Activity: Term paper on media inclusion in class.

Unit IV Essentials of Teaching

- Phases of Teaching- Pre active, Interactive, Postavtive

- Levels of Teaching- Memory level, Understanding level, reflective level.
- Maxims of Teaching

Activity: Group Discussion on importance of maxims in preparing lesson plan.

Unit V Teaching as a Profession

(a) Teacher Attributes

- Regularity, Punctuality, Teaching Attitude and Professional Ethics
  - Content Mastery and Its Maintenance

(b) Role of Teacher in Classroom Management.

Activity: Sharing Experiences as teacher in managing class.

Practicum: Any two of the following.

1. Report on Learners Behaviour in Classroom Setting.
2. Analysis of Instructional Process.
3. Collection and Presentation of Photographs related to learning inside and outside the classroom.
4. Making a model on one topic of your subject.

References:

- Hough, J. B. & James K. D. (1970). *Teaching: Description and Analysis*. U.S.A.:Addison-Wesley Publishing Company, Massachusetts.
- Cruickshank, D. R., Deborah B. J. & Kim K. M. (2009). *The Act of Teaching.* New York: McGraw-Hill Company.
- Weimer, M. (1996). *Improving your classroom Teaching*. California, U.S.A.:SAGE Publications, Inc.
- Pierce W. D., Micheal A. L. (1977). *Objectives and Methods for Secondary Teaching.* New Jersey: Prentice-Hall, Inc.
- Yadav, N. (2003). *A Handbook of Education Technology*. New Delhi: Anmol Publications Pvt. Ltd.
- Mangal, S.K. & Uma M. (2009). *Essentials of Education Technology*. New Delhi: PHI Learning Private Ltd.
- Capel, Susan, Marilyn L.k & Tony T. (1995). *Learning to teach in Secondary Schools.* London: Routlage.

- Rao, D.B. (2001).*Science & Technology Education*. New Delhi: Discovery House.
- Sampath, Panneevselvan, K.A. & Santhanam, S. (1994). *Introduction to Education Technology*, Steerling Publication pvt., Ltd.
- Sharma, R.A. (2000). *Technological Foundation of Education Technology*. Meerut: International Publications.
- Sood, J.K. (1989). *New Direction in Science Teaching*. Chandigarh: Kohli Publishers.
- Washton, N.S. (1967). *Teaching Science Creativity*. London: W.B.Saunders Company.
- Sharma R.A. (1987). *Shiksha Takniki*. Meerut: Loyal Book Depot.
- Sharma Y.K. (2002). *Fundamentals of Educational Technology*. New Delhi: Kaniska Publishers.
- Saxena, N.R.S & S.C. Oberoi (1996). *Technology of Teaching*. Meerut; R.L. Book.
- Wragg E.C. (1996). *Classroom Teaching Skills.* London: Routledge.
- Kumari, S. (2004). *Increasing Role of Technology in Education*. Delhi: Chawla Offset Press.

Web Resources:

- Instructional media and Types of Media- http://hackscience.net/etm/Efficacious%20Technology%20Management%20ver.%201.2.pdf
- Role of Teacher in Classroom Management- https://books.google.co.in/books?id=dQsE9WisCIYC&printsec=frontcover&dq=teacher+and+classroom+management&hl=en&sa=X&ved=0ahUKEwi2qq3R7dDfAhVYfCsKHQINAI8Q6AEINTAC#v=onepage&q=teacher%20and%20classroom%20management&f=false
- Learning - inside and outside the school- http://www.ignouhelp.in/ignou-study-material/
- Socio-cultural background of learner- http://egyankosh.ac.in//handle/123456789/47116
- Concept of Teaching, Instruction & Training- http://www.ignouhelp.in/ignou-study-material/
- Phases of Teaching- http://www.ignouhelp.in/ignou-study-material/

Third Semester

EDU 503 Contemporary Indian Education

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**5**	**0**	**0**	**5**

Learning Outcome:

- reflect diversity in Indian Society.
- express the constitutional values (Secularism, Socialism, Democracy) as reflected in Education.
- analyze the roles of commissions and policies in Secondary Education.
- deal with inequality and marginalization related issues in India.
- analyze and appraise the policy framework for Public Education in India.

Course Outline:

Unit I Diversity in Indian Society

- Basic Features of Indian Society
- Relationship between Education and Society.

Activity: Discussion on Society and role of Education

Unit II Constitutional Values and Education

Realisation of following Values through Education

- Secularism
- Socialism
- Democracy

Activity: Thematic presentation on attainment of Constitutional Values through Education.

Unit III Commission and Policies for Secondary Education in India.

- Secondary Education Commission (1952-53).
- Education Commission (1964-66)
- NPE-1986.

  Objectives and Structure of Education, Curriculum, Methods of Teaching, Women Education, Status of Teachers).

Activity: Critical analysis of recommendations of Commissions and Policy provisions for Secondary Education in India.

Unit IV Inequality and Marginalization in Indian Society

Status, problems and role of different agencies (Educational institution and Government) regarding-

- Education for Women
- Education for Physically disadvantaged.
- Education for Socially disadvantaged.

Activity: Presentation and discussion on status of problems related to inequality and marginalization.

Unit V Policy and programmes for Promoting Public Education in India.

Critical Appraisal of Implementation of following-

- Sarva Shiksha Abhiyan (SSA)
- Rashtriya Madhyamik Shiksha Abhiyan (RMSA)
- Mid Day Meal (MDM)

Activity: Critical analysis on status of SSA, RMSA and MDM programmes.

Practicum: Any two of the following:

- One thematic term paper and its presentation in classroom.
- Organisation of a thematic exhibition
- Group Discusssion on
  - Fundamental Rights and Duties of citizens in India.
  - Directive Principles of state policies.

References:

- अग्निहोत्री, आर. (2008). *आधुनिक भारतीय शिक्षाः समस्याएँ और समाधान.* जयपुरः राजस्थान हिन्दी ग्रन्थ अकादमी.
- भारत सरकार (1986). *नेशनल पॉलिसी ऑन एज्यूकेशन.* मानव संसाधन विकास मंत्रालय. नई दिल्लीः शिक्षा विभाग,
- भारत सरकार 1985., *शिक्षा नीति की चुनौती.* नई दिल्लीः शिक्षा मंत्रालय.
- Bhattacharya, S. (2003). *Foundations of Education.* Delhi: Atlantic Publishers and Distributors.
- Dhiman, O.P. (2007). *Principles and Techniques of Education.* Delhi: Kalpaz publications.

- Jayapalan, N. (2005). *Problems of Indian Education.* Delhi: Atlantic Publishers and Distributors.
- मदन, जी. आर. (1988). *समाजशास्त्र के सिद्धांत.* दिल्लीः आत्माराम एण्ड सन्स.
- Mangla, S. (2012). *Teacher Education, Trends and Strategies.* New Delhi: Radha Publications.
- माथुर, एस. एस. (1978). *शिक्षा सिद्धांत.* आगराः विनोद पुस्तक मंदिर.
- ओड, एल. के. (1978). *शिक्षा के नूतन आयाम.* जयपुरः राजस्थान हिन्दी ग्रन्थ अकादमी.
- पाण्डेय, आर. (2005). *शिक्षा की दार्शनिक एवं समाजशास्त्रीय पृष्ठभूमि.* आगराः विनोद पुस्तक मंदिर.
- पाण्डेय, आर. (1986). *शिक्षा के मूल सिद्धांत.* आगराः विनोद पुस्तक मंदिर.
- पारीक, एम. एवं शर्मा, आर. (2004–05). *उदीयमान भारतीय समाज और शिक्षा.* जयपुरः शिक्षा प्रकाशन.
- Pathak, R.P. (2009). *Philosophical and Sociological Foundations of Education.* Kanishka Publications distributors.
- रावत, पी. (1992). *भारतीय शिक्षा का इतिहास.* आगराः रामप्रसाद एण्ड सन्स.
- Reddy, V., Daya K. and Rao, D. B. (2006). *Value Oriented Education.* New Delhi: Discovery Publishing House.
- Report of Education Commission (1964-66). *Ministry of Education & Culture.* New Delhi: Govt. of India,
- Report of Secondary Education Commission (1952-53). *Ministry of Education & Culture.* New Delhi: Govt. of India
- Saini, S.K. (1980). *Development of Education in India: Socio economic and political perspective.* New Delhi: COSMO publications.
- सक्सैना, आर., शर्मा, जी. एवं शास्त्री, आई. (2000). *उभरते हुए भारतीय समाज में शिक्षा एवं शिक्षक.* जयपुरः क्लासिक पब्लिकेशन्स.
- शर्मा, डी. एल. (1994). *शिक्षा तथा भारतीय समाज.* मेरठः आर लाल बुक डिपो.
- शर्मा, आर. ए. (1998). *शिक्षा तकनीकी.* मेरठः आर. लाल बुक डिपो.

- Sharma, B.L. and Maheshwari, *B.K* (2010). *Education for Values, Environment Human Rights.* Meerut: R. Lall Book Depot.
- Sharma, B. (2004). *History of Indian Education.* New Delhi: Vohara Publishers and Distributors.
- Sharma, R. A. (2008). *Metaphysics, Epistemology, Axiology and Education.* Meerut: R. Lall Book Depot,
- सिंह, आर. पी. एवं उपाध्याय, आर. *शिक्षा के दार्शनिक एवं सामाजिक सिद्धांत.* आगराः विनोद पुस्तक मंदिर.
- Singh, L.C. Sharma, P.C. (1995). *Teacher Education and Teacher.* New Delhi: Vikas Publication House.
- Srivastava, K.K. (2003). *Philosophical Foundations of Education.* New Delhi: Kanishka Publishers distributors.
- Taneja, V. R (2005). *Philosophical Approach to Education.* Delhi: Atlantic Publishers Distributors.
- Taneja, V. R. (2002*). Foundation of Education (Philosophical and Sociological).* Chandigarh: Abhishek Publications.

Web Resources:

- Mid day Meal:
  http://mdm.nic.in/VDO.html
- Mid day Meal (Capacity Building):
  http://mdm.nic.in/Capacity_building.html
- Mid day Meal (School Health Program):
  http://mdm.nic.in/School%20Health%20Program.html
- Mid day Meal (Community Participation):
  http://mdm.nic.in/Community%20Participation.html
- Right to Education:
  http://rte.raj.nic.in/View/ViewDocuments.aspx?id=167&type=1
- Rashtriya Madhymik Shiksha Abhiyan
  http://rajrmsa.nic.in/Public/DOCView.aspx?Title=Documents&Id=1
- Secondary Education Commission (1952-53):
  http://dspace.gipe.ac.in/xmlui/bitstream/handle/10973/33772/GIPE-111964.pdf?sequence=2&isAllowed=y

- Education Commission (1963-64): http://www.kkhsou.in/main/education/edu_commission.html
- National Policy on Education 1986:
  www.ncert.nic.in/oth_anoun/npe86.pdf
- Review of National Policy on Education 1986:
  http://www.kkhsou.in/main/education/national_policy1992.html
  http://www.right-to-education.org/girlswomen
- Position Paper National Focus Group on Education of Children with Special Needs: http://www.ncert.nic.in/new_ncert/ncert/rightside/links/pdf/focus_group/special_ed_final1.pdf
- Policies, Programmes and Schemes for Educational Development of Children from Scheduled Castes: www.ncert.nic.in/departments/nie/degsn/pdf_files/degsnmodule6.pdf

Fourth Semester

EDU 413 Knowledge and Curriculum

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**5**	**0**	**0**	**5**

Learning Outcome:

- explain the conceptual basis of knowledge and as a process.
- analyze various approaches of knowledge structuring.
- describe the form of knowledge.
- discuss the epistemological bases of education and implementing the different learner driven pedagogies.
- explain the concept and various kinds of curriculum.
- analyze and synthesize the different phases of curriculum.
- critically analyze the curriculum frame work as a policy decisions.

Course Outline:

Unit I Conceptual Basis of Knowledge

- Meaning of Data, Information, Knowledge and Wisdom.
- Ways of Knowledge Acquisition: Observation, Experience, Reasoning and Inference.

- Knowledge and Skills needed in Democratic Citizenship

Activity: Exposing learners to diverse situations for exploring (Discussion, research and Documentation)

Unit II Epistemological Bases of Education

- Meaning of Education**:** Etymological, Analytical, Narrow and Broader**.**
- Diverse Philosophies and Perspectives in Education of: Swami Vivekananda, Mahatma Gandhi, Plato and Dewey (In reference to their Epistemological perspectives).
- Learner driven pedagogies: Activity and Discovery.

Activity: Discussion on Epistemological perspectives of Education

Unit III Approaches and form of Knowledge Structuring

- Domain Wise: Cognitive, Affective and Psycho-Motor
- Multidisciplinary and Interdisciplinary (concept and features)
- Interrelationship of the following with Education and theirreflection in Curriculum
  - Nationalism
  - Universalism
  - Secularism

Activity: Preparation of Group Project Based on any of Social Concerns

Unit IV Curriculum: Concept and Kinds

- Concept of Curriculum, Syllabus and Text Book.
- Kinds of Curriculum:
  - Recommended Curriculum
  - Taught Curriculum
  - Learnt Curriculum
  - Hidden Curriculum
- National Curriculum Framework and its association with national mission and vision

Activity: Writing and Presentation of a Paper on any Kind of Curriculum

Unit V Curriculum Development

- Need of curriculum development
- Principles of Curriculum Development

- Phases of Curriculum
  - Curriculum Development
  - Curriculum Transaction
  - Curriculum Evaluation (with respect to aims of education)

Activity: Evaluation of secondary level school subject curriculum.

Practicum: Any two of the following:

- Identify and presentation of Epistemological ideas of Vivekananda, Gandhi, Plato and Dewey.
- Writing a thematic term paper and its presentation in classroom.
- Presentation on social concerns through exhibition.
- Critical analysis of latest NCF in the specific context of constitutional values.

References:

- Aggrawal, J. C. and Gupta, S. (2005). *Curriculum Development.* New Delhi: Shipra Publisher.
- Alaxander, W. M. & Saylor, J. G. (1966). *Curriculum Planning for modern schools*. New York: Holt, Rinhart and Winston Inc.
- Balrara, M. (1999). *Principles of Curriculum Renewal*. New Delhi: Kanishka Publishers.
- Butler, D. I. (1968). *Four philosophies and their practice in Education* (II Ed). New York: Harper and Row Publishers.
- Candra, A. (1977). *Curriculum Development and Evaluation in education.* New Delhi: Sterling Publishers.
- Chandra, A. (1977). *Curriculum Development and Evaluation in education.* New Delhi: Sterling Publishers.
- Chandra, S.S. and Sharma, R.K. (2007). *Philosophy of Education*. New Delhi: Atlantic publishers & distributors pvt. Ltd.
- Darji, D. R. and Lulla, B. P. (1967). *Curriculum development in secondary schools of Baroda.* Baroda: Sadhana Press.
- Dupuis, A. M. (1966). *Philosophy of education in Historical Perspective.* New Delhi: Thomson Press India Ltd.

