

UNIVERSITY OF MUMBAI



**Syllabus for
B.Sc. B.Ed. four years integrated course
Sem – I to VIII**

(Choice Based Credit System)

(Introduced with effect from the academic year 2022-23)

UNIVERSITY OF MUMBAI



Syllabus for Approval

Sr. NoE.	Heading	Particulars
1	Title of the Course	B.Sc. B.Ed. four years integrated course
2	Eligibility for Admission	Candidates with at least 50% marks in the senior secondary/ +2 or its equivalent are eligible for admission.
3	Passing Marks	40%
4	Ordinances / Regulations (if any)	
5	No. of Years / Semesters	Sem I to VIII
6	Level	P.G. / U.G./ Diploma / Certificate (Strike out which is not applicable)
7	Pattern	Yearly / Semester (Strike out which is not applicable)
8	Status	New / Revised (Strike out which is not applicable)
9	To be implemented from Academic Year	From Academic Year 2022-2023

Name & Signature of BOS Chairperson : Dr Sunita Magre

Name & Signature of Dean:

Dr. Anita Swwami



UNIVERSITY OF MUMBAI



Ordinances, Regulations and the Curriculum
for the
B.Sc. B.Ed. Four years Integrated Programme

UNIVERSITY OF MUMBAI FOUR YEAR INTEGRATED B.Sc. B.Ed.

(Credit Based Choice Semester)

PROGRAMME GUIDELINES

Title: Bachelor of Science and Bachelor of Education (B.Sc. B.Ed.)

Objectives of the B.Sc. B.Ed. (Integrated) Course

To enable the student teachers:

1. To prepare student-teachers to bring in quality in all their endeavors.
2. To inculcate research skills to find solutions to classroom problems.
3. To inspire individual, social, emotional and intellectual competence.
4. To create an awareness among student teachers about community, national and global issues.
5. To provide opportunities to interact with experts in the field of education.
6. To foster networking and collaborative skills with their contemporaries.
7. To cultivate organizational skills through teamwork, collaboration and co-operation.
8. To train the student-teachers in imparting and evaluating learning experiences.
9. To inspire student-teachers to meet the challenges of dynamic society.
10. To provide supportive skills in dealing with academic and personal problems of learners.
11. To nurture the thirst for knowledge and skills in the latest innovation and technologies in education.
12. To sensitize the student-teachers towards the threatening environmental issues.
13. To direct the student-teachers to fulfill their role as nation builders.
14. To be sensitive about emerging issues such as environment, population gender equality, etc.
15. To inculcate rational thinking and scientific temper among the student-teachers.

Preamble:

The four-year integrated programme aims at integrating general studies comprising B.Sc. B.Ed. and professional studies comprising foundation of education and school subjects and practicum related to the tasks and functions of a school teacher. It maintains a balance between theory and practice and coherence and integration among the components of the programme representing a wide knowledge base of a secondary school teacher. The programme aims in preparing teachers for Upper Primary and Secondary stages of education.

Duration:

The B.Sc. B.Ed. programme shall be of four academic years or eight semesters including school based experiences and internship in teaching. Student teachers shall, however, be permitted to complete the programme within a maximum period of six years from the date of admission to the programme.

Working days:

1. In a year there shall be at least two hundred and fifty working days including the period of examination but excluding the admission.
2. A working day will be of minimum 5-6 hours adding up to a minimum of 40 hours per week. The institution shall ensure the availability of teachers and students for consultation and mentoring – providing group or individual guidance.
3. The minimum attendance of student- teachers shall have to be 80% for all course work and practicum and 90% for school internship.
4. 1 Credit equals to 12 hours

Intake

There shall be a basic unit of fifty (50) students. Initially two units may be permitted. The University may prescribe distribution of students for different subjects.

Eligibility

Candidates with at least 50% marks in the senior secondary/ +2 or its equivalent are eligible for admission.

Standard of Passing: 40%

Admission procedure:

1. Admission shall be made on merit on the basis of marks obtained in the qualifying examination and in the entrance examination or any other selection process as per the policy of the Central / State Government/ University administration.
2. At the time of admission to the programme, the student will need to indicate their selection of the subjects to be pursued for the discipline options and the accompanying pedagogic specializations for which they are applying, and these may be assigned on the basis of order of merit and availability.

The Professional Education Course (PEC) Component consists of the following.

1. Perspectives in Education (PE)
2. Curriculum and Pedagogic Studies
3. Ability Enhancement Course (AEC)
4. Engagement with the Field/Practicum (FE)

School Internship

School internship would be a part of the broad curricular area of 'engagement with the field' and shall be designed to lead to the development of a broad repertoire of perspectives, professional

capacities, teacher sensibilities and skills.

Internship Programme: All activities should be systematically documented and maintained for the purpose of internal assessment

Semester V (200 marks)

1. Active involvement in the college level preparation : Bridge lesson (Pedagogy 1 or 2) and skills of teaching (any four) – $5 \times 10 = 50$
2. School Internship: Practice Teaching – General Lesson $5 \times 10 = 50$ (3 Pedagogy 1 + 2 Pedagogy 2)
3. Report of Shadowing -30 (6 Lessons observation $\times 5$ Marks = 30)
4. Report of Peer Observation Lesson - $4 \times 5 = 20$
5. Organize an Activity in school- $1 \times 30 = 30$
6. Reflective Journal of major activities (College level preparation / General lessons, Peer Observation and organise school activity) – 4 reports $\times 5$ marks = 20

Semester VI - (150 marks)

1. School Internship: Peer Lesson (Pedagogy 1 or 2) – $1 \times 10 = 10$
2. Theme based Lesson (Pedagogy 1 or 2) - $2 \times 15 = 30$
3. Experiential Lesson strategies (Pedagogy 1 or 2) - $1 \times 20 = 20$
4. Observe School activity (any two) - $2 \times 10 = 20$
5. Reflective Journal of major internship activities (Peer lesson, Theme based lesson, Experiential lesson strategies and Observation of school activities) – 4 reports $\times 5$ marks = 20 marks
6. Report of Community Service – 50 Marks

Semester VII - (300 marks)

1. School Internship : General Lesson (Pedagogy 1: 5 lessons , Pedagogy 2: 5 lessons) - $10 \times 10 = 100$
2. Peer Lesson – $2 \times 10 = 20$
3. Theme based Lesson - $2 \times 15 = 30$
4. Experiential Lesson strategies – $1 \times 20 = 20$
5. Administration of Unit test and Analysis of result – 80 marks
6. Organize an Activity in school- $1 \times 20 = 20$
7. Reflective Journal of major internship activities (General Lesson, Peer lesson, Theme based lesson, Experiential learning strategies, Administration of unit test, Organize school activity) -6 reports $\times 5 = 30$

Semester VIII - (100 marks)

1. School Internship: General Lesson – $2 \times 10 = 20$ (P1-1 + P2 -1)
2. Peer Teaching - $1 \times 10 = 10$
3. Experiential Lesson- $1 \times 20 = 20$
4. Developing Learning resource- 35
5. Reflective Journal of major internship activities - (General lesson, Peer teaching, Developing learning resources) 3 Reports $\times 5 = 15$

The student teacher during internship in a school should perform the roles of a regular teacher

at the respective level under the direct guidance and supervision of the mentoring teacher (Supervising / Guide Teacher) of the school. While at school, the student teacher shall prepare the necessary teaching resources and records for teaching lessons.