- Erickson, H.L. (2007). *Concept Based Curriculum and Instruction for the thinking Classroom*. California: Corwin Press.
- Gupta, R. and Bajaj, M.M. (2008). *Principles of Education.* New Delhi: Sahib Publishers and distributors.
- Hassrin, M. (2004). *Curriculum Planning for elementary education.* New Delhi: Anmol Publishers.
- Herbert, J. W. and Geneva, D. H. (1990). *International Encyclopedia of Education Evaluation*. New York: Pergamon Press Oxford House.
- Jenkins, D. and Shifrnan, D. M. (1976). *Curriculum an introduction.* London: Pitman Publishing House.
- Jhompson, K. and White, J. C. (1975). *Curriculum development.* London: Pitman Publishing House.
- Khan, M.I. and Nigam, B.K. (2007).*Curriculum reform change and continuity*. New Delhi: Kanishka publication.
- Kumari, S. and Srivastava, D. S. (2005). *Curriculum and Instruction*. New Delhi: Shipra Publishers.
- Saxena, N.R.S. (2011). *Philosophical and Sociological Foundation*. Meerut: R.Lall book depot.
- Macdonald, B. and Walker, R. (1976). *Changing the Curriculum*. Britain: Pitman Press.
- Musgrave, P. W. (1974). *Contemporary studies in the Curriculum*. Australia: Angus and Roberston Publishers.
- Nigam, B. K. and Khan, I. M. (1993). *Evaluation and research in Curriculum Construction*. New Delhi: Kaniska Publishers.
- Ornsttein, A. C. and Hunkins, F.P. (1988). *Curriculum foundations, Principles and issues.* New Jersey: Prentice hall.
- Panday, M. (2007). *Principles of Curriculum Development*. New Delhi: Rajat publications.
- Rajput, J. S. (2004). *Encyclopedia of Indian Education*. New Delhi: NCERT.
- Satyanarayan, P.V. (2004). *Curriculum development and management*. New Delhi: DPH.

- Sharma, S. R. (1999). *Issues in Curriculum Administration*. New Delhi: Pearl Publishing House.
- Sharma, R. (2002). *Modern methods of Curriculum Organisation*. Jaipur: Book Enclave.
- Srivastava, H. S. (2006). *Curriculum and methods of teaching*. New Delhi: Shipra Publishers.
- Taba, H. (1962). *Curriculum development theory & practice*. New York: Harcourt, Brace & World Inc.
- Yadav, M.S. and Lakhmi, T.K.S. (2003). *Conceptual Inputs for Secondary Teacher Education*. New Delhi : NCTE.
- Yadav, Y.P. (2006). *Fundamentals of Curriculum design*. New Delhi: Shri Sai Printographers.
- ik.Ms;] jke'kdy- ¼2003½- *mnh;eku Hkkjrh; lekt esa f'k{kd*- vkxjk% fouksn iqLrd eafnj-
- सक्सेना, एन. आर. स्वरूप एवं चतुर्वेदी, शिखा. (2006). *उदीयमान भारतीय समाज में शिक्षक.* मेरठ : आर. लाल. बुक डिपो.
- लाल, रमन बिहारी. (1995). *शिक्षा के दार्शनिक एवं समाजशास्त्रीय सिद्धांत.* मेरठ : रस्तौगी पब्लिकेशन्स.
- चौबे, सरयुप्रसाद. (1993). *शिक्षा के दार्शनिक, ऐतिहासिक एवं समाजशाास्त्रीय आधार.* मेरठ : आर. लाल. बुक डिपो.
- ओड, एल. के. (2004). *शिक्षा की दार्शनिक पृष्ठभूमि.* जयपुर : राजस्थान हिन्दी ग्रन्थ अकादमी.
- गुप्त, रामबाबू. (1983). *महान पाश्चात्य शिक्षा शास्त्री.* कानपुर : सामाजिक विज्ञान प्रकाशन.
- पाण्डेय, रामशकल. (1994). *भारतीय शिक्षा दर्शन.* आगरा : विनोद पुस्तक मन्दिर .
- पचौरी, गिरीश. (2003). *शिक्षा के दार्शनिक आधार.* मेरठ : आर. लाल. बुक डिपो.
- तिवारी, के. एन. (2002). *तत्वमीमांसा एवं ज्ञान मीमांसा.* नई दिल्ली : मोतीलाल बनारसीदास.
- श्रीवास्तव, मदनमोहन. (2007). *शिक्षा के दार्शनिक परिप्रेक्ष्य.* वाराणसी : विजय प्रकाशन मन्दिर.

Web Resources:

- Ways of Knowledge Acquisition: Observation, Experience, Reasoning and Inference- www.ignouhelp.in/ignou-bed-study-material/ , http://www.bdu.ac.in/cde/docs/ebooks/ BEd/II/KNOWLEDGE%20AND%20CURRICULUM.pdf
- Knowledge and Skills needed in Democratic Citizenship- http://epathshala.nic.in/programmes/national-curriculum-frameworks/
- Meaning of Education**:** Etymological, Analytical, Narrow and Broader- www.ignouhelp.in/ignou-bed-study-material/ , www.elearning.uou.ac.in/mod/resource/view.php
- M K Gandhi and Education- https://www.mkgandhi.org/edugandhi/index.htm, https://www.mkgandhi.org/edugandhi/gviews.htm, http://www.shareyouressays.com/essays/ essay-on-the-main-principles-of-gandhis-educational-philosophy/116633
- Swami Vivekananda and Education-http://www.shareyouressays. com/hindi-essays/essay-on-the-life-of-swami-vivekananda-in-hindi/109423,http://www.shareyouressays.com/essays/essay-on-the-aims-of-education-according-to-swami-vivekananda/116644,http://www.shareyouressays.com/essays/essay-on-the-main-principles-of-swami-vivekanandas-educational-philosophy/116643,http://ncte-india.org/nctenew/pdf/Swami% 20Vivekananda1.pdf
- Domain Wise Knowledge structuring-http://www.nwlink.com/~ donclark/hrd/bloom.html
- Discovery as a Learner driven pedagogy- http://www.academia.edu/ 9838419
- Multidisciplinary and Interdisciplinary Approach of Knowledge Structuring https://www.researchgate.net/.../ 267939164_Disciplinary_ Multidisciplinary_Interdisciplinary-Concepts_and_Indicators, *https://pdfs.semanticscholar.org/a356/a7d8086b5d85e7804b7d25d421 520562309d.pdf*
- Concept of Curriculum, Syllabus and Text Book.- www.assets. vmou.ac.in/BED115.pdf , www.elearning.uou.ac.in/mod/resource/view.php,http://egyankosh.ac.i n/bitstream/123456789/46021/1/BES-126B2E.pdf, http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/II/KNOWLEDGE%20AND%20CURRICULUM.pdf

- Types of Curriculum- http://egyankosh.ac.in/bitstream/123456789/46021/1/BES-126B2E.pdf
- National Curriculum Framework - http://epathshala.nic.in/programmes/national-curriculum-frameworks/
- Curriculum Development- http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/II/KNOWLEDGE%20AND%20CURRICULUM.pdf
- Curriculum Transaction- http://egyankosh.ac.in/bitstream/123456789/42017/1/Block-2.pdf

Curriculum Evaluation- http://egyankosh.ac.in/handle/123456789/ 42631

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

Discipline Electives (Focal Area)

EDU 414 Language across the Curriculum

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- employ language according to its nature and function to acquaint with language diversity in classroom.
- carry out classroom interaction in reference to first, second and third language,
- appreciate multilingualism and culture in their class
- resolve Communication Problem of school Students.
- appreciate challenges of language across the curriculum(LAC).
- analyze barriers of Listening, Speaking, Reading and Writing (LSRW) skills

Course Outline:

Unit I Nature and Functions of Language

- Language – Concept
- Functions of Language

- Language used in classroom by teacher and students: Barriers & Strategies to overcome them

Activity: Group discussion on language used in classroom discourse

Unit II Language Diversity in Classrooms

- Concept and importance of First Language Acquisition and Second Language Learning
- Use of First and Second Language in the Classroom
- Multilingualism- Concept, Concern and Challenges

Activity: Presentation (Thematic paper/posters/multimedia/Role play) on relationship between language and culture

Unit III Communication and Language Across Curriculum

- Communication – Meaning and Importance
- Types of Communication (Means, Direction and Network)
- Communication flow in school
- Language Across the Curriculum: Concept, importance and Challenges

Activity: School visit to find out communication problem/apprehension in school Students

Unit IV Developing Receptive Skills

- Barriers to Listening Skills
- Activities for Developing Listening Skills
- Barriers to Reading Skills
- Activities for Developing Reading Skills

Activity: Identification of barriers of receptive skills.

Unit V Developing Productive Skills

- Barriers to Writing Skills
- Activities for Developing Writing Skills
- Barriers to Speaking Skills
- Activities for Developing Speaking Skills

Activity: Identification of barriers of productive skills.

Mode of transaction: Lecture, discussion, exercises, assignments, language games, seminar and dialogue.

Practical Work: Any two of the following:

1. Designing Games and Exercises for Developing Listening, Speaking, Writing and Reading Skills.
2. Organisation and participation in activities for Writing Skills- Summary, Letter, Paragraph, Essays, Speech.
3. Organisation and participation in activities for Speaking Skills – Oral Presentations, Debate, Elocution, Discussion, Brain-storming.
4. Assignments on Developing Listening Skills – Listening to speech, directions.
5. The thematic term paper.

References:

- Akmajian, A. et al. (2010). *Linguistics: Introduction to Language and Communication.*
- (6thed.). Cambridge: MIT Press.
- Fasold, R. & Connor-Linton, J. (2013).*An Introduction to Language and Linguistics*.
- (6thed.). Cambridge: Cambridge University Press.
- Floyd, K. (2009). *InterpersonalCommunication*. NewYork: McGraw Hill Companies Inc.
- Fromkin, V, Rodman, R & Hyms, N. (2011).*Introduction toLanguage.*(9thed.). Canada: Cengage Learning.
- Pearson, J.C. et al. (2011). *Human Communication.* (4th ed.). New York: McGraw Hill Companies Inc.
- लाल, आर., ब. (1965). *हिन्दी शिक्षण.* मेरठः रस्तोगी एण्ड कम्पनी.
- मत्तल, एस. (2005). *शैक्षिक तकनीकी.* जयपुरः राजस्थान हिन्दी ग्रन्थ अकादमी.

Web Resources:

- First and Second Language Acquisition- a Brief Comparison. Retrieved from https://www.uni-due.de/ELE/FLA_SLA_brief_comparison.pdf
- Similarities and Differences between First and Second Language AcquisitionRetrievedfrom http://multilingualism.pbworks.com/w/page/21913433/Similarities%20and%20Differences%20between%20First%20and%20Second%20Language%20Acquisition
- Activities for Developing Speaking Skill Retrieved from

http://faculty.weber.edu/ppitts/ed4320/Handouts/speakingskills.htm

http://www.educ.ualberta.ca/staff/olenka.Bilash/best%20of%20bilash/speaking.html

- Activities for Developing Listening Skill Retrieved from

  http://www.educ.ualberta.ca/staff/olenka.bilash/best%20of%20bilash/listening.html

  https://blog.udemy.com/listening-skills-exercises/

EDU 508 Understanding Discipline and Subjects

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- utilize the nature and importance of Disciplinary Knowledge in class
- differentiate present content of teaching subject in school with its history
- appreciate the paradigm shift in disciplines
- critically appraise the Disciplinary and Interdisciplinary Subjects
- appraise the phenomenon of Interdisciplinary approach to Subjects

Course Outline:

Unit I Disciplinary Knowledge

- Nature of Disciplinary Knowledge
- Importance of understanding disciplinary knowledge for teachers

Activity: Presentation of disciplinary knowledge from socio-Cultural, Political and Intellectual Context

Unit II Disciplinary areas in School

- Disciplinary areas in School education– Language, Mathematics, Social Science, Science
- Paradigm shifts in nature of discipline
- History of teaching subject areas in school at a glance.

Activity: Poster presentation on History of Teaching subject in school.

Unit III Understanding School Subject (Content)

Nature of content in school subject

- Theory of Content-
  - content selection,
  - framing in syllabus
  - transformation of content
- Relationship between Curriculum, syllabus and text book-basic features in modern context

Activity: Discussion on identification of organization of knowledge in any one school subject.

Unit IV Disciplinary Subject in School

- Role of disciplinary Knowledge in School Curriculum
- Critical Appraisal of disciplinary subject in school

Activity: Discussion on knowledge of disciplinary subject

Unit V Interdisciplinary Approach and Subject

- Objectives of Interdisciplinary subjects
- Critical Appraisal of Interdisciplinary subject in school

Activity: Presentation and discussion on phenomenon of Interdisciplinary approach

Practicum

- One thematic term paper
- Critical Appraisal of inter Disciplinary subject in school curriculum.

Reference:

- Maisnan Premlata, Lenka, S.K., Gandhi A.K., (2016), *Understanding Discipline and Subject*, Meerut, Surya R. Lall Publisher.
- Makel, Rajesh, MakalLalita, (2016), *Understanding Discipline and Subject*, Delhi.
- Pandey, Ranjana, 2016, *Understating Discipline and subject*, Meerut, Surya R. LallPubl.
- TallaMrunalini, 2012, *Curriculum Development - Perspectives*, Principles and Issues, Noida, Pearson India education Service Pvt. Ltd.
- Yadav, GhawriSapna, 2016, *Knowledge and Curriculum*, New Delhi, Paragon International Publ.
- Yadav, M.S. and Lakhmi, T.K.S. (2003) *Conceptual Inputs for Secondary Teacher Education*, NCTE, New Delhi.

- Alaxander, W. M., & Saylor, J. G. (1966).*Curriculum Planning for modern schools*. New York: Holt, Rinhart and Winston Inc.
- Balrara, M. (1999).*Principles of Curriculum Renewal*. New Delhi: Kanishka Publishers.
- Candra, A. (1977).*Curriculum Development and Evaluation in education*. New Delhi: Sterling Publishers.
- Darji, D. R., &Lulla, B. P. (1967).*Curriculum development in secondary schools of Baroda*.Baroda: Sadhana Press.
- Erickson, H.L.(2007) *Concept based curriculum and instruction for the thinking classroom* California; corwin press.
- Hassrin, M. (2004).*Curriculum Planning for elementary education*. New Delhi: AnmolPublishers.
- Satyanarayan, P.V. (2004).*Curriculum development and management*. New Delhi: DPH.
- Taba, H. (1962).*Curriculum development theory & practice*. New York: Harcourt, Brace &World Inc.
- Yadav, Y.P. (2006). *Fundamentals of Curriculum design*. New Delhi; ShriSaiPrintographers.
- NCERT(2000) *National curriculum framework* (NCF 2000), New Delhi.
- NCERT(2005) *National Curriculum framework* (NCF2005), New Delhi
- Arulsamy, S., (2011). Curriculum Development, Hyderabad, Neelkamal Publication Pvt. Ltd.
- Kalaiyarasan, G., (2017). Curriculum Development, New Delhi, APH Publishing Corporation.
- सिन्धु, पू., यादव सं. (2014). *पाठ्यक्रम विकास और अनुदेशन.* नई दिल्ली: अर्जुन पब्लिशिंग हाउस.
- भाटिया, एस., के., जिन्दल, स. (2017). *पाठ्यचर्या, शिक्षण–शास्त्र एवं मूल्यांकन.* नई दिल्ली: पैरागॉन इण्टरनेशनल पब्लिशर्स.
- लाल, ब., र., पलोड़, स. (2016). *ज्ञान और पाठ्यचर्या.* मेरठ: आर. लाल बुक डिपो.
- सक्सैना, स्व., एन. आर, गुप्ता, महिमा, कुमार, सं., कु, ध. (2016). *ज्ञान और पाठ्यक्रम.* मेरठ: आर. लाल बुक डिपो.

- तावडे, र., तिवारी, कु, म. (2015). *शिक्षा के उद्देश्य, ज्ञान एवं पाठ्यचर्या.* जयपुरः अनु प्रकाशन.
- पालीवाल, प्र, तिवारी, क. (2016). *ज्ञान एवं पाठ्यक्रम, भाग–2.* आगराः राखी प्रकाशन प्रा. लि.
- परवीन, अ., गुप्ता, अं, शर्मा, स., गुप्ता, र. (2016). *ज्ञान और पाठ्यक्रम.* जयपुरः आस्था प्रकाश.

Web Resources:

- Understanding Disciplines and Subjects, retrieved from www.tnteu.in/pdf/c5.pdf
- The Paradigm Shift in Education In India, retrieved from
- shodhganga.inflibnet.ac.in/bitstream/10603/29463/9/09_chapters%201-6.pdf
- Formation of school subjects as curriculum content, retrieved from oru.diva-portal.org/smash/get/diva2:303864/FULLTEXT01.pdf
- School subjects and academic disciplines: the differences, retrieved from https://www.researchgate.net/.../284157807_School_subjects_and_academic_disciplines..
- Inter Disciplinary Subjects , retrieved from *shodhganga.inflibnet.ac.in/bitstream/10603/96850/11/11_chapter%203.pdf*
- Disciplinary, Multidisciplinary, Interdisciplinary -Concepts and Indicators https://www.researchgate.net/.../267939164_Disciplinary_Multidisciplinary_Interdisciplinary.
- HM Kliebard (1985) Structure of the Disciplines as an Educational Slogan www1.udel.edu/educ/whitson/897s05/files/KliebardStructDiscs-.pdf
- *Slattery, J.M.; Carlson, J.F. (2005)."Preparing an effective syllabus: current best practices". College Teaching.54 (4): 159–164.* doi:10.3200/CTCH.53.4.159-164
- *Habanek, D.V. (2005). "An examination of the integrity of the syllabus". College Teaching.53 (2): 62–64.* doi:10.3200/ctch.53.2.62-6

EDU 504 Gender, School and Society

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

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

- approve and appreciate gender equality .
- elucidate the constitutional and legal provisions related to women.
- disapprove the gender bias in family, workplace and educational institution.
- appreciate the role of education in eradicating gender bias.
- discuss the achievements and problems related to transgender.
- reflect roles and responsibilities of various agencies in promoting gender equalities.

Unit-I: Basic Concepts related to Gender

- Sex and Gender-Concept and Difference
- Patriarchy and Matriarchy-Concept and Difference
- Gender related terms
  - Gender Bias
  - Gender Stereotype
  - Gender Disparity
  - Gender equality

Activity – Discussion on key Gender related termsGender

Unit- II: Constitutional and Legal Provisions

- Constitutional Provisions related to women
- Legal Provisions
  - Dowry Prohibition Act, 1961
  - Sexual Harassment Act,2013
  - The Protection of Women from Domestic Violence Act, 2005

Activity - Presentation and Discussion on Constitutional Provisions and Legal Polices related to women.

Unit- III: Gender Bias in School and Society

- Gender bias in School Education

  (School Setting, Text Book, Class Interaction and Co-Curricular Activities)
- Gender bias in family
- Gender bias in workplace
- Role of Education in eradicating gender bias in School and Society.

Activity –Analysis of Secondary level text book.

Unit –IV: Transgender: Issues and Legal Provision

- Concept of Transgender
- Problems related to Transgender
- Achievements of Transgender
- Legal Provision for Transgender
- Role of Education to overcome the problems of Transgender

Activity - Presentation and Discussion on Problems and Achievements of Transgender.

Unit –V: Role and Responsibilities in Promoting Gender Equalities

- Family
- Community
- Mass Media: Print and Electronic Media

Activity - Display roles of Mass Media towards gender equality through poster/charts.

Practicum- Any two of the following:

- School Visits/Observe the Schooling Processes from a Gender Perspectives and Submission of its Report.
- Thematic term paper
- Exhibition on gender related issues
- Survey based activity on gender issues

References:

- Bagchi, Jasodhara, Guha, Jaba and Sengupta, Piyali (eds). (1997). *Loved and Unloved: the Girl Child in West Bengal*. Kolkata: Stree Publishers.
- Bank, B.J. (2007). *Gender and Education: An Encyclopedia.* London: Praeger, Westport.
- Batliwala, Srilatha. (1993). *Empowerment of Women in South Asia: Concepts and Practices*. New Delhi : Asian-South Pacific Bureau of Adult Education.
- Bhasin, Kamla.(2000). *Understanding Gender*. New Delhi: Kali for Women.
- Bhasin, Kamla. (2004). *Exploring Masculinity*. New Delhi: Women Unlimited.
- Bhatt, B.D. & Sharma, S.R. (1992). *Women's' education and social Development.* Delhi: Kanishka.
- Chanana, Karuna(ed.). (1988). *Socialisation, Education and Women: Explorations in Gender Identity*. New Delhi: Orient Longman.
- Gould, S. J. (1981). *The Mismeasure of Man*. London: Penguin Books.
- Govinda, R. (ed.). (2002). *India Education Report: A Profile of Basic Education*. New Delhi: Oxford University Press.
- Kathleen, W. (1988). *Women Teaching for Change: Gender, Class, and Power*. New York: Bergin Garvey.
- Mehrotra, S. (2006). *Child Malnutrition and Gender Discrimination in South Asia.* Economics and Political Weekly, Vol. 41, No. 10 (Mar. 11-17, 2006), pp. 912-918.
- Ramachandran, V. (2004). *Gender and Social Equity in Education: Hierarchies of Access*. New Delhi: Sage.
- Ramchandran, V. (1998). *Girls and women Education: Policies and implementation Mechanism.* Case study: India, Bangkok, UNESCO.
- Sharma, M.C. & Sharma, A.K. (2003). *Discrimination based on Sex, caste, religion and disability: Addressing through educational interventions; A handbook for Sensitizing Teacher and Teacher educators.* NCTE & NHRC.
- Subramanyam, R. (2003). *Gender Equality in Education: Definitions and Measurements*. International Journal of Educational Development, July 2005. Vol.25 No.4: p.p. 395-407.

Web Resources:

- Gender School and Society, http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/II/GENDER,%20SCHOOL,%20SOCIETY%20AND%20INCLUSIVE%20SCHOOL.pdf
- Gender Bias in Education, http://uou.ac.in/sites/default/files/bed17/PE-5.pdf
- Dowry prohibition Act, 1961. http://wcd.nic.in/act/dowry-prohibition-act-1961
- Sexual Harassment Act,2013 http://legislative.gov.in/sites/default/files/A2013-14.pdf
- Domestic Violence Act, 2005. http://wcd.nic.in/sites/default/files/wdvact.pdf
- Problems of Transgender. www.academia.edu/33006703/problems-of-transgender-in-india-a-study-from-social-exclusion-to-social-inclusion
- Transgender Rights in India- http://iasscore.in/national-issues/transgender-rights-in-india
- Transgender Rights. www.clearias.com/transgender-rights

EDU 402 Creating an Inclusive School

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

Student teacher will be able to :

- Analyze and explain the diversity in Indian classroom, School and Society.
- Differentiate the concept of Special Education, Integrated Education and Inclusive education.
- Analyze and discuss about National initiatives and provisions for Inclusive Education.
- Use various aids and equipments in Inclusive Classroom.
- Create learning environment of an Inclusive Classroom.
- Discuss the role of supportive services in Inclusive Schools.

Course Outline:

Unit I : Classroom as Reflection of Society

- Meaning of Diversity
- Diversities in Indian Society
- Diversities in Indian Classroom
- CWSN (Children with Special Need) in classrooms.
  - Concept & Categories

Activity: Discussion on the type of diversity which exist in Indian Classroom.

Unit II : Inclusive Education: An Overview

- Concept of Inclusion
- Different relative concepts - Special Education, Integrated Education, Inclusive Education.
- National Initiatives for Inclusive Education
  - RCI Act 1992
  - PWD Act 1995
  - Sarva Shiksha Abhiyaan (SSA)
  - NCF 2005

Activity: Presentation on any initiative programme for Inclusive Education.

Unit III : Inclusive Schools - Provision

- Provision in Inclusive Schools
  - Physical Facilities
  - Aids & Equipments
- Curricular Adaption for CWSN.
- Role of a Teacher in Inclusive School.

Activity: Discussion on teacher's role in inclusive school.

Unit IV : Generating Learning Environment in Inclusive Classroom

- Pedagogical strategies to support learners' need-
  - Cooperative Learning,
  - Peer Tutoring,
  - Individualized Education Programm (IEP),
  - Multisensory Teaching.

- Evaluation process in Inclusive Classroom (with reference to CBSE & RBSE's Provisions).

Unit V : Supportive Services for Inclusive Schools

- Role of Supportive Services for Inclusive Schools
  - In-service Teacher Educations Institutions
  - Professionals.
  - Parents
  - Community

Activity: Group discussion on supportive services for Inclusive Schools.

Practicums: (Any two of the following)

1 Visit and observation of Inclusive school and preparation of a report about provisions in inclusive school.

2 Exhibition on Inclusive Education

3 Thematic Term paper.

References:

- Dash, N. (2006). *Inclusive Education for CWSN*. New Delhi: Atlantic Publisher and Distributers.
- Loreman, T.., Jaonne D.., & Davice, H. (2005). *Inclusive Education A Practical guide to Supporting Diversity in classroom*. London: Roudledge Falmer.
- Puri, M. & George, A. (2009), *Handbook of Inclusive Education for Educators, Administrators and Planners*. New Delhi: Sage Publications.
- Balsara, M. (2011). *Inclusive Education for Special Children*. New Delhi: Kanishk Publishers.
- Dash, N. (2003). *Integrated Education for Children, with Special Need.* New Delhi: Dominant Publishers.
- Sharma, B. (2011). *Inclusive Education-Needs Practices and Prospects*. New Delhi: Kanishk Publishers.
- Gargiulo, R. M. & Debbie, M. (2008). *Teaching in Today's Inclusive Classroom.* California, USA: Wadsworth Publishing Company.
- Alur, M. & Timmous. (2009). *Inclusive Education across Cultures*. New Delhi: Sage Publication.

Web Resources:

- Inclusive Education- https://education.cu-portland.edu/blog/classroom-resources/inclusive-education/
- RCI Act- http://rehabcouncil.nic.in/writereaddata/rti_manual.PDF
- NCF 2005- http://www.ncert.nic.in/rightside/links/pdf/framework/ncf_hindi_2005/ncf2005.pdf
- Cooperative Learning- https://serc.carleton.edu/introgeo/cooperative/whatis.html
- Multi Sensory Learning- http://www.calverteducation.com/learning-motivation/an-introduction-to-multi-sensory-learning

EDU 405 Educational Guidance and Counselling

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

Student teacher will be able to :

- develop conceptual understanding of guidance and counselling.
- familiarize with the process and procedures being used in guidance & counselling.
- develop competence of providing guidance and counselling to school Students.
- develop conceptual understanding and skills of organizing guidance services at school level.
- develop conceptual understanding of barriers of guidance and counselling.

Unit I Guidance - An overview

- Concept of Guidance
- Characteristics of Guidance
- Objectives of Guidance
- Importance of Guidance
- Principles of Guidance

Unit II Types of Guidance

(Meaning, Objectives, Importance, Principle & Steps)

- Educational Guidance
- Vocational Guidance
- Personal Guidance

Unit III School Guidance Services & its Organization

- School guidance services
  - Individual Inventory Service
  - Information Service
- Organization of Guidance Services
  - At secondary level
  - At senior secondary level

Unit IV Essentials of Counselling

- Concept & Nature of Counselling
- Need of Counselling
- Principle of Counselling
- Process of Counselling
- Role of Counsellor

Unit V Types of Counselling

- (Meaning, Characteristics, Steps, Advantages & Limitations)
  - Directive counselling
  - Indirective counselling
  - Eclectic counselling
- Barriers of Guidance & Counselling

Practicum: (Any Two)

- Visit & observation of Guidance & Counselling cell & preparation of report.
- Thematic term paper.
- Exhibition on Guidance and Counselling theme.

References:

- Gupta, Manju, Effective guidance & councelling, Mangal Deep Publications, Jaipur.

- Oberoi, S.C., Career information in career guidance: International Publications House, Meerut.
- Shrivastava, K.K., Principles of guidance and counselling Kanishka Publishers, Distributors, New Delhi.
- राय एवं अस्थाना, निर्देशन एवं परामर्शन, मोतीलाल बनारसीदास, दिल्ली।
- सक्सेना, राधारानी, शिक्षा में निर्देशन एवं परामर्श, राजस्थान हिन्दी ग्रन्थ अकादमी।
- शर्मा, चतुर्वेदी शिखा, शैक्षिक एवं व्यावसायिक निर्देशन एवं परामर्शन, सूर्या पब्लिकेशन, मेरठ।
- Dosajh N.L., (1969). Guidance service in India, New Delhi: Arya book depot.
- Crow & Crow, (1962). An introduction to guidance, New Delhi: Euraria Publication House.
- S., Narayan, (2000). Counsellings & guidance, New Delhi, MC Graw Hill Publishing company Ltd.
- Sharma S., R.: Vocational education and training, Mittal Publications: New Delhi.
- Pandey, K. P., Educational and vocational guidance in India, Vishwavidyalaya Prakashan.

Web Resources:

- Concept of Guidance and counseling- http://ncert.nic.in/textbook/pdf/lehe108.pdf
- Organization of guidance services in schools- http://www.yourarticlelibrary.com/education/guidance-in-schools/guidance-services-in-schools-introduction-committees-and-scope/63674
- Need of Guidance and Counselling- https://www.nalandaschool.org/importance-of-guidance-and-counselling
- Follow up services- http://www.yourarticlelibrary.com/education/guidance-in-schools/follow-up-service-in-schools-meaning-functions-and-ways-to-conduct-it/63682

EDU 406 Educational Technology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- explain basic concepts related to Educational Technology.
- match appropriate strategies to Teaching Levels.
- clarify the concept of Communication & its relation to Instruction.
- demonstrate improvement in teaching behavior.
- develop and use Instructional Support Materials.

Course Outline:

Unit I Nature of ET

(a) Meaning & Nature of ET

(b) Concept of ET

(c) System Approach in ET

Unit II Communicative Process

(a) Communicative Process (educational) within & outside school.

(b) Role of Instructional Material & its development based on

- Target audience
- Instructional Objective
- Available Resources

Unit III Teaching Levels and Teaching Strategies

(a) Teaching Levels:

- Memory level
- Understanding level
- Reflective level

(Concept, Features and attainment)

(b) Teaching Strategies: Concept, nature and functions

Unit IV Teaching Models and Modification of Teaching Behavior

(a) Teaching Models- Concept and Classification

(b) Modification of Teaching Behavior through:

- Skill Based Teaching,

- Flanders Interaction Analysis
- Simulations

(Concept and importance)

Unit V Support material for Teaching Learning Process

Development and use of following Support materials:

- Chart
- Map 4
- Model
- Transparency
- Photographic Slide and
- Power Point Presentation

(Importance, Basic considerations and Limitations)

References:

- Cruickshank, Donald R., Deborah B. Jenkins & Kim K. Metcalf (2009). *The Act of Teaching.* New York: McGraw-Hill Company.
- Hough, John B. & James K. Duncan (1970). *Teaching: Description and Analysis.* Massachusetts: Addison-Wesley Publishing Company.
- Jyoce, B. & Weil M. (1985). *Models of Teaching.* New Delhi: Prentice Hall of India.
- Levine, J.M. (1989). *Secondary instruction: A manual for classroom Teaching.* Boston: Allyn & Becon.
- Mangal, S.K. & Mangal, Uma (2009). *Essentials of Education Technology.* New Delhi: PHI Learning Pvt. Ltd.
- Mangal, S.K. and Uma Mangal (2009). *Shiksha Takniki.* New Delhi: PHI Learning Pvt. Ltd.
- Rao, Usha (1991). *Educational Technology*. Bombay: Himalaya Publishing House.
- Sampath, K. Panneerselvam, A. And santhanam S., (1984). *Introduction to Educational Technology.* New Delhi : Sterling Publishers.
- Sharma, Mittal (1985). *System Approach : Its Application in Education. Bombay:* Himalaya Publishing House.
- Sharma, R.A. (1987). *Shiksha Takniki,* Meerut : Loyal book Depot.

- Sharma, R.A. (2012). *Technological Foundation of Education.* Meerut: R. Lall Book Depot.
- Yadav, Neelam (2003). *A Handbook of Education Technology.* New Delhi: Anmol Publications Pvt. Ltd.