Scheme of Assessment and Examination

Semester - Subject wise Mark Distribution

Semester	Credit	B.Sc.	B.Ed.	Total
Semester I	45	500	250	750
Semester II	45	500	250	750
Semester III	45	400	350	750
Semester IV	45	400	350	750
Semester V	45	400	350	750
Semester VI	45	400	350	750
Semester VII	45	200	550	750
Semester VIII	45	200	550	750
Total	360	3000	3000	6000
Percentage of Mark Distribution		50%	50%	100%

Semester wise Details

Semester I – B.Sc. B.Ed.

Part	Course	Name of the Course	Credit	B.Sc. (SE)	B.Sc. (CE)	B.Ed. (SE)	B.Ed. (CE)	Total
B.Sc	Curriculum & Pedagogical Studies – Course I: Physics	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc	Curriculum & Pedagogical Studies- Course I: Chemistry	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc	Curriculum & Pedagogical Studies – Course I: Mathematics/ Botany	Curriculum & Pedagogical Studies (M/B)	6	60	40			100
B.Sc	Curriculum & Pedagogical Studies - Course I: (Science Foundation / Mathematics Foundation)	Curriculum & Pedagogical Studies (Foundation M/S)	6	60 (40 Theory +20 Practical)	40			100
B.Sc.	Curriculum & Pedagogical Studies Practical Course I: Physics Practical, Chemistry Practical, Botany Practical/Mathematics Practical	Physics, Chemistry, Botany /Mathematics	6	Physics Practical– 35				100
				Chemistry Practical – 35				
				Botany /Mathematics Practical – 30				
B.Ed.	Perspectives in Education – B.Ed. Course I	Childhood and Growing Up	6			60	40	100
B.Ed.	Perspectives in Education - B.Ed.Course II	Creating an Inclusive School	6			60	40	100
B.Ed.	Ability Course - B.Ed.Course III	Health and Yoga	3				50	50
			45					750

Semester II– B.Sc. B.Ed.

Part	Course	Name of the Course	Credit	B.Sc. (SE)	B.Sc. (CE)	B.Ed. (SE)	B.Ed. (CE)	Total
B.Sc.	Curriculum & Pedagogical Studies- Course II: Physics	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies- Course II : Chemistry	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies- Course II : Zoology / Mathematics	Curriculum & Pedagogical Studies (M/B)	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies - (Course II: Science Foundation / Mathematics Foundation)	Curriculum & Pedagogical Studies Science	6	60 (40 Theory +20 Practical)	40			100
B.Sc.	Curriculum & Pedagogical Studies Practical Course II: Physics Practical, Chemistry Practical, Zoology Practical/Mathematics Practical	Physics, Chemistry, Zoology /Mathematics	6	Physics – 35				100
				Chemistry – 35				
				Zoology /Mathematics – 30				
B.Ed.	Perspectives in Education – B.Ed.Course IV	Learning and Teaching	6			60	40	100
B.Ed.	Perspectives in Education - B.Ed.Course V	Knowledge and Curriculum	6			60	40	100
B.Ed.	Ability Course - B.Ed.Course VI	Critical Understanding of ICT	3				50	50
			45					750

Semester III– B.Sc. B.Ed.

Part	Course	Name of the Course	Credit	B.Sc. (SE)	B.Sc. (CE)	B.Ed. (SE)	B.Ed. (CE)	Total
B.Sc.	Curriculum & Pedagogical Studies - Course III: Physics	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies - Course III: Chemistry	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies – Course III: Mathematics / Botany	Curriculum & Pedagogical Studies (M/B)	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies Practical Course III: Physics Practical, Chemistry Practical, Botany Practical/Mathematics Practical	Physics, Chemistry, Botany /Mathematics	6	Physics – 35				100
				Chemistry – 35				
				Botany /Mathematics – 30				
B.Ed.	Perspectives in Education- B.Ed.Course VII	Assessment for Learning	6			60	40	100
B.Ed.	Curriculum & Pedagogical Studies - Course B.Ed.Course VIII	Pedagogy of School Subject	6			60	40	100
B.Ed.	Curriculum & Pedagogical Studies – Mathematics : B.Ed.Course IX	Pedagogy of School Subject	6			60	40	100
B.Ed.	Ability Course : B.Ed.Course X	Drama and Art in Education	3				50	50
			45					750

Semester IV– B.Sc. B.Ed.

Part	Course	Name of the Course	Credit	B.Sc. (SE)	B.Sc. (CE)	B.Ed. (SE)	B.Ed. (CE)	Total
B.Sc.	Curriculum & Pedagogical Studies – Course IV: Physics	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies - Course IV: Chemistry	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies – Course IV: Zoology / Mathematics	Curriculum & Pedagogical Studies (M/B)	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies Practical Course IV: Physics Practical, Chemistry Practical, Zoology Practical/Mathematics Practical	Physics, Chemistry, Zoology /Mathematics	6	Physics – 35				100
				Chemistry – 35				
				Zoology /Mathematics – 30				
B.Ed.	Perspectives in Education - B.Ed.Course XI	Contemporary India and Education	6			60	40	100
B.Ed.	Curriculum & Pedagogical Studies – Science - B.Ed.Course XII	Pedagogy of School Subject	6			60	40	100
B.Ed.	Curriculum & Pedagogical Studies- Mathematics : B.Ed.Course XIII	Pedagogy of School Subject	6			60	40	100
B.Ed.	Ability Course - B.Ed.Course XIV	Reading and Reflecting of Text	3				50	50
			45					750

Semester V– B.Sc. B.Ed.

Part	Course	Name of the Course	Credit	B.Sc. (SE)	B.Sc. (CE)	B.Ed. (SE)	B.Ed. (CE)	Total
B.Sc.	Curriculum & Pedagogical Studies - Course V: Physics	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies - Course V: Chemistry	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies – Course V: Mathematics / Botany	Curriculum & Pedagogical Studies (M/B)	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies Practical Course V: Physics Practical, Chemistry Practical, Botany Practical/Mathematics Practical	Physics, Chemistry, Botany /Mathematics	6	Physics – 35				100
				Chemistry – 35				
				Botany /Mathematics – 30				
B.Ed.	Perspectives in Education - B.Ed.Course XV	Educational Management	6			60	40	100
B.Ed.	Ability Course - B.Ed.Course XVI	Understanding the Self	3				50	50
B.Ed.	Engagement with the Field/Practicum - B.Ed. Course XVII	School Internship Internship Lesson Plan Coaching / Orientation and Demonstration class (4 weeks – 5 days/ week)	12				200	200
			45					750

Active involvement in the college level preparation : Bridge lesson (Pedagogy 1 or 2) and skills of teaching (any four) – 5X10= 50/ School Internship: Practice Teaching – General Lesson 5 X10 =50 (3 Pedagogy 1 +2 Pedagogy 2) /Report of Shadowing -30 (6 Lessons observation X 5 Marks = 30)/ / Report of Peer Observation Lesson -4x5= 20/Reflective Journal of major activities (College level preparation / General lessons, Peer Observation and Shadowing) – 4 reports x 5 marks= 20/ Organize an Activity in school- 1x 30= 30

Semester VI– B.Sc. B.Ed.