Web Resources:

- Educational Technology:
  http://epathshala.nic.in/wp-content/doc/NCF/Pdf/educational_technology.pdf
- Technology Education vs. Educational Technology:
  http://iteaconnect.org/TAA/Resources/TAA_Differences.html
- Educational Technology:
  http://ddceutkal.ac.in/Syllabus/MA_Education/PAPER_10.pdf
- Models of Teaching:
  http://thesecondprinciple.com/teaching-essentials/models-teaching
- Understanding Level of Teaching:
  https://www.scribd.com/doc/57768891/99/Understanding-Level-of-Teaching
- Evaluation and Selection of Learning Resources: A Guide:
  www.gov.pe.ca/photos/original/ed_ESLR_08.pdf

Seventh Semester

EDU 502 Assessment for Learning

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**5**	**0**	**0**	**5**

Learning Outcome:

- interpret concept of assessment in education, evaluation and its related term.
- differentiate between kinds of evaluation.
- apply appropriate tools of evaluation in field.
- elucidate different forms and characteristics of achievement test.
- organize an effective evaluation program.
- apply ICT skills during evaluation program.
- conduct an action research related to problems at school level.

Course Outline:

Unit I Assessment in Education

- Concept of Assessment in Education, Test, Measurement, Evaluation.
- Relationship of Educational Evaluation with IO's (Instructional Objectives) and Learning Experience
- Kinds of Assessment
  - Internal and External
  - Formative and Summative
  - Continuous Comprehensive Evaluation (CCE)

Activity: Presentation of Critical Analysis of any one kind of Assessment

Unit II Various Evaluation Tools: Concept and Characteristics

- Following evaluation tools related testing, self reporting and observation Technique: (concept only)
  - Achievement Test, Diagnostic Test and Performance Test, Check List, Interview, Observation, ARC (Anecdotal Record Cards) and CRC (Cumulative Record Cards)
- Characteristics of Good Assessment tool
  - Objectivity, Reliability, Validity and Usability

Activity: Practice to Prepare a Performa/format of Observation based Tool

Unit III Assessment of Learner's Achievement

- Kinds of Achievement Test
  - Teacher Made and Standardized Test
  - Oral, Written, Practical
  - NRT and CRT
- Designing Evaluation Programme (Scholastic & Non-scholastic): Time, duration, Mode.
- Assessment as Providing Feedback: Student, Teachers, Administrators, Parents

Activity: Practice to construct different types of Test items in their respective Subject.

Unit IV Reforms in Educational Assessment

- Reforms in Examination -
- Grading System: Concept, Determination and use
- Question Bank

- Open Book Exam, Online Examination
- Importance of ICT in Assessment
- Use of ICT: Question Paper Making, Administration, Scoring, Preparing Results and Showcasing

Activity: Discussion on use of ICT/anyone reforms in examination

Unit V Action Research in Educational Assessment

- Meaning and difference of research and action research
- Purpose of action research
- Importance of action research
- Steps of action research
- Action research and different problems
- Proposal and Reporting format of action research

Activity: Practice to prepare a reporting of action research for any school problem

Practicum: (any two of the following)-

(1) Reporting the Result of any Achievement Test in Terms of Grading.

(2) A Report Presentation on Organization of Assessment Activities in School during Internship.

(3) Administration and Interpretation of one Standardized Psychological Test.

(4) Prepare a proposal for action research.

References:

- Best, J. W., & James V. K. (1992). *Research in Education*. IV edition, New York : Prentice Hall Inc.
- Borg, W., R. (1981). *Applying Educational Research, A Practical Guide to Teacher.* New York: Longman Inc.
- Ebel, R. L., & David A. F. (1986). *Essentials of Educational Measurements.* New Jersey Prentice Hall, Inc, E. Clifs.
- Grounlund, N. E. (1976). *Measurement of Evaluation in Teaching.* New York: MacMillan Publishing Co.
- Pandey, K. P. (2010). *Fundamentals of Educational Research.* Varanasi: Vishwavidyalya Prakashan.
- Pathak, R.P. (2012). *Measurement & Evaluation in Education*. New Delhi: Dorling Kindessely (India) Pvt. Ltd., Pearson, South Education.

- Rao, V.K. & Reddy, R.S.(1992). *Perspective in Educational & Evaluation* (World Education Development-Series-8) New Delhi: Commonwealth Publishers.
- Rummel, F., J. (1984). *An Introduction to Research Procedure in Education*. II edition. New Jersey: Harper & Row Publishers.
- Vashist, S.R. (1994). *Perspectives in Measurement & Evaluation in Education Series*. New Delhi: Anmol Publications.
- Worthen, B. R., & Sunders, J. R. (1987). *Educational Evaluation*. New Delhi: Longman INC.
- अस्थाना, वि. एवं अस्थाना, एस. (2009). *मनोविज्ञान और शिक्षा में मापन तथा मूल्यांकन,* सोलहवॉ संस्करण, आगरा, अग्रवाल पब्लिकेशन्स.
- बालिया, एस., अरोड़ा, आर., शर्मा, ओ. पी. (2013). *शिक्षा में मापन एवं मूल्यांकन,* तृतीय संस्करण, जयपुर, राजस्थान हिन्दी ग्रन्थ अकादमी
- भार्गव, एम. (2010). *आधुनिक मनोवैज्ञानिक परीक्षण एवं मापन.* 19वॉ सस्करण. आगरा, राखी प्रकाशन.
- भटनागर, ए. बी. भटनागर, एम. (1999). *मापन एवं मूल्यांकन.* तृतीय संस्करण. मेरठरू आर. लाल बुक डिपो.
- पाण्डे, के. पी. (2011). *शैक्षिक मापन एवं मूल्यांकन,* वाराणसी रू विश्वविद्यालय पब्लिकेशन्स.
- गुप्ता, एस. पी. एवं. गुप्ता ए., (2000). *आधुनिक मापन एवं मूल्यांकन.* इलाहाबाद, शारदा पुस्तक मन्दिर.
- कपिल, एच. के. (2006). *अनुसंधान विधियॉ.* आगरा : भार्गव बुक हाउस.
- रायजादा, बी. एस. (2010). *शिक्षा में अनुसंधान के मूल आधारण* जयपुर : राजस्थान हिन्दी ग्रन्थ अकादमी.

Web Resources:

- Concept of Measurement- http://www.yourarticlelibrary.Com /statistics-2/measurement-of-data-meaning-types-and-characteristics-statistics/92436
- Relationship of Educational Evaluation with Instructional objectives- https://www.nap.edu/read/5287/chapter/6
- Formative and Summative Evaluation- https://cft.vanderbilt.edu/ student-assessment-in-teaching-and-learning/
- Continuous Comprehensive Evaluation-http://www.ncert.nic.in/oth_ anoun/CCE_Guidelines.pdf
- Concept of Reliability and Validity- https: //chfasoa. uni. edu/re^liabilityandvalidity.htm, https://opentextbc.ca/researchmethods /chapter/reliability-and-validity-of-measurement/, https://www.cpp.edu

/~smemerson/nbu-programeval/trochimppp/Part203/Types20of 20Reliability.ppt, https://social researchmethods.net/kb/reltypes.php

- Teacher made and Standardized Test- https://www.theclassroom.com/ similarities-difference-classroom-test-standardized-achievernent-test-15626.html
- NRT and CRT- https ://www.researchgate.net/figure/Differences-between-Norm-Referenced-Tests-NRT-and-Criterion-Referenced-Tests-CRT_tbll_295530493
- Open Book exam- http://www.studygs.net/tsttak7.htm
- Online Examination https://www.onlineexambuilder.com/knowledge-center/exam-knowledge- center/advantages-and-disadvantages-of-online-examination-svstem/item 10240
- Use of ICT in assessment https://eppi.ioe.ac.uk/cms/Default.aspx?tabid=462
- Grading System https://content.wisestep.com/advantages-disadvantages-grading-system-education/
- Grading and its determination- https://www.ierf.org/wp-content/uploads/2016/01 /IERFGrading2011 .pdf
- Action Researchhttp://www.ncert.nic.in/departments/nie/der/ publication/modules material.html

Discipline Elective (Main Pedagogy)-I

EDU 438 Pedagogy of General Science -I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- explain the nature and importance of general science.
- discuss and correlate the general science with other school subject.
- analyze the NCF 2005 with reference to science education.
- frame instructional objectives in behavioural terms.
- prepare unit plan and lesson plan based on different method.

Course Outline:

Unit I Nature of Science

- Concept and nature of Science: Process and Product.
- Importance of General Science in School curriculum.
- Influence of Science on Man and Environment

- Co-relation of General Science with other School Subject.

Activity: Presentation on Contribution of Scientist in the field of Science.

Unit II Curriculum in General Science

- Concept of Curriculum & Syllabus.
- Difference between Curriculum and Syllabus
- Principles of Curriculum Construction in General Science.
- NCF 2005 with reference to Science Education.

Activity: Analysis of Science Curriculum with reference to NCF 2005

Unit III Objectives of General Science

- Meaning and difference between Objectives and Teaching Objectives in Science Teaching
- General Objectives of Science Teaching at Secondary stage
- Writing specific Objectives of Teaching in behavioral terms.

Activity: Practice on writing Teaching Objectives in behavioural term

Unit IV Planning in General Science

- Concept of Unit Plan and Lesson Plan.
- Difference between Unit Plan and Lesson Plan.
- Need of Planning.
- Consideration points of effective Lesson Plan and Unit Plan.

Activity: Practice on Preparing Unit Plan and Lesson Plan.

Unit V Methods of Teaching (I)

(Teaching Methods- Meaning, Advantages and Limitations.)

- Lecture –cum- Demonstration method.
- Problem Solving Method.
- Heuristic Method.

Activity: Preparation of Lesson Plan based on above methods.

Practicum: Any Two of the following-

- Term paper on "Correlation of General Science with other School Subject".
- Present a Report of Critical Appraisal of NCF-2005 with Reference to General Science Education.
- Submission of Instructional Objectives in Behavioural Terms for One Unit.

- Preparation of One Unit and Lesson Plan.
- Preparation of Lesson Plan Based on any one Teaching method.

References:

- Bhandula, N. & Shrama, Sidheswar. (2009).*Teaching of Science.* Ludhiyana :Vijaya Publications.
- Das, D.N. (2007). *Practice Teaching.* Jaipur : Pointer Publisher.
- Gupta, Nirmala . (1967). *Method of Teaching Science.* Meerut :Rastogi and Company.
- Misra, Karuna Sankar. (2008). *Effective Science Education.* Allahabad : Anubhav Publishing House.
- Prasad, Janardhan.(1999). *Practical Aspects in Teaching of Science.* Delhi : Kanishka Publishers Distributors.
- Rajan, Sonika. (2012). *Methodology of Teaching Science (I ed.),* Delhi : Pearson Publication.
- Rawat, Hemant, . (2009).*Teaching of Science.* New Delhi : Lakshay Publication.
- Sharma, R.C. (2001). *Modern Science Teaching.* New Delhi : Dhanpat Rai Publishing co. Pvt. Ltd.
- Sood, J.K. (1989). *New Direction in Science Technology.* Chandigarh : Kohli Publishers.
- Sen, B.R. (2005).*Teaching Science in Secondary school.* New Delhi : Commonwealth Publisher's.
- Vaidya, Narendra . (1996). *Science teaching for the 21st century.* New Delhi : Deep and Deep Publications.
- कुलश्रेष्ठ, अरूण कुमार एवं कुलश्रेष्ठ, नीर कमल. (2013). *विज्ञान शिक्षण.* मेरठ : आर0लाल बुक डिपो.
- भटनागर, ए0 बी0. (2014). *विज्ञान शिक्षण.* मेरठ : आर0 लाल बुक डिपो.
- मंगल, एस0 के0. (2007). *साधारण विज्ञान शिक्षण (पॉचवा संस्करण).* नई दिल्ली : आर्य बुक डिपो.
- रावत, एम0 एस0, एवं अग्रवाल, एम0 बी0 लाल. (2008). *नवीन विज्ञान शिक्षण (बारहवॉ संस्करण*). आगरा : अग्रवाल पब्लिकेशन्स.
- सूद, जे0 के0. (2010). *विज्ञान शिक्षण (पंचम् संस्करण).* आगरा : विनोद पुस्तक मन्दिर.

- श्रीमाली, नन्द किशोर., भूषण आनन्द एवं रिहानी, इन्दु. (2013). *विज्ञान शिक्षण (आठवॉ संस्करण).* जयपुर : राजस्थान हिन्दी ग्रन्थ अकादमी.

Web Resources:

- Nature of Science- http://www.project2061.org/tools/sfaaol/chap1.htm
- Objective and Curriculum- http://egyankosh.ac.in/bitstream/123456789/6665/1/Unit-1.pdf
- Blooms Taxonomy of Learning Domain- https://www.giocities.com/eltsqu/cognitive.htm
- Correlation with other school subject- https://www.galaxy.org/correlations/gal scope seq.html

  https://www.researchgate.net/publication/266884550_How_to_write_behavioural_objectives
- Lecture-method-http://www.studylecturenotes.com/curriculum-instructions/lecture-method-of-teaching-focus-applications-merits-and-demerits,
- Problem solving method-https://unacademy.com/lesson/problem-solving-and-project-method/VWEX9NFB
- Advantages and disadvantages of Problem solving method

  https://www.prodigygame.com/blog/advantages-disadvantages-problem-based-learning/, https://4h.unl.edu.volun/arlen/method1.htm
- Heuristic Method- http://www.preservearticles.com/201105216966/advantages-and-disadvantages-of-heuristic-method-of-teaching-science.html

EDU 442 Pedagogy of Mathematics-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- discuss the nature of Mathematics.
- critically analyze the Mathematics Text Book.
- reflect on different methods of teaching Mathematics.
- prepare the lesson plan in teaching mathematics.
- reflect on framing and marking test items of achievement test in mathematics.

Course Outline:

Unit- I: Nature & Scope of Mathematics

a) Nature of mathematics

b) Place in Secondary School Curriculum

c) Correlation with other School Subjects

Activity – Poster making on any one of above topics

Unit-II: Aims and objectives of Teaching Mathematics

a) Aims and General Objectives of Teaching Mathematics at school level

b) Formulation of Instructional Objectives with respect to Arithmetic, Algebra, Geometry, Mensuration and Trigonometry

c) Value development through Teaching of Mathematics

Activity- Workshop to formulate the Instructional Objectives.

Unit-III: Curriculum and Textbook of Mathematics

a) Content and branches of Mathematics at Secondary Level

b) Curriculum of Mathematics at Secondary level in reference to NCF-2005

c) Characteristics of a good Mathematics Text Book

Activity- Critical Analysis of Mathematics Text Book of class X.

Unit-IV: Planning for Teaching

a) Annual plan – Need, Main consideration and Format

b) Unit plan - Concept and steps of planning

c) Lesson plan – Need and preparation

Activity- Workshop on Planning at different level.

Unit-V: Approaches to Teach Mathematics

Concepts, Procedures, Advantages and Limitations of following approaches/ methods

a) Analytical – Synthetical

b) Inductive – Deductive

c) Lecture cum Demonstration

Activity- Workshop on Method based planning.

Practicum: (Any two)

1. Prepare a scrap book on 'Mathematics in News Paper'.
2. Develop strategy to connect any three teaching points with value inculcation.

3. Develop a Annual Plan of teaching Mathematics at secondary level.

Reference:

- Butler, H.C. and Wren, F.L.(1965). *The Teaching of Secondary Mathematics*. New York: Mc Graw Hill Book Co.
- Chadha, B.N. (1961). *Teaching of Mathematics*. Delhi : Gurudas Kappor and Sons.
- Cornelius, Michael. (1982). *Teaching mathematics*. London : Croom Helm.
- Jain, S.L. (1973).*Ganit Shikshan*. Jaipur :Rajasthan Hindi Granth Academy.
- Johnson, D.A. & Rahtz. R. (1961).*The New Mathematics in Our Schools*. New York: The macmillan Co.
- Maheshwari, Vijayandra Kishore (1995). *Ganit Shikshan*. Meerut :Lay Book Deptt.
- Mangal, S.K.(1997). *Ganit Shikshan*. New Delhi :Arya Book Depot.
- Sidhu, K. S. (1986).*The Teaching of Mathematics*. New Delhi :Sterling Publisher.

Web Resources:

- **Nature of Mathematics, Aims and General Objectives of Teaching Mathematics at school level, Approaches to Teach Mathematics, Unit Plan, Lesson Plan:**

  http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/I/TEACHING%20OF%20MATHEMATICS.pdf

  http://www.tnteu.in/pdf/3-maths.pdf

  http://egyankosh.ac.in/bitstream/123456789/46799/1/BES-143B2-E.pdf

- **Place in Secondary School Curriculum:**

  http://egyankosh.ac.in/bitstream/123456789/46799/1/BES-143B2-E.pdf

- **Planning for Teaching:**

  http://pedagogybyvasu.blogspot.com/2015/08/unit-test.html

  https://repository.nie.edu.sg/bitstream/10497/1824/1/TL-9-1-15.pdf

  http://egyankosh.ac.in/bitstream/123456789/6691/1/Unit-4.pdf

  https://ndpublisher.in/admin/issues/EQv8n32.pdf

Discipline Elective (Main Pedagogy)-II

EDU 439 Pedagogy of General Science-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- select and use of various methods of teaching general science.
- select and use of ISM in teaching general science.
- construct improvised apparatus in teaching general science.
- explain and organize different strength activities in general science.
- analyze related subject content for framing different types of test items.
- discuss on different ways of professional development of Science teacher.

Course Outline:

Unit I Methods in General Science Teaching (II)

Meaning, Procedure, Advantage and Limitations of following-

- Project
- Seminar,
- Workshop

Activity: Orgainse a seminar on any Science theme.

Unit II Identifying and Developing Instructional Support Material (ISM) for General Science Teaching

- Concept, Classification, Importance of ISM
- Improvised Apparatus – Concept and Advantage
- Selection Criteria of ISM in General Science Teaching

Activity: Preparing one ISM for General Science Teaching.

Unit III Strengthening General Science Education

Developing creativity and discovery through

- Science Club
- Science Museum

- Science Fair

Activity: Organize Science Exhibition on the bases of above Activities

Unit IV Assessment in General Science

- Types of Assessment in General Science Teaching
  - Oral, Written and Practical
- Test Items for Assessment of learning out-comes
  - Objective Type
  - Short answer Type
  - Essay type

Activity: Framing different types of Test Items.

Unit V Professional Development of Science Teacher

- Qualities of an ideal Science Teacher
- Teacher as a Researcher
- Ways of Professional Development

Activity: List out the expected qualities of Science Teacher.

Practicum: Any two of the following:

1. Preparation of one Improvised apparatus.
2. Preparation of Scholastic Test including Different Types of Test Items
3. Term Paper on "Ways of Professional Development of a Teacher".
4. Preparation of Lesson Plan based on any one Method

References:

- Bhandula, N. & Shrama, Sidheswar. (2009).*Teaching of Science.* Ludhiyana :Vijaya Publications.
- Bhatt, Dipti Pinakin. (2011). *Teaching of Science.* New Delhi : A.P.H. Publishing Corporation.
- Mohan, Radha. (2002).*Innovative Science teaching (II edi).* New Delhi: Prentice Hall of India Pvt. Ltd.
- Nagaraju, M.T.V. (2008). *Handbook for Teaching Physical Sciences (Methods and Techniques).* New Delhi: Kanishka Publisher's.
- Sen, B.R. (2005).*Teaching Science in Secondary school.* New Delhi : Commonwealth Publisher's.
- Sharma, R.C. (2001). *Modern Science Teaching.* New Delhi : Dhanpat Rai Publishing co. Pvt. Ltd.

- Vaidya, Narendra . (1996). *Science teaching for the 21st century.* New Delhi : Deep and Deep Publications.
- Yadav, M.S. (2007).Teaching of Science. New Delhi : Anmol Publications Pvt. Ltd.
- Das, D.N. (2007). *Practice Teaching.* Jaipur : Pointer Publisher.
- Gupta, Nirmala . (1967). *Method of Teaching Science.* Meerut :Rastogi and Company.
- Misra, Karuna Sankar. (2008). Effective Science Education. Allahabad : Anubhav Publishing House.
- Prasad, Janardhan.(1999). *Practical Aspects in Teaching of Science.* Delhi : Kanishka Publishers Distributors.
- Rajan, Sonika. (2012). *Methodology of Teaching Science (I ed.),* Delhi : Pearson Publication.
- Rawat, Hemant, . (2009).*Teaching of Science.* New Delhi : Lakshay Publication.
- Sharma, R.C. (1971).*Teaching of Science.* Delhi : Dhanpat Rai & Sons.
- Sood, J.K. (1989). *New Direction in Science Technology.* Chandigarh : Kohli Publishers.
- कुलश्रेष्ठ, अरूण कुमार एवं कुलश्रेष्ठ, नीर कमल. (2013). *विज्ञान शिक्षण.* मेरठ : आर0लाल बुक डिपो.
- भटनागर, ए0 बी0. (2014). *विज्ञान शिक्षण.* मेरठ : आर0लाल बुक डिपो.
- रावत, एम0 एस0, एवं अग्रवाल, एम0 बी0 लाल. (2008). *नवीन विज्ञान शिक्षण (बारहवॉ संस्करण).* आगरा : अग्रवाल पब्लिकेशन्स.
- सूद, जे0 के0. (2010). *विज्ञान शिक्षण (पंचम् संस्करण).* आगरा : विनोद पुस्तक मन्दिर.
- श्रीमाली, नन्द किशोर., भूषण आनन्द एवं रिहानी, इन्दु. (2013). *विज्ञान शिक्षण (आठवॉ संस्करण).* जयपुर : राजस्थान हिन्दी ग्रन्थ अकादमी .

Web Resources:

- Project Method - http://www.studylecturenotes.com/curriculum-instructions/project-method-of-teaching-meaning-advantage-disadvantages , https://unacademy.com/lesson/project-method-in-hindi/XQ0C6FFL, https://unacademy.com/lesson/project-method-in-hindi/XQ0C6FFL

- Importance of Audio-Visual aids - http://www.lisbdnet.com/ importance-of-audio-visual-aids-in/
- Science club - http://www.vkmaheshwari.com/WP/?p=2380
- Science Museum - https://www.fgsi.co.in/blog/best-science-museums/
- Science fair-https://www.fgsi.co.in/blog/top-science-fairs-in-india/
- Assessment in Science Education -https://www.nap.edu/read/4962 /chapter/7
- Qualities of science teacher - http://info.marygrove.edu/MATblog /bid/85000/Essential-Qualities-of-a-Highly-Effective-Science-Teacher
- Teacher as a Researcher- https://www.ericdigests.org/1993/researcher. htm
- Ways of Professional Development- https://www.teachhub.com/15-professional-development-skills-modern-teachers

EDU 443 Pedagogy of Mathematics-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- apply various methods and techniques of teaching mathematics.
- reflect on framing and marking test items of achievement test in mathematics.
- demonstrate the models on audio visual aids.
- prepare the ICT based materials in teaching mathematics.

Course Outline:

Unit I Methods of Teaching

Concept, Procedure, Advantage and Limitation

a) Laboratory,
b) Problem-solving,
c) Project

Activity- Workshop on Method based planning.

Unit II Techniques for meaningful learning

Importance & Implementation of

a) Oral, written, drill & home-work

b) Self-study, group study, supervised study

c) Audio-Visual aids in teaching Mathematics

Activity- Construction of audio-visual aids.

Unit III Evaluation in Mathematics:

a) Construction & Concept of achievement test:
   - Planning (blue print) and Preparation of different types of test items
   - Assessment of different types of items.

b) Learning difficulty and backwardness in Mathematics:
   - Diagnostic testing
   - Remedial teaching

Activity-Workshop on planning of an Achievement test

Unit IV Strengthening Teaching of Mathematics

a) Arousing and maintaining interest in learning of Mathematics.

b) Enrichment programmes for gifted learners in Mathematics.

c) Organising Mathematics club in school.

Activity-Collecting and reporting various ways of developing interest in Mathematics.

Unit V Use of ICT for Teaching Mathematics

a) Scope of ICT in Mathematics teaching

b) Interactive board for Mathematics teaching.

c) Softwares - Geogebra, forums & blogs for Mathematics teachers

Activity-Workshop on using Geogebra.

Practicum: (Any two)

1. Planning & construction of a Diagnostic Test for a topic of Secondary Mathematics.
2. Planning, teaching & reporting of Secondary Level class using Geogebra.
3. Prepare a project based on computer assisted teaching and learning in Mathematics.
4. A term paper on softwares / forums / blogs of Mathematics.

Reference:

- Butler, H.C. and Wren, F.L.(1965).*The Teaching of Secondary Mathematics*. New York:Mc Graw Hill Book Co.

- Chadha, B.N. (1961). *Teaching of Mathematics*. Delhi : Gurudas Kappor and Sons.
- Cornelius, Michael. (1982).*Teaching mathematics*. London : Croom Helm.
- Jain S.L. (1973). *Ganit Shikshan*. Jaipur: Rajasthan Hindi Granth Academy.
- Johnson, D.A. & Rahtz. R. (1961).*The New Mathematics in Our Schools.* New York:The macmillan Co.
- Maheshwari, Vijayandra Kishore . (1995).*Ganit Shikshan*. Meerut : Lay Book Deptt.
- Mangal, S.K. (1997). *Ganit Shikshan*. New Delhi : Arya Book Depot
- Sidhu, K.S. (1986). *The Teaching of Mathematics*. New Delhi : Sterling Publisher.

Web Resources:

- Teaching of Mathematics Course Material Prepared by Bharathidasan University Retrieved From:

  http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/I/TEACHING%20OF%20MATHEMATICS.pdf
- Pedagogy of Mathematic Prepared by Course Material s Prepared by Tamilnadu Teachers Education University Retrieved From: http://www.tnteu.in/pdf/3-maths.pdf
- Pedagogy of Mathematics Course Material Prepared by IGNOU Retrieved From: http://egyankosh.ac.in/bitstream/123456789/46799/1/BES-143B2-E.pdf
- Teaching of Mathematics Course Material Prepared by NCERT Retrieved From:

  http://www.ncert.nic.in/departments/nie/dse/activities/advisory_board/PDF/teaching_maths.pdf

  https://webarchive.nationalarchives.gov.uk/20101119135224/http://www.standards.dcsf.gov.uk/ntrp/l ib/pdf/wilsonmiller.pdf
- Furner, J.M. & Marinas,C.A.,Teaching Math Concepts through Historical locations using Geogebra and Photography Retrieved From: http://archives.math.utk.edu/ICTCM/VOL27/A017/paper.pdf

Discipline Elective (Subsidary Pedagogy)

EDU 416 Pedagogy of Biology

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- explain the rationale of study of Biology.
- develop skill in framing instructional objective in behavioral terms.
- discuss the major principles of curriculum construction.
- identify and use various method of teaching Biology.
- develop skill in preparing unit and lesson plan.
- selection and use of ISM and related science activities.
- construct various test items for making question paper.

Course Outline:

Unit I Instructional Objectives of Teaching Biology

- Rationale behind the study of Biology.
- Objectives of Teaching Biology with special reference to Blooms Taxonomy.
- Writing Instructional Objectives in behvaioural terms.

Activity: Group Discussion and Submission of Report on Correlation of Biology with other School Subjects.

Unit II Curriculum in Biology teaching

- Difference between the terms Syllabus and Curriculum.
- Major principles of curriculum construction

Activity: Group Discussion on Major Criteria of Curriculum Construction

Unit III Instructional Design and Planning in Biology teaching.

- Meaning, Steps, Merits and Demerits – Lecture Method, Problem solving method, Project Method.
- Unit and Lesson Planning in Biology Teaching.
- Difference between Unit and Lesson Plan .

Activity: Workshop on Preparation of a lesson plan using specific instructional method to teach Biology.

Unit IV Ancillary to Biology teaching

- Science Activity- Need and importance
  - Field trips
  - Science Exhibition
- Instructional Support Material- Model, Charts, Herbarium, Aquarium for teaching Biology.
- Importance of Biology Laboratory.

Activity: Prepare one Instructional Support Material to teach Biology in classroom

Unit V Assessment in Biology Teaching

- Preparation of a Question paper.
- Framing test item to assess various objectives in teaching Biology
- Prepare a Blue Print.

Activity: Workshop on Quality of good Question Paper in Biology Teaching.

Practicum: Any two

1 Prepare ten instructional objectives in behavioural terms from Cognitive, Affective and Psychomotor domain.

2 A critical appraisal of Biology curriculum at Senior Secondary level.

3 Prepare two computer based lesson plan on any topic from Biology.

4 Prepare One Power Point Presentation by using e-resources in teaching of Biology.

5 Prepare a Blue Print on any topic of Biology from class XII for 50 marks to assess Instructional Objectives from Cognitive, Affective and Psychomotor domain.

Reference:

- Arthur, Carwin., & Robers, B.(1970). *Teaching Modern Science.* U.S.A.: Charles E, Merrill Publishing Company.
- Das, R.C. (1985). *Science Teaching in schools.* New Delhi : Sterling Publishers Pvt. Ltd.
- Dave, R.M. (1969). *Taxonomy of Educational objectives and Achievement Teaching.* London: London University Press.
- Gupta, S.K. (1983). *Technology of Science Education.* New Delhi : Vikas publishing House Pvt. Ltd.

- Heiss, Obourm., & S. Hoffman W.(Ed). (1961). *Modern Science Teaching.* New York : The Macmillian company.
- Kohli, V.K. (1969). *Teaching of Science*. Jullundur : Krishna Brothers Chowk Adda Tanda.
- Mangal, S.K. (1996). *Science teaching.* New Delhi : Arya Book Depot.
- Nathan, S. (1967). *Teaching Science Creatively in the Secondary School,* New Delhi : W.B. Saunders Company.
- Paul, B. Weize. (1969*). Elements of Biology (3ed.).* NewYork : Mc Graw Hill Co.
- Pual, B. Weise., & Fuller Melvin S.(1962). *Science of Botany.* New York : Mc Grew hills Book Co.
- Ratho, T.N., & Prakash, Ravi .(1996). *Emerging trends in teaching of Botany.* New Delhi : Kanishka Publishers, Distributors.
- Ratho, T.N., & Prakash, Ravi .(1996). *Emerging trends in teaching of Zoology.* New Delhi : Kanishka Publishers, Distributors.
- Richardson, J.S. (1957). *Science Teaching in secondary schools.* Prentice Hall Inc. Englewood Cliff, New Jersey.
- Sharma, R.C. (1971). *Teaching of Science,* Jullundhur : Dhanpat Rai and Sons.
- Sood, J.K. (1980). *New Direction in Science Teaching.*Chandigarh : Kohli Publications.
- Sood, J.K., . (1987). *Teaching life Science.* Chandigarh : Kohli publishers.
- Sood, J.K., . (1989). New Direction in Science teaching. Kohli publishers, Chandigarh, 1989.
- Thurbur, W. and A Collette. (1959). *Teaching Science todays secondary schools,* New York: Boston Allyn and Bacon Inc.
- Vaidya, N. (1996). *Science teaching for the 21st century.* New Delhi : Deep and Deep publication.