Part	Course	Name of the Course	Credit	B.Sc. (SE)	B.Sc. (CE)	B.Ed. (SE)	B.Ed. (CE)	Total
B.Sc.	Curriculum & Pedagogical Studies- Course VI: Physics	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies- Course VI: Chemistry	Curriculum & Pedagogical Studies	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies- Course VI: Zoology / Mathematics	Curriculum & Pedagogical Studies (M/B)	6	60	40			100
B.Sc.	Curriculum & Pedagogical Studies Practical Course VI: Physics Practical, Chemistry Practical, Zoology Practical/Mathematics Practical	Physics, Chemistry, Zoology /Mathematics	6	Physics – 35				100
				Chemistry – 35				
				Zoology /Mathematics – 30				
B.Ed.	Curriculum & Pedagogical Studies- Science : B.Ed.Course XVIII	Pedagogy of School Subject	6			60	40	100
B.Ed.	Curriculum & Pedagogical Studies- Mathematics : B.Ed.Course XIX	Pedagogy of School Subject	6			60	40	100
B.Ed.	Engagement with the Field/Practicum - B.Ed.Course XX	School Internship (3 Weeks -5 days / Week) + 1-week community Internship Lesson Plan Coaching / Orientation	9				150	150
			45					750

School Internship: Peer Lesson (Pedagogy 1 or 2) – 1X10 = 10 /Theme based Lesson (Pedagogy 1 or 2) -2 x15 =30 / Experiential Lesson strategies (Pedagogy 1 or 2) - 1 X 20 = 20 / Observe School activity (any two) -2x10= 20 / Reflective Journal of major internship activities (Peer lesson, Theme based lesson, Experiential lesson strategies and Observation of school activities) – 4 reports X 5 marks= 20 marks / Report of Community Service – 50 Marks

Semester VII– B.Sc. B.Ed.

Part	Course	Name of the Course	Credit	B.Sc. (SE)	B.Sc. (CE)	B.Ed. (SE)	B.Ed. (CE)	Total
B.Sc.	Curriculum & Pedagogical Studies – One Major Course VII 1 (Physics / Chemistry / Mathematics / Botany)	Curriculum & Pedagogical Studies	6	60 (40 Theory +20 Practical)	40			100
B.Sc.	Curriculum & Pedagogical Studies – One Major Course VII 2 Physics / Chemistry / Mathematics / Zoology)	Curriculum & Pedagogical Studies	6	60 (40 Theory +20 Practical)	40			100
B.Ed.	Perspectives in Education - B.Ed.Course XXI	Peace Education	6			60	40	100
B.Ed.	Perspectives in Education - B.Ed.Course XXII	Language across Curriculum /	6			60	40	100
B.Ed.	Engagement with the Field/Practicum - B.Ed.Course XXIII	School Internship (8 weeks – 5 days/ Week) Internship Lesson Plan Coaching / Orientation Action Research Guidance	18				300	300
B.Ed.	Engagement with the Field/Practicum - B.Ed.Course XXIV	Participation and organizing in co-curricular activities and report (1)	3				50	50
			45					750

School Internship : General Lesson (Pedagogy 1: 5 lessons , Pedagogy 2: 5 lessons) -10 x10 =100 / Peer Lesson – 2X 10 = 20 / Theme based Lesson -2 x15 =30 / Experiential Lesson strategies – 1 x20 = 20 / Administration of Unit test and Analysis of result - 80 / Organize an Activity in school- 1x 20= 20/ Reflective Journal of major internship activities (General Lesson, Peer lesson, Theme based lesson, Experiential learning strategies, Administration of unit test, Organize school activity) -6 reports x 5 = 30

Semester VIII– B.Sc. B.Ed.

Part	Course	Name of the Course	Credit	B.Sc. (SE)	B.Sc. (CE)	B.Ed. (SE)	B.Ed. (CE)	Total
B.Sc.	Curriculum & Pedagogical Studies – One Major Course VIII 1 (Physics / Chemistry / Mathematics / Botany)	Curriculum & Pedagogical Studies (P/C)	6	60 (40 Theory +20 Practical)	40			100
B.Sc.	Curriculum & Pedagogical Studies – One Major Course VIII 2 Physics / Chemistry / Mathematics / Zoology)	Curriculum & Pedagogical Studies (M/B)	6	60 (40 Theory +20 Practical)	40			100
B.Ed.	Perspectives in Education - B.Ed.Course XXV	Gender School and Society	6			60	40	100
B.Ed.	Perspectives in Education - B.Ed.Course XXVI	Action Research	6			60	40	100
B.Ed.	Perspectives in Education - B.Ed.Course XXVII	Guidance and Counselling / Environmental Management				60	40	100
B.Ed.	Engagement with the Field/Practicum - B.Ed.Course XXVIII	School Internship (3 Weeks) + Learning resources based on Pedagogy	6				100	100
B.Ed.	Engagement with the Field/Practicum - B.Ed.Course XXIX	Action Research Project	3				50	50
B.Ed.	Engagement with the Field/Practicum - B.Ed.Course XXX	Educational Feld trip report OR Development of Learning Resources on Health Education / Environmental Education material and publish (24 hours self-learning program)	3				50	50
B.Ed.	Ability Course - B.Ed.Course XXXI	Cyber law	3				50	50
			45					750

School Internship: General Lesson – 2 X 10 = 20 (P1-1 + P2 -1)/ Peer Teaching -1 X10= 10 / Experiential Lesson- 1 x 20= 20/ Developing Learning resource- 35 / Reflective Journal of major internship activities - (General lesson, Peer teaching, Developing learning resources) 3 Reports x 5 = 15

Syllabus

PHYSICS

B.Sc. B.Ed. Course

Semester Course No.	Course Title	Subjects
Semester 1	Physics- 1	Mechanics
Semester 2	Physics - 2	Optics
Semester 3	Physics -3	Thermodynamics
Semester 4	Physics -4	Electricity and Magnetism
Semester 5	Physics -5	Electronics
Semester 6	Physics -6	Modern Physics and Quantum Mechanics
Semester 7	Physics -7(1)	Solid State Physics
	Physics-7 (2)	Atomic, Molecular and Nuclear Physics
Semester 8	Physics -8(1)	Advanced Mechanics and Special Relativity
	Physics -8(2)	Applied Physics

SEMESTER-I

COURSE I: MECHANICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

Course Outcome

By the end of the course, student will be able to:

1. apply Newton's laws to classical systems.
2. explain Newton's laws of motion and conservation principles.
3. explain the analytical mechanics as a systematic tool for problem solving.
4. describe the concepts of work-energy principle, gravitational potential energy, conservative and non-conservative forces.
5. explain the dynamics of rotating objects i.e. rigid bodies, angular velocity, the moment of inertia, the motion of rigid bodies, parallel axis theorem.
6. state conservation of angular momentum and torque.
7. explain the application of central force to the stability of circular orbits, Kepler's laws of planetary motion.
8. explain SHM, its applications, damped and forced oscillations and resonance.
9. describe elasticity as the basics of material property and its different moduli.
10. explain the basics of motion of fluid in different forms like, streamlined and turbulent flows. Buoyancy, Bernoulli's Equation, Viscosity and Turbulence
11. analyze interference and superposition of mechanical waves.
12. describe the properties of sound waves, their interference, resonance, beats, and Doppler effect

Module I- Motion and Energy of a Body

2 Credits

Unit I: Newton's Laws and Applications

- a) Newton's Laws: Newton's first, second and third laws of motion
- b) Applying Newton's Laws: applications of Newton's first and second law of motion, frictional forces, Dynamics of Circular Motion
- c) Worked out examples