Web Resource:

- Importance of the study of Biology - https://www.quora.com/Why-is-biology-important-to-study
- Inter relationship of biology with other school subjects- https://www.galaxy.org/correlations/gal scope seq.html

- Objectives of teaching biology with special reference to Bloom's Taxonomy-https://www.giocities.com/eltsqu/cognitive.htm
- Major principles of curriculum construction-http://www.preservearticles.com/2012010920286/the-main-principles-of-curriculum-construction-may-be-mentioned-as-under.html
- Developmental History of Science Curriculum- http://www.ignouhelp.in/ignou-bes-141-study-material/
- Lecture method-Merit and Demerit-http://www.studylecturenotes.com/curriculum-instructions/lecture-method-of-teaching-focus-applications-merits-and-demerits
- Problem solving method-Merit and Demerit-https://unacademy.com/lesson/problem-solving-and-project-method/VWEX9NFB
- Demerits of Problem solving method-https://www.prodigygame.com/blog/advantages-disadvantages-problem-based-learning/
- Community Resources-http://www.sedl.org/scimath/compass/v03n01/usingcom.html
- Use of audio visual aids-https://www.elixirpublishers.com/articles/1351336051_50%20(2012)%2010597-10605.pdf
- Science club- http://vigyanprasar.gov.in/science-communication-programs/vipnet/

EDU 417 Pedagogy of Chemistry

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- analyze concepts and generalization used in framing chemistry curriculum.
- analyze nature of chemistry and the relationship between nature of chemistry and objectives of teaching chemistry.
- Discuss role of laboratory, text book and other resources in teaching of chemistry formulate IOs for cognitive, affective & psychomotor domain.
- frame test items for different types of test.
- reflect on different teaching methods used in Chemistry.

Course Outline:

Unit I Nature of Chemistry and Objectives of Teaching Chemistry

- Chemistry as a Specific Branch of Science
- Nature of Content in Chemistry
- Instructional Objectives in Chemistry teaching for Cognitive, Affective and Psychomotor Domain.

Activity: Practice on Writing the Instructional Objectives in Behavioural Terms.

Unit II Curriculum and Planning in Chemistry Teaching

- Curriculum and Syllabus: Concept
- Consideration Points in Developing Learner Centered Curriculum in Chemistry
- Concept and Components of Unit Plan and Lesson Plan

Activity: Practice for Preparing of Unit Plan and Lesson Plan

Unit III Teaching Methods in Chemistry

(Concept, Procedure, Advantage and Limitation)

- Lecture Cum Demonstration Method
- Problem Solving Method
- Laboratory Method

Activity: Preparation of Lesson Plan based on above method

Unit IV Instructional Support Material in Chemistry Teaching

- Laboratory- Organization, maintainance and Importance in Chemistry Teaching
- Role of Chart, Model, Text Book and Internet in Chemistry Teaching

Activity: Designing a Layout for Chemistry Lab

Unit V Assessment in Chemistry Teaching

- Types of Assessment in Chemistry
- Evaluation of Learning Outcomes in Chemistry Teaching by
  - Preparing a Blue Print and Test Items
  - Framing Test Items for Practical Examination

Activity: Practice on Preparation of Different Type of Test Items

Practicum: Any two of the following.

1. Term Paper on "Importance of Chemistry in Our Daily Life"

2. Critical Appraisal of Present Chemistry Curriculum at Senior Secondary Level
3. Lesson Plan Based on any One Method
4. Submission One ISM for Teaching Chemistry Content
5. Preparation One Scholastics Test Including Different Test Items

References:

- Bhandula, N. and Shrama Sidheswar. (2009). *Teaching of Science*. Ludhiyana: Vijaya Publications.
- Das, D.N. (2007). *Practice Teaching.* Jaipur: Pointer Publisher.
- Gupta, Nirmala. (1967). *Method of Teaching Science.* Meerut: Rastogi and Company.
- Prasad, Janardhan. (1999). *Practical Aspects in Teaching of Science.* Kanishka Publishers Distributors.
- Rajan, Sonika. (2012). *Methodology of Teaching Science.* Delhi: Pearson.
- Rawat, Hemant. (2011). *Teaching of Science.* New Delhi: Lakshay Publication.
- Sharma, R.C. (1971). *Teaching of Science.* Delhi: Dhanpat Rai & Sons.
- Sood, J.K. (1989). *New Direction in Science Technology.* Chandigarh: Kohli Publishers.
- Bhatt, Dipti. (2011).*Teaching of Science.* New Delhi: A.P.H. Publishing Corporation.
- Mohan, Radha. (2002). *Innovative Science teaching.* New Delhi: Prentice Hall of India Pvt. Ltd.
- Mishra, K. S. (2008). *Effective Science Teaching.* Allahabad: Anubhav publishing House.
- Nagaraju, M.T.V. (2008). *Handbook for Teaching Physical Sciences (Methods and Techniques).* New Delhi: Kanishka Publishers.
- Sen, B.R. (2005).*Teaching Science in Secondary school.* New Delhi: commonwealth publishers.
- Sharma, R.C. (2001). *Modern Science Teaching.* New Delhi: Dhanpat Rai Publishing co., Pvt., Ltd.

- Vaidya, Narendra. (1996). *Science teaching for the 21st century*. New Delhi: Deep and Deep Publications.
- Yadav, M.S. (2007). *Teaching of Science*. New Delhi: Anmol Publications Pvt. Ltd.
- कुलश्रेष्ठ, अरूण, कुमार और कुलश्रेष्ठ, नीर, कमल. (2013).*विज्ञान शिक्षण.* मेरठः आर0लाल बुक डिपो.
- भटनागर, ए0, बी0. (2014).*विज्ञान शिक्षण.* मेरठः आर0 लाल डिपो.
- रावत, एम0 एस0, और अग्रवाल, एम0 बी0 लाल. (2007/2008). *नवीन विज्ञान शिक्षण (बारहवॉ संस्करण).* आगराः अग्रवाल पब्लिकेशन्स.
- सूद, जे0 के. (2010). *विज्ञान शिक्षण (पंचम् संस्करण).* आगराः श्री विनोद पुस्तक मन्दिर.
- श्रीमाली, नन्द किशोर., भूषण आनन्द., और रिहानी, इन्दु. (2013). *विज्ञान शिक्षण (आठवॉ संस्करण).* जयपुरः राजस्थान हिन्दी ग्रन्थ अकादमी.
- Sunder, Prem. (2010). *Teaching of Chemistry*. NewDelhi: KSK Publishers and Distributirs.
- Aggarwal, D. D. (2001). *Modern Methods of Teaching Chemistry*. New Delhi: Sarup and Sons Publishers.
- Singh, P. P. and Kalia, V. D. (2004). *Teaching of Chemistry: New Trends and Innovations*. New Delhi: Deep and Deep Publications Pvt. Ltd.
- Rathor, T. N. and Ravi Prakash. (2007). *Emerging Trends in Teaching of Chemistry*. New Delhi: Kanishka Publishers and Distributors.

Web Resources:

- Nature of Science- http://www.project2061.org/tools/sfaaol/chap1.htm
- Objective and Curriculum- http://egyankosh.ac.in/bitstream/123456789/6665/1/Unit-1.pdf
- Blooms Taxonomy of Learning Domain- https://www.giocities.com/eltsqu/cognitive.htm
- Correlation with other school subject- https://www.galaxy.org/correlations/gal scope seq.html
- https://www.researchgate.net/publication/266884550_How_to_write_behavioural_objectives

- Lecture-method-http://www.studylecturenotes.com/curriculum-instructions/lecture-method-of-teaching-focus-applications-merits-and-demerits,
- Problem solving method-https://unacademy.com/lesson/problem solving-and-project-method/VWEX9NFB
- Advantages and disadvantages of Problem solving method

  https://www.prodigygame.com/blog/advantages-disadvantages-problem-based-learning/, https://4h.unl.edu.volun/arlen/method1.htm
- Heuristic Method- http://www.preservearticles.com/201105216966/advantages-and-disadvantages-of-heuristic-method-of-teaching-science.html

EDU 419 Pedagogy of Computer Science

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- Acquaint with the aims and objectives of pedagogy of computer science
- Familiarize with the various methods that can be employed for the pedagogy of computer science.
- Acquaint in preparation of instructional materials for Computer Science teaching.
- Acquire knowledge of latest trends in Information Technology and assessment practices.

Course Outline:

Unit I : Computer Science as a School Subject

- Concept, Need and Scope of Computer Science.
- Need and Significance of Teaching Computer science at various levels.
- Aims and Objectives of Teaching Computer Science
- Writing objectives in behavioral terms

Activity: Practice on Writing the Instructional Objectives in Behavioural Terms.

Unit II Methods and Techniques of Teaching Computer Science

- Methods of Teaching (Concept, Procedure, Advantages and Limitation)
  - Lecture-cum-Demonstration
  - Laboratory
  - Project
  - Problem Solving
- Techniques of Teaching: CML,CAI, Mobile Learning, Buzz session, e-learning, smart classroom, surfing, blogging

Activity: Preapare a Lesson plan based on above method

Unit III Designing for Instruction

- Concept, Need, Preparation of Unit plan and Lesson plan
- Preparation of Blue-print and Test items
- Techniques and Tools of Evaluation, E-assessment
- Types of Tests used in Computer Science.

Activity: Preapare a question paper based on Blue-print

Unit IV Development of Instructional material

- Meaning, Importance, classification and preparation of Instructional Material.
- Text Books: Characteristics and Criteria for Selection of Computer Books with special reference to Theory and Practical Books of Computer Subject
  - Self-Instructional Material
  - Computer Assisted Instructional Material
- Computer Science Laboratory: Planning, Organization and its importance

Activity: Prepare a material on Computer Assisted Instruction

Unit V Trends and Issues in Teaching-Learning

- LMS, PODCAST
- Multimedia
- Virtual Learning,
- Web based Learning,
- Teleconferencing,
- Interactive Boards
- Technophobia (difficulties in handling hardware and software)

Practicum: Any two of the following.

- Preparation of Lesson plan based on above method

- Preparation of question paper based on Blue-print
- Prepare a material on computer assisted Instruction
- Prepare a material on computer assisted Instruction

References:

- Chauhan, S.S. (1985). *Innovations in teaching learning process*. New Delhi: Vikas Publishing Ltd
- Goel, H.K. (2005). *Teaching of Computer Science*. New Delhi: R.Lall Book Depot.
- Kochchar, S.K.(1992). *Methods and techniques of teaching*. New Delhi: Sterling Publishers Pvt Ltd.
- Mangal, S.K., Uma Mangal, (2009). *Essentials of Educational Technology*. New Delhi: PHI learning Private Limited.
- Sharma, R.A.(2008). *Technological foundation of Education*. Meerut: R.Lall Book Depot.

Web Resources:

- Concept, Need and Scope of Computer Science.
- Need and Significance of Teaching Computer science at various levels.
- General Aims and Objectives of Teaching Computer Science

  http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/I/TEACHING%20OF%20COMPUTER%20SCIENCE.pdf
- Concept, Need and Scope of Computer Science.
- Need and Significance of Teaching Computer science at various levels.
- General Aims and Objectives of Teaching Computer Science

  http://tnteu.in/pdf/BED_CMaterial_2016-17.pdf
- Methods of Techniques of Teaching Computer Science- http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/I/TEACHING%20OF%20COMPUTER%20SCIENCE.pdf http://tnteu.in/pdf/BED_CMaterial_2016-17.pdf
- Designing for Instruction

  http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/I/TEACHING%20OF%20COMPUTER%20SCIENCE.pdf

  http://tnteu.in/pdf/BED_CMaterial_2016-17.pdf

- Development of Instructional material-http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/I/TEACHING%20OF%20COMPUTER%20SCIENCE.pdf
- Trends and Issues in Teaching-Learning- http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/I/TEACHING%20OF%20COMPUTER%20SCIENCE.pdf

EDU 423 Pedagogy of Geography

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

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

- describe the nature of content in Geography subject.
- formulate Instructional objectives and plan for Geography teaching at Senior Secondary Level.
- apply different methods of teaching Geography in classroom.
- select and use appropriate resources and media for Geography teaching.
- use various resources for enrichment of Geography teaching.
- reflect on framing and marking test items of achievement test in Geography.

Course Outline:

Unit I : Nature of Geography as a subject.

- Meaning, Nature and Scope of Geography as a subject.
- Relevance of Geography at Senior Secondary Level.
- Correlation of Geography with other school subjects.
- Aims and Objectives of Geography teaching.

Activity: Writing of Instructional Objectives in behavioural terms.

Unit II : Curriculum and Designing Instruction

- Principles of curriculum construction of Geography.
- Critical Appraisal of Geography Curriculum at Senior Secondary Level.
- Concept and Need of planning for Geography Teaching.
- Designing instruction (Concept and Components of)-
  - Annual Plan

- Unit Plan
- Lesson Plan

Activity: Critical appraisal of Geography curriculum of CBSE/SBSE/ Banasthali Board.

Unit III : Methodology of Teaching-Learning of Geography

- Concept, Steps, Advantages and Limitations of -
  - Lecture Method
  - Demonstration Method
  - Laboratory Method
  - Regional Method
  - Field Trip Method
  - Project Method

Activity: Preparing a Lesson Plan based on any one of the Method

Unit IV : **Media and Resources for Teaching and Learning**

- Significance and use of Audio, Visual and Audio-Visual Media in Geography teaching
- Geography Room
- Geography Club
- Geography Exhibition
- Geography Museum

Activity: Organizing Geography Exhibition

Unit V Evaluation of Geography Learning

- Concept of Evaluation in Geography.
- Types of Acheivement Test-Written, Oral (Viva) and Practical.
- Different types of Test items (Essay type, Short type and Objective type).
- Construction of Blue Print and Question paper.

Activity: Construction of question paper with blue print for class XI/XII of Geography subject

Practicum: Any Two

1. Prepare a Model on any Geographical theme such as-Dam, Solar Plant, Power station,etc.
2. Prepare a map of the main Geographical features of India with descriptions.

3. Write a report of your experiences related to observed programme about the flora and fauna aspect on National Geographical Channel.
4. Collection of leaves/fossils etc and write their description.
5. Make a chart of Geographical signs and symbols.
6. Prepare a PPT presentation on any Geographical theme.

References:

- Basha, S.,& Bhaskar Rao, Digumarti.(2004). *Methods of Teaching Geography*.New Delhi: Discovery Publishing House.
- Hoti Prasad.(2005). *Methods of Teaching Geography*. Jaipur: ABP Publishers.
- Long, M.(1964). *Handbook for Geography Teachers.* The English language Book Society and Methuen & Co. Ltd.
- Siddiqui, Mujibul Hasan. (2004). *Teaching of Geography*.New Delhi: A.P.H. Publishing Corporation.
- जैन, मदनलाल. (1967). *भूगोल अध्यापन.* आगराः रामप्रसाद एण्ड संस.
- दुबे, सुशील कुमार. (2014). *भूगोल शिक्षण में तकनीकी नवाचार.* जयपुरः बाइकिंग बुक्स.
- बालिया, शिरीष. अरोड़ा, रीता एवं शर्मा, ओ. पी. (2013). *शिक्षा में मापन एवं मूल्यांकन.* जयपुरः राजस्थान हिन्दी ग्रन्थ अकादमी.
- वर्मा, जगदीश प्रसाद. (1971). *भूगोल अध्यापन.* आगराः विनोद पुस्तक मंदिर.
- शर्मा, माता प्रसाद. (2008). *भूगोल शिक्षण.* जयपुरः अपोलो प्रकाशन.
- शर्मा, रमा एवं मिश्रा, एम. के. (2009). *भूगोल शिक्षण.* नई दिल्लीः अर्जुन पब्लिशिंग हाउस.
- सिंह, हरनारायण. (1968). *भूगोल शिक्षण.* आगराः विनोद पुस्तक मंदिर.
- अमरनाथ, कपूर. (2004). *भौगोलिक शब्दकोष और परिभाषाएँ.* नई दिल्लीः राधा पब्लिकेशन्स.
- *Philips World Atlas.(*2002). Great Britain: The Royal Geographical Society.
- Susan, Mathew. (2009). *Oxford Dictionary of Geography.* Oxford University Press.

- Webster International Encyclopedia-I Edition. (2003) Trident Press International.