Unit II: Work Energy and Applications

- a) Work And Energy: Kinetic Energy and the Work–Energy Theorem, Work and Energy with Varying Forces, Power
- b) Gravitational Potential Energy, Elastic Potential Energy, Conservative and Nonconservative Forces, Force and Potential Energy
- c) Worked out examples from the reference book

Unit III: Rotational Motion and Momentum

- a) Rotational Motion: Angular Velocity and Acceleration Rotation with Constant Angular Acceleration Relating Linear and Angular Kinematics Energy in Rotational Motion Parallel-Axis Theorem
- a) Moment-of-Inertia Calculations
- b) Torque, Torque and Angular Acceleration for a Rigid Body, Rigid-Body Rotation About a Moving Axis, Work and Power in Rotational Motion, Angular Momentum, Conservation of Angular Momentum
- c) Worked out examples from the reference book

Module II- Gravitation, Fluid Mechanics and Waves

2 Credits

Unit IV: Gravitation and Motion

- a) Gravitation: Newton's Law of Gravitation, Weight, Gravitational Potential Energy, The Motion of Satellites, Kepler's Laws and the Motion of Planets, Spherical Mass Distributions, Apparent Weight and the Earth's Rotation
- b) Periodic Motion: Describing Oscillation, Simple Harmonic Motion, Energy in Simple Harmonic Motion, Applications of Simple Harmonic Motion, The Simple Pendulum, The Physical Pendulum, Damped Oscillations, Forced Oscillations and Resonance
- c) Worked out examples from the reference book

Unit V: Equilibrium and Fluid Mechanics

- a) EQUILIBRIUM AND ELASTICITY: Conditions for Equilibrium, Center of Gravity, Solving Rigid-Body Equilibrium Problems, Stress, Strain, and Elastic Moduli, Elasticity and Plasticity
- b) FLUID MECHANICS: Gases, Liquids, and Density, Pressure in a Fluid, Buoyancy, Fluid Flow, Bernoulli's Equation, Viscosity and Turbulence
- c) Worked out examples from the reference book

Unit VI: Mechanical and Sound Waves

- a) MECHANICAL WAVES: Types of Mechanical Waves, Periodic Waves, Mathematical Description of a Wave, Speed of a Transverse Wave, Energy in Wave Motion, Wave Interference, Boundary Conditions and Superposition, Standing Waves on a String, Normal Modes of a String
- b) SOUND AND HEARING: Sound Waves, Speed of Sound Waves, Sound Intensity Standing Sound Waves and Normal Modes, Resonance and Sound, Interference of Waves, Beats, The Doppler Effect, Shock Waves
- c) Worked out examples from the reference book

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	Internal Theory: One Assignment / Class test	10 marks
2	Internal Practical and Journal Submission (Any six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

1. Flat spiral spring (η)
2. Young's modulus by Koenig's method
3. Torsional Oscillation: To determine Modulus of rigidity η of a material of wire by Torsional oscillations.
4. To determine Coefficient of Viscosity (η) of a given liquid by Poisseuli's Method.
5. Surface Tension/Angle of contact
6. Bifilar pendulum
7. Flywheel
8. Verification of Stokes theorem

References

1. Hugh D. Young, Roger A. Freedman, Sears and Zemansky's University Physics with Modern Physics (2015, Pearson Education)
2. Concepts of Physics, H. C. Varma (Bharati Bhawan Publishers)

SEMESTER-II

COURSE II: OPTICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

Course Outcomes

By the end of the course, student will be able to:

1. explain phenomenon based on light and related theories .
2. identify and apply formulas of optics and wave physics.
3. analyse the events like reflection, refraction, interference, diffraction
4. explain the applications of interference and diffraction.
5. explain the designing and working of interferometers.
6. explain the concept of resolving power of different optical instruments.
7. elaborate principles and working of LASER systems and their applications

Module I: Physics, Characteristics, and Properties of LIGHT

2 Credits

Unit I: Light and Applications

- a) Brief history of Light, Four theories of light,
- b) Properties of light (rectilinear propagation, reflection, refraction, polarisation, interference, diffraction, photoelectric effect, Compton effect – introduction), dual nature of light.
- c) Fermat principle of least time, Law of reflection, Law of refraction, the thin lens formula,

Unit II: Reflection and Refraction

- a) Light ray, reflection at plane surface, reflection at spherical mirror, Refraction of light, total internal reflection,
- b) Lateral magnification, longitudinal magnification, Lens maker's formula, power of lens
- c) Cardinal points, the three magnifications and their inter relationship

Unit III: Dispersion and Magnification

- a) Dispersion by a prism, Dispersive power, deviation without dispersion, dispersion without deviation, direct vision spectroscope,
- b) Aberrations, spherical aberration, coma, astigmatism, chromatic aberration,
- c) Simple magnifier, Huygens eyepiece, Ramsden eyepiece, compound microscope, telescope

Module II: Physics of Optical instruments

2 Credits

Unit IV: Interference

- a) Superposition of waves, Interference,
- b) interferometry, plane parallel film interference, variable film interference,
- c) Newtons ring, Michelson's interferometer

Unit V: Diffraction and Resolving Power

- a) Fraunhofer diffraction at single slit, Fraunhofer diffraction at circular aperture, Plane diffraction grating,
- b) Resolving power, Rayleigh's criterion, resolving power of optical instrument,
- c) RP of telescope, RP of microscope.

Unit VI: Photon interactions and LASERs

- a) The photoelectric effect, The Compton Effect, The photon mass
- b) Population inversion, LASER.
- c) He-Ne LASER, Ruby LASER

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

1. Refractive index of glass by using glass slab.
2. Use of spectrometer to determine angle of prism.
3. Use of spectrometer to determine RI of prism for different colour.
4. Focal length of convex lens by displacement method (using filament lamp)
5. Cardinal points of a lens system.
6. Bi-prism interference.
7. Diffraction grating to determine wavelength of light.
8. Single slit diffraction using LASER beam.

References:

1. A textbook of Optics, for BSc students as per UGC model syllabus (Revised Edition), Dr N Subrahmanyam Brijlal, Dr M N Avadhanulu (Module 1 Unit 1, 2, 3 Module 2 Unit 1, 2)
2. Optics, Ajoy Ghatak (Module 2 Unit 3)

SEMESTER-III
COURSE III: THERMODYNAMICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

Course Outcomes

By the end of the course, student will be able to:

1. explain Kinetic theory of gases.
2. describe the process of thermal conductivity, viscosity and diffusion in gases.
3. Explain the nature of thermodynamic properties of matter like internal energy, enthalpy, entropy, temperature, pressure and specific volume
4. explain the efficiency of Carnot's engine.
5. explain the significance of first and second laws of thermodynamics.
6. explain the implications of the second law of thermodynamics and limitations placed by the second law on the performance of thermodynamic systems.
7. explain the entropy changes in a wide range of processes and determine the reversibility or irreversibility of a process from such calculations.
8. describe the interrelationship between thermodynamic functions and ability to use such relationships to solve practical problems.