Web Resources:

- Evaluation in Teaching Learning Process- http://www.yourarticlelibrary.com/statistics-2/evaluation-in-teaching-and-learning-process-education/92476
- Teaching and Learning Process in Geography- http://egyankosh.ac.in//handle/123456789/46729
- Tools of Teaching Geography- http://egyankosh.ac.in// handle/123456789/46746
- Introduction of Curriculum Construction- http://egyankosh.ac.in/bitstream/123456789/31625/1/Unit-1.pdf
- NCF 2005-http://www.ncert.nic.in/rightside/links/pdf/framework/ncf_hindi_2005/ncf2005.pdf

EDU 428 Pedagogy of Mathematics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- discuss the nature of Mathematics.
- critically analyze the Mathematics Text Book.
- reflect on different methods of teaching Mathematics.
- prepare the lesson plan in teaching mathematics.
- reflect on framing and marking test items of achievement test in mathematics.

Course Outline:

Unit I Nature & Scope of Mathematics

a) Nature of mathematics
b) Place in Secondary School Curriculum
c) Correlation with other School Subjects

Activity – Poster making on any one of above topics

Unit II Aims and objectives of Teaching Mathematics

a) Aims and General Objectives of Teaching Mathematics at school level

b) Formulation of Instructional Objectives with respect to Arithmetic, Algebra, Geometry, Mensuration and Trigonometry

c) Value development through Teaching of Mathematics

Activity- Workshop to formulate the Instructional Objectives.

Unit III Curriculum and Textbook of Mathematics

a) Content and branches of Mathematics at Secondary Level

b) Curriculum of Mathematics at Secondary level in reference to NCF-2005

c) Characteristics of a good Mathematics Text Book

Activity- Critical Analysis of Mathematics Text Book of class X.

Unit IV Planning for Teaching

a) Annual plan – Need, Main consideration and Format

b) Unit plan - Concept and steps of planning

c) Lesson plan – Need and preparation

Activity- Workshop on Planning at different level.

Unit V Approaches to Teach Mathematics

Concepts, Procedures, Advantages and Limitations of following approaches/ methods

a) Analytical – Synthetical

b) Inductive – Deductive

c) Lecture cum Demonstration

Activity- Workshop on Method based planning.

Practicum: (Any two)

1. Prepare a scrap book on 'Mathematics in News Paper'.
2. Develop strategy to connect any three teaching points with value inculcation.
3. Develop a Annual Plan of teaching Mathematics at secondary level.

References:

- Butler, H.C. and Wren, F.L.(1965). *The Teaching of Secondary Mathematics*. New York: Mc Graw Hill Book Co.
- Chadha, B.N. (1961). *Teaching of Mathematics*. Delhi : Gurudas Kappor and Sons.

- Cornelius, Michael. (1982). *Teaching mathematics*. London : Croom Helm.
- Jain, S.L. (1973).*Ganit Shikshan*. Jaipur :Rajasthan Hindi Granth Academy.
- Johnson, D.A. & Rahtz. R. (1961).*The New Mathematics in Our Schools*. New York: The macmillan Co.
- Maheshwari, Vijayandra Kishore (1995). *Ganit Shikshan*. Meerut :Lay Book Deptt.
- Mangal, S.K.(1997). *Ganit Shikshan*. New Delhi :Arya Book Depot.
- Sidhu, K. S. (1986).*The Teaching of Mathematics*. New Delhi :Sterling Publisher.

Web Resources:

- Nature of Mathematics, Aims and General Objectives of Teaching Mathematics at school level, Approaches to Teach Mathematics, Unit Plan, Lesson Plan:

  http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/I/TEACHING%20OF%20MATHEMATICS.pdf

  http://www.tnteu.in/pdf/3-maths.pdf

  http://egyankosh.ac.in/bitstream/123456789/46799/1/BES-143B2-E.pdf

- Place in Secondary School Curriculum:

  http://egyankosh.ac.in/bitstream/123456789/46799/1/BES-143B2-E.pdf

- Planning for Teaching:

  http://pedagogybyvasu.blogspot.com/2015/08/unit-test.html

  https://repository.nie.edu.sg/bitstream/10497/1824/1/TL-9-1-15.pdf

  http://egyankosh.ac.in/bitstream/123456789/6691/1/Unit-4.pdf

  https://ndpublisher.in/admin/issues/EQv8n32.pdf

EDU 431 Pedagogy of Physics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcome:

- discuss the nature and relevance of Physics as a School Subject.

- identify Aim and objectives of teaching Physics.
- discuss various methods of Physics teaching.
- organize and develop Physics lab.

Unit I Concept, Nature and Scope of Physics as a School Subject.

- Concept and Nature of Physics
- History of Physics and its branches
- Relevance of Physics in School Curriculum at Secondary and senior secondary level

Activity: Preparation of a chart based on any of above topic

Unit II Aims, Objectives and Curriculum of Physics

- Aims and Objectives of teaching Physics
- Physics Curriculum at School Level
- Nuffield, PSSC (Physical Science Study Committee) and HPP (Harward Physics Projects)

Activity: Preparation of a chart based on any of above project

Unit III Methods in Teaching Physics

(Concept, Procedure, Advantage and Limitation)

- Laboratory Method
- Problem Solving Method
- Project Method
- Demonstration Method
- Development of Unit Plan and Lesson Plan

Activity: Prepare a Lesson Plan based on any one method

Unit IV Resources for Physics Teaching

Role of audio-visual Resources in Physics Teaching

- Preparation and use of Improvised Teaching Aids
- Organization and maintenance of physics laboratory in school

Activity: Preparation of an improvised material.

Unit V Assessment and Trends in Physics Teaching

Development of Achievement Test

- Construction of Test items
- Assessment of Practical work in Physics
- Use of ICT and Virtual Laboratory for Physics Teaching

Activity: Practice on preparation of different type of test items for Practical Examination

Practicum: Any two of the following.

1. Term Paper on 'Importance of Physics in Our Daily Life'
2. Critical Appraisal of Present Physics Curriculum at School Level
3. Preparation of a Unit Plan.
4. Preparation One Scholastics Test Including Different Test Items

References:

- Bhandula, N. & Shrama, S. (2009). *Teaching of Science*. Ludhiyana :Vijaya Publications.
- Das, D.N. (2007). *Practice Teaching*. Jaipur: Pointer Publisher.
- Gupta, N. (1967). *Method of Teaching Science*. Meerut: Rastogi and Company.
- Mishra, K.S. (2008). *Effective Science Education*. Uttar Pradesh: Anubhav Publishing House.
- Prasad, J. (1999). *Practical Aspects in Teaching of Science*. New Delhi: Kanishka Publishers Distributors.
- Rajan, S. (2012). *Methodology of Teaching Science*. Delhi: Pearson.
- Rawat, H. (2011). *Teaching of Science*. New Delhi : Lakshay Publication.
- Sharma, R.C. (1971). *Teaching of Science*. Delhi : Dhanpat Rai & Sons.
- Sood, J.K. (1989). *New Direction in Science Technology*. Chandigarh : Kohli Publishers.
- Bhatt, D.P. (2011). *Teaching of Science*. New Delhi : A.P.H. Publishing Corporation.
- Mohan, R. (2002). *Innovative Science Teaching*. New Delhi : Prentice Hall of India Pvt. Ltd.
- Nagaraju, M.T.V. (2008). *Handbook for Teaching Physical Sciences (Methods and Techniques)*. New Delhi: Kanishka Publisher's.
- Sen, B.R. (2005).*Teaching Science in Secondary School*. New Delhi: Commonwealth publisher's.

- Sharma, R.C. (2001). *Modern Science Teaching*. New Delhi : Dhanpat Rai Publishing co., Pvt., Ltd.
- Vaidya, N. (1996). *Science Teaching for the 21stcentury*. New Delhi : Deep and Deep publications.
- Yadav, M.S. (2007). *Teaching of Science*, New Delhi : Anmol Publications Pvt. Ltd.
- Brandwein Paul, F. et. al. (1958). *Teaching High School Science*, *A Book of Methods*. New York: Harcourt Brace Jovanovich, Columbus, Ohio: Carless E. Merrill Books, Inc.
- Croxton,W.C. (1937). *Science Teaching in the Elementary School*. NewYork: Mcgraw Hill.
- Gupta, S.K. (1985). *Teaching Physical Science in Secondary Schools*. New Delhi: Sterling Publishers.
- Gaez,Albert V.(nd). *Innovations in Science Education world wide* paris. UNESCO Press.
- Negi, J.S. (1999). *Bhautiki Shikshan*. Agra: Vinod Pustak Mandir.
- Bhaskara Rao, D. (2016). *Methods of Teaching Physics*. New Delhi: Discovery Publishing House.
- Vanaja, M. & Rao, B.D. (2016). *Methods of Teaching Physics*. New Delhi: Discovery Publishing House.
- कुलश्रेष्ठ, अरूण कुमार और कुलश्रेष्ठ, नीर कमल. (2013). *विज्ञान शिक्षण.* मेरठः आर0लाल बुक डिपो.
- भटनागर, ए. बी. (2014). *विज्ञान शिक्षण.* मेरठः आर0 लाल डिपो.
- रावत, एम0 एस0, और अग्रवाल, एम0 बी0 लाल. (2008). *नवीन विज्ञान शिक्षण.* आगराः अग्रवाल पब्लिकेशन्स.
- सूद, जे0 के0. (2010). *विज्ञान शिक्षण.* आगराः श्री विनोद पुस्तक मन्दिर.
- श्रीमाली, नन्द किशोर, भूषण आनन्द और रिहानी इन्दु. (2013). *विज्ञान शिक्षण.* जयपुरः राजस्थान हिन्दी ग्रन्थ अकादमी.

Web Resources:

- Concept and Nature of Physics:
  http://scert.cg.gov.in/pdf/bedmedstudy2015/bed/pedagogyof_science.pdf
  http://assets.vmou.ac.in/BED123.pdf

http://www.iapweb.org/nature_of_physics.pd

https://hemantmore.org/physics-1/p11101001/2760/

https://www.univie.ac.at/pluslucis/Archiv/ICPE/B1.html

- History of Physics and its Branches:

  http://poincare.matf.bg.ac.rs/~zarkom/Book_Wikipedia_PHYSICS.pdf
- Methods in Teaching Physics: http://www.ncert.nic.in/ departments/ nie/desm/publication/pdf/phy_sci_partI.pdf

  https://www.aapt.org/resources/policy/roleoflabs.cfm

  https://sites.nationalacademies.org/cs/groups/dbassesite/documents/webpage/dbasse_073330.pdf

  https://www.britishcouncil.org.za/sites/default/files/163275-planning-practical-science-interactive.pdf
- Use of ICT and Virtual Laboratory for Physics Teaching:

  http://www.ipedr.com/vol37/062-ICMEI2012-E10015.pdf

  http://ndpublisher.in/admin/issues/tlv3n1f.pdf

  http://blog.scientix.eu/2015/08/virtual-laboratories-in-teaching-and-learning-science/
- UNESCO Source Book of Science Teaching.
- UNESCO Publication in new methods and techniques in education.

Discipline Electives (Enhancing Professional Capacity Courses)

EDU 301L Reading and Reflecting on Texts

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40+ESA:60)	**0**	**0**	**6**	**3**

Learning Outcome:

- read and respond to a variety of texts in different ways by learning to think together, depending on the text and the purposes of reading.
- enhance their capacities as readers and writers by becoming participants in the process of reading.
- develop the skill of critical thinking by offering opportunities to read a wide variety of texts,

- write with a sense of purpose and audience, through tasks such as, responding to a text with one's own opinions or writing within the context of other's ideas.

Course Outline:

Unit I : Skills for Reflection: Reading & Writing

- Reading-Meaning and Importance
- Types of Reading-
  - Loud Reading (Individual & Group)
  - Silent Reading (Intensive & Extensive)
- Development of Reading
- Writing-Meaning and Importance
- Types of writing
  - Narrative
  - Descriptive
  - Expository
  - Persuasive
- Mechanics of writing
- Development of writing (Observe and write, listen and write, see and write, writing with proper speed and comprehensive and spontaneous writing).

Unit II : Reflection on Texts

- Reflection-Meaning, elements and Importance
- Stages of reflection
- Reading for Comprehension and Reflection
- Reflection through Writing

Unit III : Practice Components

1. **Engaging with Narative and Descriptive Accounts**

Suggested Activities (any two)

- Reading for comprehending and visualizing the account (individual plus group reading and discussion/explanation)
- Re-telling the account-in one's own words/from different points of view (taking turns in a smaller group)
- Narrating/describing a related account from one's life experience (in front of a smaller group)
- Discussion of characters and situations-sharing interpretations and points of view (in a smaller group)

- Writing based on the text, e.g. summary of a scene, extrapolation of story, converting a situation into a dialogue, etc. (individual task).

2. Engaging with Popular Subject Based Expository writing (any two)

- Identifying major concepts and ideas involved and making notes on these in some schematic form-flow diagram, tree diagram, mind map, etc. (guided working in pairs).
- Explaining the gist of the text/topic to others (in the larger subject group)
- Attending the writing style, subject-specific vocabulary and 'perspective' or 'reference frame' in which different topics are presented-this will vary across subjects and texts, and requires some interpretative skills for 'placing' the context of each text (group discussion and sharing).
- Writing a review or a summary of the text, with comments and opinions (individual task)

3. Engaging with Educational Writing and its presentation

- Reading for discerning the theme(s) and argument of the essay (guided reading-individually or in pairs)
- Analyzing the structure of the argument: Identifying main ideas, understanding topic, sentences of paragraphs, supporting ideas and examples, terms used as connectors and transitions (small group discussion).
- Discussion of the theme, sharing responses and point (s) of view (small group discussion)
- Writing a response paper (individually or in pairs)
- Presentations of selected paper, questions and answers (large group).

References:

- Brookfield, S. (1995). *Becoming a critically reflective teacher.* San Francisco: Jossey-Bass Inc.
- Dewey, J. (1933). *How we think: A restatement of the relations of reflective thinking to the educative process.* Boston: D.C. Heath.
- Goodlad, J. I .(1990). The occupation of teaching in school. In J.I. Goodlad, R.Soder & K.A.Sirotnik (Eds.) *The moral dimensions of teaching*. 03-34. San Franscisco: Jossey-Bass.

- Hole, S.& McEntee, G. (1999). Reflection is at the heart of practice. *Educational Leadership.* 56 (8) May, p34-37.
- Kottamp, R. (1990). Means of facilitation reflection. *Education and Urban Society*. 22.2, pp. 182-203.
- Ross D. Bondy, E. & Kyle D. (1993) *Reflective teaching for student empowerment: Elementary curriculum and methods.* New York : Macmillan.
- Schon, D. (1983). *Educating the reflective practitioner.* New York: Basic Books.
- Schon, D. (1987). *Educating the reflective practitioner.* San Francisco: Jossey-Bass.
- Zeichener, K.M. & Liston, D.P. (1987). Teaching student teachers to reflect, *Harvard Educational Review*, 56(1), 23-48.