Module 1– Ideal and Real Gases

2 Credits

Unit I : Elementary Kinetic Theory and Maxwellian Distribution

- a) Introduction, Basic assumptions of Kinetic Theory, Kinetic Interpretation of Temperature, Root Mean Square Speed
- b) Some Elementary Deductions from Kinetic Theory, Classical theory of Heat Capacities of Gases
- c) Distribution of Molecular Velocities in a Perfect Gas: Maxwell - Boltzmann Distribution Law, Molecular Distribution of Speeds, Some useful deductions from Maxwell's law

Unit II: Mean Free Path and Transport Phenomena

- a) Introduction, Mean Free Path, Expression for Mean Free Path, Distribution of Free Path
- b) Transport Phenomena, Viscosity- transport of momentum, thermal Conductivity- Transport of Energy, Diffusion- Transport of Matter
- c) Brownian Motion, examples of Brownian motion, Random walk

Unit III: Real Gases: Vander Waal's equation of state

- a) Introduction, Deviations from perfect gas behaviour, Regnault's experiments' Andrew's experiments on Carbon Dioxide, Amagat's Experiments
- b) Onnes' equation of state, Vande Waals' equation of state, Discussion of van der Waals' equation-comparison with experimental results, Determination of van der Waals' constants, Virial coefficient-Boyle temperature, Limitations of van der Walls' equation, reduced equation of state
- c) Molecular Attraction- Existence and implications, Joule experiment, The porous plug experiment, Joule-Thomson coefficient for a van der Waals' gas

Module II - Laws of Thermodynamics**2 Credits****Unit IV Zeroth and First Law of Thermodynamics**

- Introduction, Thermodynamic system, surroundings and boundaries, state of a system and thermodynamic variables, thermodynamic equilibrium, thermodynamic processes
- The zeroth law and the concept of temperature, some deductions from the equation of state, measurement of temperature, Scale of temperature
- Origin of the first law, the internal energy, thermal interaction, mechanical interaction, diffusive interaction, The first law, Applications of the first law, Heat capacities of a gas, Adiabatic transformation- equation of state, the enthalpy, Adiabatic and isothermal elasticities

Unit V: Second Law of Thermodynamics

- Introduction, origin of the second law, Heat engines, the Carnot cycle, Carnot cycle as Refrigerator
- The Kelvin-Planck and Clausius statements, equivalence of the statements, Carnot theorem, thermodynamic temperature, Unattainability of absolute zero
- Irreversibility and unavailable energy, Power cycles, Rankine cycle, Air standard cycles, refrigeration cycles, vapor-Compression refrigeration cycle

Unit VI : Entropy

- Introduction, Concept of Entropy, Entropy change in reversible processes, the Carnot cycle, reversible heat transfer
- The Clausius inequality, entropy change in irreversible process, the principle of increase of entropy
- The entropy of the first law, entropy of an ideal gas, entropy of mixing, unavailable energy and thermal death of universe, physical concept of entropy

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
- To determine the Coefficient of Thermal Conductivity of Copper by Searle's Apparatus.
- To determine the Temperature Coefficient of Resistance.
- To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
- To Calibrate a Thermocouple to measure Temperature in a Specified Range using (1) Null Method (2) Direct Measurement using an Op-Amp Difference Amplifier and to determine Neutral Temperature.
- To calculate loss of heat due to radiation while determining Joule's constant.
- Few experiments on virtual lab: <http://htv-au.vlabs.ac.in/> apparatus can be arranged in the lab of the college as shown.
- Following three experiments at <https://facultyweb.cortland.edu/douglas.armstead/S15/intermediate/Lab12Thermodynamics.pdf> : (i) Coefficient of Linear Expansion of Metals, (ii) Specific Heat, (iii) Thermocouple Voltage can be studied with simulators or apparatus can be arranged in the lab.

References:

1. Thermal Physics, S C Garg, R M Bansal & C K Ghosh, McGrawHill Education (India) Second ed (2013)
2. Heat and Thermodynamics- M M Zemansky, McGrawHill Education (India) 8ed (2011)
3. Geeta Sanon, B. Sc. Practical Physics, 1st Edn. (2007), R. Chand & Co. 2. B. L.
4. Worsnop and H. T. Flint, Advanced Practical Physics, Asia Publishing House, New Delhi. 3.
5. Indu Prakash and Ramakrishna, A Text Book of Practical Physics, Kitab Mahal, New Delhi. 4.
6. D. P. Khandelwal, A Laboratory Manual of Physics for Undergraduate Classes, Vani Publication House, New Delhi.

SEMESTER-IV
COURSE IV: ELECTRICITY AND MAGNETISM

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

Course Outcomes

By the end of the course, student will be able to:

1. explain Electric field as well as force, electric charge, electric potential, current, voltage, resistors, inductors and capacitors.
2. analyse electrical circuits with the help of different circuit theorems.
3. explain different methods to measure values of capacitors and inductors.
4. analyse working of ac as well as dc circuits with inductors, capacitors and resistors.
5. describe generation of magnetic field and its measurement
6. explain the working of systems based on magnetic fields.
7. handle the instruments working on the principles of magnetization.

Module I- Electricity

2 Credits

Unit I: Electric Current

(Review of - Electric current, Ohm's law, Resistive circuit and Kirchhoff's laws.)

- a) Thevenin's theorem, Current source, Norton's theorem,
- b) Maximum power transfer theorem,
- c) Wheatstone bridge, Kelvin double bridge

Unit II: Resistor, Inductor and Capacitor

- a) Transient response of LR, CR, LCR circuits.
- b) The AC signal, AC response of a resistor, an inductor, a capacitor.
- c) Representation of sinusoid by complex number

Unit III: Response of Circuits to AC signal

- a) AC signal applied across CR, AC applied across LR,
- b) AC signal applied across LCR (series and parallel).
- c) AC bridges - Sauty AC Bridge, Maxwell Bridge.

Module II - Magnetism

2 Credits

Unit IV: Magnetization

- a) Magnetization, Magnetic pole density,
- b) Magnets and magnetic shells
- c) Hysteresis in ferromagnetic material,

Unit V: Magnetic Force

- a) Lorentz force, Origin of magnetic field,
- b) Force on current carrying conductor in magnetic field, Biot-Savart law,
- c) Applications of Biot-Savart law, Current carrying loop in magnetic field

Unit VI: Magnetic Induction and Galvanometers

- a) Electromagnetic induction, Eddy current, self-induction, mutual induction,

- b) Moving coil galvanometer, Sensitivity and accuracy of MCG,
- c) Moving Magnet (Tangent) galvanometer, Sensitivity and accuracy Tangent galvanometer.

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

1. Verification of Thevenin's theorem.
2. Use of Post Office box to measure high resistance.
3. Verification of maximum power transfer theorem.
4. LCR series resonance.
5. Capacity of De-Sauty AC Bridge.
6. Deflection magnetometer.
7. Current sensitivity of MCG.
8. Current sensitivity of tangent galvanometer.

References:

1. Electricity And Magnetism, D Chattopadhyay, P C Rakshit

SEMESTER-V
COURSE V: ELECTRONICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

Course Outcomes

By the end of the course, student will be able to:

1. explain basics of semiconductor & devices and their applications in different areas.
2. elaborate biasing techniques to operate BJT and comparison between them.
3. describe parameters of OPAMP and design different circuits using OPAMPs.
4. explain digital signal, digital logics, Boolean algebra, and various logics systems.
5. handle the minimization techniques to simplify the hardware requirements of digital circuits and apply them for real time digital systems.
6. examine the structure of various number systems and its application in digital design.
7. analyze and design various combinational and sequential circuits.

Module I – Analog Electronics

2 Credits

Unit I: Semiconductor Diodes and their applications

- a) Review of extrinsic semiconductors of n and p types, diode characteristics, DC and AC resistance of diode. Effect of temperature on diode characteristics, series and parallel configurations of diodes.
- b) Applications as logic gates (AND, OR), Zener diode characteristics and voltage regulator
- c) Light Emitting Diodes, voltage multipliers.

Unit II : Bipolar Junction Transistors

- a) Transistor construction and operation, CB and CE modes, Current amplification factors in CB and CE modes and their relationship
- b) Input and output characteristics of transistor in CE mode, Concepts of load line and operating point. Dc biasing of transistor - Fixed bias, Emitter bias with equation of load line.
- c) Voltage divider bias with approximate and exact analysis. Comparison of stability in fixed bias, emitter bias and voltage divider bias

Unit III : Operational Amplifier

- a) Properties of ideal OPAMP and OPAMP 741, Concepts of -ve feedback and virtual short, Inverting & non-inverting amplifier, unity gain circuit, Summing amplifier
- b) Concepts of CMRR, Bandwidth, gain bandwidth product, slew rate, Integrator and differentiator circuits, Instrumentation amplifier and its applications
- c) Introduction to 555 timer and its application to generate clock signal

Module II - Digital Electronics

2 Credits

Unit IV: Digital Logics and Implementation

- a) Review of Digital principles and Digital logics, Boolean identities, De Morgan's laws, NAND & NOR logics, NAND and NOR gates as universal building blocks
- b) SOP method to write Boolean equations, Karnaugh Maps, POS method and simplification and implementation of Boolean equations
- c) EXOR operation with its Boolean expression using SOP and POS methods

Unit V : Number systems

- Binary number system (4 bit), Binary to decimal and decimal to binary conversion, Octal number system, Octal to binary/decimal and binary/decimal to octal conversion
- Hexadecimal number system, Conversion from/to hexadecimal, Binary arithmetic, subtraction using 1's and 2's complements
- Half and full adder circuits, Adder-subtractor circuit

Unit VI: Flip Flops and counters

- RS flip- flop using NOR gates and NAND gates, concepts of pulse and edge triggering, Clocked RS FF, D FF, PRESET and CLEAR functions, switch contact debounce circuit
- JK FF, M/S JK FF
- Counters with natural count, UP-DOWN Ripple counter

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any six experiments from the list:

- Zener voltage regulator
- Output characteristics of Transistor in CE mode.
- Plotting load line for transistor with emitter bias.
- Inverting, Non- inverting and unity gain amplifier using OPAMP.
- 555 timer as square wave generator.
- NAND and NOR as universal building blocks.
- Half adder circuit using basic gates.
- RS flip flop using NOR/NAND gates with manual clock.
- JK flip flop as divide by two circuit.

Reference Books:

- Electronics Devices and Circuit Theory — Boylestad & Nashelsky 11th edition, Pearson Publication
- Electronic Principles — Malvino , Tata McGRAW Hill
- Digital Principles and Applications — Leach, Malvino & Saha, Tata McGRAW Hill

SEMESTER-VI
COURSE VI : MODERN PHYSICS AND QUANTUM MECHANICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

Course Outcomes

By the end of the course, student will be able to:

1. explain the production and properties of X-rays, their applications and Bragg's law
2. derive the origin of quantum theory, Blackbody radiation, matter waves.
3. elaborate wave properties of particles, DE Broglie waves and its implications on the uncertainty principle.
4. explain Schrödinger's equation for many systems such as particle in a box, Hydrogen Atom and familiarize with 1d and 3d potential well, potential step problems.
5. explain the tunneling effect.
6. explain working principle of scanning tunneling microscope and scanning electron microscope.
7. explain the alpha decay process.
8. explain the working of 1d harmonic oscillator.

Module I- Modern Physics

2 Credits

Unit I : Basics of Quantum physics

- a) X-RAYS: X-Rays production and properties, Continuous and characteristic X-Ray spectra, Applications of X-Rays, X-Ray Diffraction, Bragg's Law, Frank-Hertz experiment
- b) Origin of Quantum theory, Black body (definition), Black body spectrum, Wien's displacement law, Matter waves, Wave particle duality, Heisenberg's Uncertainty Principle, Davisson-Germer experiment, G. P. Thompson experiment.
- c) Numerical problems from reference book

Unit II: Wave Function

- a) Wave function, the wave equation, Schrodinger's equation: time dependent form.
- b) Linearity and superposition, expectation values, operators and eigenvalues.
- c) Worked out examples on allowed/ not allowed wave functions, operators and eigenvalues, expectation values.

Unit III: Schrodinger's equation and its applications

- a) Schrodinger's equation: steady state form, free particle, probability current.
- b) Particle in 1d infinite potential well, wavefunctions and energies. Particle in finite potential well (only wavefunctions and $E < V$)
- c) Solved examples on probability current, energies in 1d infinite potential well

Module II - Quantum Mechanics

2 Credits

Unit IV: Potential well

- a) Particle in 3d infinite potential well (complete solution), degeneracy.

- b) Finite potential step, reflection coefficients in both the cases $E < V$ and $E > V$.
- c) Solved examples on energies in 3d infinite potential well and reflection coefficient in potential step.

Unit V: Tunneling effect

- a) Potential barrier (Finite height and width) penetration and tunneling effect (derivation of approximate transmission probability),
- b) Scanning Tunneling Microscope and Scanning Electron Microscope.
- c) Solved examples in transmission coefficient in potential barrier

Unit VI: Alpha decay, Harmonic Oscillator

- a) Theory of alpha particle decay from radioactive nucleus.
- b) Harmonic oscillator (one-dimension), correspondence principle, diatomic molecule.
- c) Solved examples in alphas decay and harmonic oscillator

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six experiments only

1. Frank-Hertz experiment
2. Determination of Planck's constant using LEDs of different colors.
3. Visit to an X-ray diffraction facility and understanding working of the instrument (equivalent to two experiments)
4. Visit to STM and SEM facility (equivalent to two experiments).
5. Numerically solving Schrodinger equation using excel programming.

References

1. Concepts of Modern Physics by Arthur Beiser.
2. Modern Physics by Kenneth Krane.

SEMESTER-VII
COURSE VII -1: SOLID STATE PHYSICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcomes

By the end of the course, student will be able to:

1. explain the basic concepts of force between atoms and bonding between molecules
2. analyses the relationship between conductors, insulators and superconductivity
3. describe free-electron model and energy band and distinction between metals, semiconductors and insulators
4. explain the properties of matter and its classifications
5. explain properties of semiconductors
6. describe phonons impact on heat capacity and heat transport

Module I – Crystal Bonding and Crystal Structure

2 Credits

Unit I: Concept of Crystal

- a) Introduction of crystals, Ionic crystal, Covalent crystal, Metals, Concept of inter – atomic forces, types of bonding, ionic bonding, covalent bonding, molecular or Vander Waal's bonding, hydrogen bonding, metallic bonding, atomic radii
- b) Introduction of Crystal Lattice and translation vectors, unit cell, types of lattice (Plane lattice and Space lattice with bcc and fcc
- c) Miller indices, Concept of reciprocal lattice and its properties, Brillouin zones (only concept)

Unit II: Electron and Electron Theory

- a) Free Electron theory: Free Electron model, Fermi - Dirac distribution, electronic specific heat, thermionic emission from metals, energy distribution of the emitted electrons
- b) Band theory of Solids: Origin of energy band, Energy bands in solid, Bloch functions, Kronig- Penney model (no mathematical derivation)
- c) Motion of electrons in one – dimensional periodic potential, Distinguish between metal, semiconductor and insulator, concept of a 'hole'

Unit III: Semiconductor Crystal and Thermal Properties

- a) Semiconductor Crystal: Electrons and Holes densities in an Intrinsic Semiconductor (undoped), Doped Semiconductor, Carrier densities in doped semiconductor, Metal - Insulator transition, Fermi level in extrinsic semiconductors, Diffusion, Carrier lifetime
- b) Phonons: Phonons and heat capacity, Debye Model for density of states.