Web Resources:

- **Types of Reading:**
  https://slllc.ucalgary.ca/Brian/611/readingtype.html
- **Types of Academic Writing:**
  https://sydney.edu.au/students/writing/types-of-academic-writing.html
- **Reflecting on Teaching Reading:**
  https://www.press.umich.edu/pdf/9780472035052-ch1.pdf
- **Gibbs' Reflective Cycle:**
  https://my.cumbria.ac.uk/media/mycumbria/documents/ReflectiveCycleGibbs.pdf
- **Reflection Models and Frameworks:**
  https://www.bradford.ac.uk/wimba-files/skill-space/Reflective_Writing_HTML/page_04.htm
- **Reflection, Elements and Reflective Writing:**
  http://universityofhullscitts.org.uk/scitts/reflection/reflectionmodels.html

EDU 459L Aesthetic Appreciation through Art and Drama

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**6**	**3**

Learning Outcome:

- discuss the concepts of Art and Type of Arts
- apply Fundamentals of Visual Art
- explain Drama, Its Elements and Types of Drama
- apply different type of Arts in teaching.
- create Various Products by Using Art
- perform Various Type of Drama by Organizing the Stage

Course Outline:

Unit I Visual Art and Craft

- Concept of Art
- Types of Art - (a) Visual Art (b) Performing Art
- Fundamentals of Visual Art
- Classification of Art Style
- An introduction of Medium (Material) and Methods of Art
- Importance of Visual Art Education

Unit II Performing Art: Drama

- Meaning of Dramatic Art
- Importance of Drama in Education
- Elements of Drama
- Types of Drama
  - Individual
  - Group
- Importance of Stage – Setting in Drama

Unit III Visual Art and Craft (Practical)

- Creating new, product through manipulating Different Material of Visual Art and Craft: (Any One)
  - Paper, Sand, Color, Pan-Ink, Clay, Paper Mashie, Waste Material
- Creation by the use of Different Methods of Art: (Any Two)

- Preparation of Composition (for Teaching) with the Application of Fundamentals of Art
- Painting, Printing, Collage, Clay Modeling, Paper Mushy, Paper Cutting and Failing
- Preparation of Composition (for Teaching) with the appreciation of fundamental of Art.

Unit IV Improvised Material (Practical)

- Making Puppet through Improvised Materials

or

- Making a Improvised Instructional Aid

Unit V Drama and Theatre (Practical)

- Listening, Viewing and Disrning Different Kinds of Drama and Present Report
- Perform any one of the form of Drama with planning, organizing and of setting the stage (Rang Manch).

References:

- शर्मा, प्रभा. (2007). *कला विज्ञान शिक्षण,* जयपुरः श्रुति पब्लिकेशन.
- कासलीवाल, एम. (2003). *ललितकला के आधारभूत सिद्धान्त.* जयपुरः राजस्थान ग्रन्थ अकादमी.
- वैश्य, आर. पी. (1969). *चित्रकला शिक्षण.* आगराः विनोद पुस्तक मन्दिर.
- गोदीका, साधना एवं सावित्री माथुर. (2008). *कला शिक्षा शिक्षण.* जयपुरः आस्था प्रकाशन.
- शर्मा, माता प्रसाद. (2008). *कला शिक्षा शिक्षण.* जयपुरः अपोलो प्रकाशन.
- Husain Ashfaque. (1956). *Seminar on Art Education.* New Delhi: Lalit Kala Academy.
- Ganga Darshan Munger, (1995). Bihar: India.

Web Resources:

- Concept of Art

  https://www.jstor.org/stable/2107219?seq=4#metadata_info_tab_contents
- Fundamental of Art

https://study.com/academy/lesson/what-are-the-principles-of-art-definition-examples.html

https://thevirtualinstructor.com/artfundamentals.html

- Importance of Visual Art in Education

  https://www.quora.com/What-is-the-importance-of-visual-art-in-education

- Meaning of Dramatic Art

  http://autocww.colorado.edu/~toldy3/E64ContentFiles/TheaterAndActing/DramaAndDramaticArts.html

- Importance of Drama in Education

  https://evolvetreatment.com/blog/positive-effects-drama-programs/

- Elements of Drama

  https://study.com/academy/lesson/elements-of-drama-characters-plot-setting-symbolism.html

- Creating New Material through Different Material of Visual Art and Craft

  http://www.noteaccess.com/MATERIALS/index.htm

EDU 467L Understanding the Self and Yoga

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**6**	**3**

Learning Outcome:

- facilitate student to understand the self.
- develop capacity to identify the values for a good teacher.
- facilitate student to perform self reflected activities.
- discus students with the meaning and importance of yoga.
- develop essential skills to perform various asanas.

Course Outline:

Unit I Understanding the self

a. Self and self development- Concept and Importance

b. Concept and types of values-

   - Individual

- Social

c. Importance of Values

Unit II Yoga and self development

a. Concept of yoga.
b. Importance of yoga for self development.
c. Pranayam-types and importance.
d. Three milestones of woman's life and yoga.
e. Do's and Don'ts of Asanas.

Unit III Self reflection and personal integration

a. Expression of Aspiration & Expectations.
b. Self observation exercise to understand one's own strength and weakness.
c. Self expression through creative activities.

Unit IV Enhancing self development

a. Community participation through Radio Banasthali or Group work.
b. Self reflecting report, based on one's own experience or reading great authors.
c. Identification of the values for a good teacher.

Unit V Yoga for healthy mind and body.

a. Practice of various asanas.
b. Practice of various skills of pranayam.

References:

- Ananda, Sri. (1999). *The Complete Book of Yoga Harmony of Body and Mind.* Delhi: Orient paperbacks,
- Dale, Carnegie, Leader in you. (1993). *you to win friends, influence people and succeed in a changing world.*
- Das, Gupta & Surendranath.(1987). Yoga: its Philosophy & Religion.
- Joshi, K.S. (2003). *Yogic Pranayam.* Allied Publishers Pvt. Ltd.
- Kumar Praveen. (2014).Value Education, New Delhi: KSK Publishers.
- M. Vanaja, M. and Charathi Vijaya. (2008).Value Oriented Education. New Delhi: Neelkamal Publication Pvt. Ltd.
- Madarasa Road, Kashmere Gate.

- Niranjanananda, Paramahamsa. (1993). *Yoga Darshan, Vision on Yoga Upnishads.* Bihar: Sri Panchadashnam Paranahamsa Alakh Bara, Deoghar, India.
- Sharma, P.D. (1984). *Yoga Yogasana and Pranayama for Health.* Ahmedabad: Navneet Publications (I) Limited.
- Sinha, Phulgenda. (2003).*Yogic Cure for Common Diseases.* Allied Publishers Pvt. Ltd.
- अग्रवाल विजय. (2014). *स्टूडेन्ट और पर्सनैलिटी डेवलपमेंट.* भोपालः बेंटेन बुक.
- अग्रवाल विजय. (2009). *स्टूडेन्ट और मन की शक्ति.* भोपालः बेंटेन बुक.
- बधेका, गिजुभाई. (2006). *दिवास्वप्न.* नई दिल्लीः नेशनल बुक इंडिया.
- शास्त्री, दिवाकर. (2007). *गीता का नीतिशास्त्र.* नई दिल्लीः सस्ता साहित्य मण्डल.
- गॉधी, मोहनदास करमचन्द. (2013). *सत्य के प्रयोगः गांधीजी की संक्षिप्त आत्म–कथा.* दिल्लीः राजपाल.
- शर्मा, योगेश कुमार एवं प्रज्ञा शर्मा. (2003).*नोबेल पुरस्कार से सम्मानित विश्व की महिलाएँ.* जयपुरः पोइण्टर पब्लिशर्स.
- खेड़ा, शिव. (2000). *जीत आपकीः कामयाबी की ओर ले जाने वाली सीढ़ी.* दिल्लीः फु सर्कल.

Web Resources:

- Self and self development, concept and importance http://www.businessmanagementideas.com/notes/management-notes/organisation-development/self-development-concept-process-and-methods-management/5313
- concept, types and importance of values.http://www.yourarticlelibrary.com/society/values-its-meaning-characteristics-types-importance/35072
- Importance of Yoga foe self development

  https://thriveglobal.com/stories/10-benefits-of-yoga-for-personal-growth/amp/
- Concept of Yoga

  https://www.speakingtree.in/blog/concept-of-yoga/m-lite
- Pranayam - types and Importance

https://www.speakingtree.in/allslides/different-types-of-pranayam-and-their-respective-benefits-into-treating-diseases/m-lite

- Dos and don'ts of Asanas

  http://theyogainstitute.org/yoga-asanas-dos-and-donts-for-beginners/

- Self expression through Creativity

  https://www.google.com/url?sa=t&source=web&rct=j&url=https://windsor.watermarkcommunities.com/self-expression-through-creative-activities/&ved=2ahUKEwiqmNG10vngAhXFp48KHfLFBKMQFjAKegQIBhAB&usg=AOvVaw1cQwCc_reTx-1WloqNvE9i

- Identification of the values for a good Teacher

  https://www.google.com/url?sa=t&source=web&rct=j&url=https://www.skillsyouneed.com/rhubarb/effective-teaching.html&ved=2ahUKEwiwn_Lm0vngAhVFvY8KHakbAmcQFjALegQIAhAB&usg=AOvVaw3B_uh7fKSdew6iKPIcQsmd

Eighth Semester

Reading Electives

EDU 461R Disaster Management Education

Max. Marks : 100	**L**	**T**	**P**	**C**
(ESA: 100)	**0**	**0**	**4**	**2**

Learning Outcome:

- interpret causes, effects and prevention of natural and man-made disaster.
- clarify the meaning and need of disaster management.
- appreciate the governmental efforts for disaster management.
- discuss the role of educational institutions, Pre-service and In-service teacher education Institute in disaster management.

Course Outline:

- Causes, Effects and Preventions of Natural disasters (Earth-Quake, flood, Famine, Tsunami), Man-Made disaster (Terrorist activity, Fire, Stampede, Electrical Fault)
- Efforts for disaster management by government authorities and Non Governmental organization.

- Role of Educational Institutions, Role of Pre-service and in-service teacher Education programmes in Disaster Management.

References:

- Ariyabandu, Madhavi Malagoda (2005). *Gender Dimensions in disaster management: a guide for South Asia.* New Delhi: Zubaan.
- Asthana, N.C., Priyanka Asthana (2014). *Disaster Management*. Jaipur: Aavishkar Pub.
- Coppola P. Damon. (2011). *Introduction to international disaster management.* Amsterdam: Elsevier.
- Dhunna, Mukesh. (2009). *Disaster Management.* New Delhi: Vayu Education of India.
- Ghosh G.K. (2015). *Disaster Management*. New Delhi: APH Pub.
- Gupta, Harsh K., (2003). *Disaster Management*. Hydrabad: University Press.
- I. Sundar and T. Sezhiyan, (2007).*Disaster Management*. New Delhi: Sarup & Sons.
- Rajib. Shaw, Krishnamurthy, (2009). *Disaster Management: Global challenges and local Solutions*. Hyderabad: University Press.
- Taori, Kamal, (2005). *Disaster Management through Panchayati Raj*. New Delhi: Concept Publishing company.
- जाट, बी0सी0 (2013). *आपदा प्रबन्धन,* जयपुर, मंथन पब्लिकेशन्सण
- शील, कुमार. (2007). पर्यावरणीय आपदा प्रबन्धन दिल्ली, ज्योति इण्टरप्राइज़ेज .
- प्रिय रंजन त्रिवेदी एवं उत्तम कुमार सिंह, आपदा प्रबंधन परिचय. नई दिल्ली,

Web Resources:

- Natural Disaster: https://books.google.co.in/books?id=WhUXtA6qSF4C&printsec=frontcover&dq=Natural+disaster+in+india&hl=en&sa=X&ved=0ahUKEwigi73I4NPgAhXLq48KHd5vDjQQ6AEIPzAE#v=onepage&q=Natural%20disaster%20in%20india&f=false
- Natural Hazards: Causes and Effects http://epdfiles.engr.wisc.edu/dmcweb/BB02NaturalHazardsCausesandEffects.pdf
- Man-Made Disaster: https://www.infoplease.com/world/disasters/man-made

- Efforts of government authorities: https://nidm.gov.in/
- Role of Education http://www.academia.edu/11136022/THE_ROLE_OF_EDUCATION_IN_NATURAL_DISASTER_RISK_REDUCTION

EDU 468R Women's Education

Max. Marks : 100	**L**	**T**	**P**	**C**
(ESA: 100)	**0**	**0**	4	**2**

Learning Outcome:

- critically analyze the status of women in Indian society.
- discuss the problems of women education at different levels.
- analyze and appraise the recommendations of committees, commissions and policies formed for women education.
- analyze the legal provisions for women in India.

Course Outline:

- Status of Women in Indian Society-Pre Independents and Post Independence, Problems of Women Education at different levels.
- Committees on Women's Education-Durgabai Deshmukh Committee, Hansa Mehta Committee and Bharatvaslam Committee.
- Commission and policy on Women's Education-Secondary Education Commission (1952-53), Education Commission (1964-66) and NPE 1986.

References:

- M.H.R.D. (2008). *Elementary Education in India-Analysis Report 2006-07, NEUPA and Department of School education and Literacy, Ministry of Human Resource Development.* New Delhi: Government of India,
- Satya, B.R. (2003). *Trends in Education.* New Delhi: Anmol Publication.
- Sharma, Usha, B.M. Sharma. (1995). *Girl's Education, Women and Educational Development Series-6.* New Delhi: Common Wealth Publishers.

- Verma, G.C. (1984). *Modern Education, Growth and Development in Rajasthan*. Jaipur: Publication Scheme.
- शिक्षा विभाग. (2008). *वार्षिक प्रतिवेदन एवं अंकेक्षित लेखा, सर्व शिक्षा अभियान, शिक्षा विभाग,* जयपुरः राजस्थान सरकार.
- पारीक, मथुरेश्वर, सम्पादक. (2002). *राजस्थान में शिक्षा.* जयपुरः राजस्थान हिन्दी ग्रन्थ अकादमी.
- वर्मा, सांवलिया बिहारी, एम0 एल0 सोनी एवं संजीव गुप्त. (2005). *महिला जाग्रति और सशक्तिकरण.* जयपुरः आविष्कार पब्लिशर्स.
- Goel, Aruna. (2004). *Education and Socio-Economic Perspectives of Women Development and Empowerment.* New Delhi: Government of India.
- Panigrahi, L.K. (2003). *Women and child Education.* Chandigarh: Abhishek Publication.

Web Resources:

- **Secondary Education:**

  www.education.nic.in
- **Education for all towards quality for equality**

  http://www.educationforallinindia.com
- **Durgabai Deshmukh Committee**

  https://www.indiatoday.in/education-today/gk-current-affairs/story/durgabai-deshmukh-started-national-council-for-women-know-about-its-aims-and-functions-1368951-2018-10-16
- **Legal Provisions for Women:**

  http://www.legalserviceindia.com/helpline/woman_rights.htm

EDU 466R Peace Education

Max. Marks : 100	**L**	**T**	**P**	**C**
(ESA: 100)	**0**	**0**	4	**2**

Learning Outcome:

- Clarify the concept of Peace education
- Assess need for peace education
- Appraise the peace initiatives and movements for peace

- Organize curricular and co-curricular activities for promotion of peace in school

Course Outline:

- Issues related to Global peace, Need of peace for today's world, Relevance of Peace education in present scenario, Strategies for peace education
- Peace Initiatives and Movements: Contribution of Gandhiji's and Nelson Mandela's, Delor's Commission 1996 , UNESCO's Conference for peace and International Understanding, Tokyo, 1999 , Creation of UNO, UNESCO, UNICEF
- Integration of Peace Education with Subject Context, Teaching Methods, Yoga and Meditation, Sports and Games

References:

- Harris, I. & Morrison, M. (2003). *Peace Education.* New York: McFarland & Co. Chapter 3.
- Montessori, M. (1972). *Education and peace.* Chicago: Henry Regnery. .
- NCERT. (2004). *Peace Education: Self Instructional Package for Teacher Education.* New Delhi: NCERT.
- NCERT. (2006). *NCF 2005 Position Paper, National Focus Groups on Education for Peace.* New Delhi.

Web Resources:

- http://www.bdu.ac.in/cde/docs/ebooks/B-Ed/II/PEACE%20EDUCATION.pdf,
- *https://www.scribd.com/.../INTEGRATING-PEACE-EDUCATION-IN-THE-PRESEN...*
- *https://minds.wisconsin.edu/bitstream/handle/1793/.../MarkellLockwood.pdf?...1...y*
- *https://www.isesco.org.ma/wp-content/.../11/IMPEDIMENTS-PEACE-WORLD.pdf*
- *https://en.unesco.org/partnerships/.../promoting-culture-peace-and-non-violence*
- https://en.unesco.org/70years/building_peace