- c) Thermal Properties of phonons

Module II - Magnetic Properties

2 Credits

Unit IV: Concept Magnetism

- Classification of magnetic materials, Origin of permanent magnetic dipoles, dynamics of dipole in magnetic field, Magnetic susceptibility
- Introduction of Diamagnetism and Paramagnetism, diamagnetism and the Larmor precession, static paramagnetic susceptibility, Quantum mechanical theory of paramagnetism
- Nuclear paramagnetism, The Hamiltonian for an electron in a magnetic field

Unit V: Introduction to Ferromagnetism and Ferrimagnetism

- Ferromagnetism - The Weiss molecular field, interpretation of the Weiss field, anisotropy energy, thickness and energy of the Bloch wall, Coercive forces and hysteresis
- Introduction of Antiferromagnetism, Two sublattice model, Super exchange interaction
- Introduction to Ferrimagnetism, structure of ferrites, Elements of Neel's theory

Unit VI: Paramagnetic relaxation and Superconductivity

- Paramagnetic relaxation - phenomenological description, relaxation mechanism - spin - lattice and spin spin relaxation
- Introduction of Nuclear magnetic resonance, conduction required for absorption of resonance, Bloch equation and the complex susceptibility
- Superconductivity: Occurrence of Superconductivity, destruction of superconductivity by magnetic field, Meissner effect, Applications

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- Measurement of resistivity by using 4 - probe technique.
(<https://vlab.amrita.edu/?sub=1&brch=282&sim=1512&cnt=4>)
- Study of hall effect
(http://mpv-au.vlabs.ac.in/modern-physics/Hall_Effect_Experiment/#)
- To understand the concepts of crystal structure, atomic packing, and Miller Indices as well as their applications to materials properties and development
(<http://user.engineering.uiowa.edu/~matsci/crystallography.html>)
- To study Bravais lattices with the help of models

<http://www.omgroup.edu.in/downloads/files/n5375e8edae2b2.pdf>)

5. Thermal properties of metal (Steel)

(<http://www.omgroup.edu.in/downloads/files/n5375e8edae2b2.pdf>)

6. To find the thermal conductivity of a material by the two slabs guarded hot plate method and
To find the thermal resistance of the sample.

(<https://vlab.amrita.edu/index.php?sub=1&brch=194&sim=801&cnt=4>)

7. Nuclear Magnetic Resonance

(<https://www.labster.com/simulations/nuclear-magnetic-resonance-2/>)

References:

1. Pillai, S.O. : Solid state physics 3rd ed. New Delhi, New Age International (P) Ltd. 1999 .
2. Kittel, Charles: Introduction to solid state physics 8th ed. Reprint New Delhi Wiley India Pvt. Ltd. 2005(2015)
3. Dekker, Adrianus J.: Solid state physics. Indian Reprint Delhi Macmillan Publishers India Ltd. 1957(2014)
4. Solid State Physics - S.P.Kakani and Amit Kakani

SEMESTER-VII

COURSE VII 2: ATOMIC, MOLECULAR AND NUCLEAR PHYSICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcomes

By the end of the course, student will be able to:

1. explain atomic structure, atomic spectra and excitations.
2. explain Schrodinger equation for Hydrogen atom and its solution.
3. analyse set of different quantum numbers and their selection rules.
4. explain symmetric and antisymmetric wave function, electron spin and spin orbit coupling.
5. describe rotational and vibrational energy levels of complex molecules and molecular spectra.
6. explain the radioactive decay process, its decay and growth and applications.
7. explain the basic properties of nucleus, nuclear energy and liquid drop model.
8. explain the principle and working of nuclear detectors.

Module I - Atomic Physics

2 Credits

Unit I : Atom and Energy level

- a) The nuclear atom, Electron orbit, atomic spectra,
- b) Bohr atom, energy level and spectra,
- c) Atomic excitation.

Unit II: Schrodinger's approach with Quantum numbers

- a) Schrodinger equation for the hydrogen atom, Separation of variables,
- b) Quantum numbers, Principal quantum number, Orbital quantum number,
- c) Magnetic quantum number, Selection rule

Unit III: Interaction between electron spin and orbital motion.

- a) Electron spin, Exclusion principle,
- b) Symmetric and anti-symmetric wave function, atomic structure,
- c) Spin orbit coupling Total angular momentum

Module II - Molecular and Nuclear Physics

2 Credits

Unit IV: Molecular Bond and Energy Level

- a) Molecular bond, Hydrogen molecule,
- b) Complex molecules, Rotational energy level, Vibrational energy level,
- c) Spectra of molecules.

Unit V: Radioactive Properties

- a) Radioactivity, properties of radioactive rays,
- b) law of radioactive decay, Radioactive growth and decay, Determination of age of earth,
- c) ideal equilibrium, transient and secular equilibrium,

Unit VI: Introduction to Nucleus

- a) Constituents of the nucleus and some of their properties,
- b) alpha beta and gamma rays, liquid drop model, Nuclear energy,
- c) Introduction of Instrument like – GM counter, NMR, ESR

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

1. Absorption spectra in sunlight
2. Franck-Hertz Experiment (available on virtual lab by Amrita University)
3. Determination of Cauchy's constants
4. Hydrogen spectra using spectrometer.
5. Experiment on GM counter.
6. Determination of Rydberg constant using spectrometer.
7. Use of Simulator for understanding physical concepts.

References:

- a) Concepts of Modern Physics Arthur Beiser (Module 1 Unit 1 to 3, Module 2 Unit 1)
- b) Nuclear Physics - An Introduction by S B Patel (Module 2 Unit 2,3)

SEMESTER-VIII
COURSE VIII 1: ADVANCED MECHANICS AND SPECIAL RELATIVITY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcomes

By the end of the course, student will be able to:

1. define and understand motion under central force, elliptical orbits with Kepler's laws.
2. describe and understand the systems with an inertial frame of reference.
3. describe and understand the motion ideal fluid and its conservation laws.
4. describe and understand Euler's theorem, Euler's equation of motion of rigid bodies.
5. explain the concepts of special relativity, space and time dilation, length contraction
6. explain the concept of General Relativity.

Module I – Mechanics of a moving body and fluid

2 Credits

Unit I: Introduction to Central Force

- a) Motion under a central force, the central force inversely proportional to the square of the distance, Elliptic orbits, The Kepler problem.
- b) Moving origin of coordinates, Rotating coordinate systems, Laws of motion on the rotating earth, The Foucault pendulum, Larmor's theorem.
- c) Worked out examples from the reference book

Unit II: Kinematics of moving fluids and Rigid Dynamics

- a) Kinematics of moving fluids, Equation of motion for an ideal fluid, Conservation laws for fluid motion, Steady flow.
- b) Rigid dynamics: introduction, degrees of freedom, rotation about an axis: orthogonal matrix,
- c) Worked out examples from the reference book

Unit III: Euler's Theorem

- a) Euler's theorem, Eulerian angles, inertia tensor, angular momentum of rigid body,
- b) Euler's equation of motion of rigid body, free motion of rigid body, motion of symmetric top (without nutation).
- c) Worked out examples from the reference book

Module II – Relativity

2 Credits

Unit IV: Special Relativity

- a) Introduction to Special relativity, Lorentz transformations
- b) Spacetime and time dilation
- c) Worked out examples from the reference book

Unit V: Electricity and Magnetism

- a) Doppler effect, length contraction and twin paradox
- b) Electricity and Magnetism, relativistic momentum
- c) Worked out examples from the reference book

Unit VI: Energy and Momentum

- a) Mass and energy, energy and momentum
- b) General relativity
- c) Worked out examples from the reference book

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

1. To study Doppler effect using 'phyphox'
2. To study Motion of a spinning top using 'tracker' software
3. Determination of 'g' by Kater's pendulum
4. Logarithmic decrement
5. Study of Coupled oscillations and resonance
6. Determination of Y-Flat spiral spring
7. Surface tension of soap solution
8. Elastic constants of a rubber tube

References

1. Classical Mechanics, P. V. Panat (Narosa).
2. Classical Mechanics-a Modern Perspective: V. D. Barger and M. G. Olsson. (Mc Graw Hill International 1995 Ed.)
3. Mechanics : Keith R. Symon, (Addison Wesley) 3rd Ed.
2. An Introduction to Mechanics: Daniel Kleppner & Robert Kolenkow Tata Mc Graw Hill (Indian Ed. 2007).
3. Concepts of Modern Physics, Arthur Beiser, Chapter 1.
4. Modern Physics, Kenneth Krane, Chapter 2.

SEMESTER-VIII
COURSE VIII 2: Applied Physics

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcomes

By the end of the course, student will be able to:

1. explain major concepts in physics.
2. relate scientific knowledge with real life situations.
3. analyse typical optical imaging systems, with emphasis on the human eye
5. apply the aspects of nuclear reactions in view of compound nuclear dynamics
6. explain ionization and the results of ionization during exposure to x-rays.

Module I – Applications of Mechanics, Light and Thermodynamics **2 credits**

Unit I: Every day applications of Mechanics

- a) Review of Newton's I, II and III law of motion, inertia, mass, net force, inertial frame of reference, Physics behind Skating and ballet dance
- b) Review of projectile motion, energy, work, conservation of energy, gravitational potential energy, Physics behind falling balls and Ramps, Looping the loop, motorcycles in cage ball
- c) Work out problems

Unit II: Applications of basic properties of Light

- a) Review of light, refraction, reflection, dispersion, interference in electromagnetic waves, polarized reflection Physics behind Sunlight, industrial applications of different phenomena of light in non-destructive testing
- b) Review of levels of solid, band structure, fermi level, metal, semiconductor, insulator, photoconductors, p - n junction diode), Brief description of LED
- c) LASER: Spontaneous and Stimulated emission, population inversion

Unit III: Thermodynamics as applied to different machines

- a) Review of laws of Thermodynamics, heat, entropy, heat pumps, thermodynamics efficiency, Working of Air Conditioners
- b) Review of heat engines, thermodynamics efficiency, Physics behind Automobiles
- c) Work out problems from the reference book

Module II – Applications of Electricity, Magnetism and Nuclear reactions 2 credits

Unit IV: Machines working on the Principles of Electricity

- Review of electric fields and voltage gradients, electric fields inside and outside conductors, discharges, charging by induction, capacitors, Physics behind Xerographic copiers
- Review of electric current, electric circuit, direction of current, electrical resistance, voltage drop and rise, ohm's law, series and parallel circuit) Physics behind Flashlight
- Work out problems from the reference book

Unit V: Physics behind home appliances

- Review of relationship between changing electric and magnetic fields, electric field energy, tank circuit, electromagnetic waves, antennas, speed of light, modulations (amplitude and frequency, bandwidth) Brief description of Radio
- Review of speed, frequency and wavelength in electromagnetic waves, polar and non - polar molecules, Lorentz force, cyclotron motion) Physics behind Microwave ovens
- Work out problems from the reference book

Unit VI: Use of Nuclear reactions and Nuclear Energy

- Review of nuclear structure, Heisenberg uncertainty principle, quantum tunnelling, radioactivity, half-life, fission, chain reaction, isotopes, alpha decay, fusion, isotopes, transmutation of elements, radioactive fallout) Physics behind Nuclear Weapons
- Review of controlling nuclear fission, delayed neutrons, thermal fission reactors, moderators), Nuclear Reactors
- Review of X - Rays, photoelectric effect, Compton scattering, gamma rays, beta decay), Medical Imaging and Radiation

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- To determine specific gravity of solid.
- Atwood's Machine
- To find the Modulus of Torsion of a Wire by Maxwell's Vibration Needle.

4. Determination of the Velocity of Sound in Air by Measurement of the Length of a Resonance Tube corresponding to a Fork of known Pitch
5. Determine the freezing and boiling points of the given thermometer.
6. Determine the coefficient of expansion of the given liquid and of cubical expansion of the given solid.
7. Compare the illuminating power of the gas- flame and standard candle.

Reference:

1. How things Work, The Physics of everyday life by Louis A. Bloomfield, Wiley
2. <https://archive.org/details/practicalphysics00glazuoft/page/262/mode/2up>

Chemistry

SEMESTER I

COURSE I: CONCEPTS OF ANALYTICAL AND INORGANIC CHEMISTRY I

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment : 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Comprehend and interconvert concentration terms such as molarity, normality, formality, molality, mole fraction and ppm.
2. Determine empirical formula and molecular formula for a compound from the given experimental data; and perform stoichiometric calculations.
3. Differentiate between precision and accuracy, examine errors and their sources.
4. Present experimental data using statistical methods of data representation and significant figures.
5. Explain the definition of solubility and solubility product, calculate the value of K_{sp} and predict formation of precipitate.
6. Identify the mathematical relationships between the various properties of gases, use the combined gas law to compute the values of various gas properties under specified conditions and recognize why gases do not behave as ideal gases.
7. Describe quantum mechanical model of the atom, quantum numbers, radial and angular distribution curves and shapes of s, p, and d orbitals.
8. Identify periodicity in atomic and ionic radii, electronegativity, ionization energy, electron affinity of elements of the periodic table.

Module I - Introduction to Analytical Chemistry and its interdisciplinary nature

(2 Credits)

UNIT I: Chemical Calculations and Stoichiometry

- a) Mole concept, determination of molecular mass by gram molecular volume relationship for chemical reactions, problems based on mole concept. Methods of expressing concentration of solutions: molarity, normality, molality, molefraction, formality, dilution of solutions, inter-conversion between different concentration units, concept of milliequivalents, millimoles, ppm and ppb.
- b) Gravimetric and Volumetric analysis: use of digital balance, calibration of glassware, pipette, burette and volumetric flask, primary and secondary standards.
- c) Importance of accuracy, precision and sources of error in analytical measurements, presentation

of experimental data and results from the point of view of significant figures.

UNIT II: Buffers, solubility product and its applications

- a) Buffer solutions: types of buffers, derivation of Henderson–Hasselbelch equation and its applications; buffer capacity, buffer range, buffer action and applications of buffers in analytical chemistry.
- b) Solubility product, factors affecting precipitation equilibria (solubility product) in qualitative analysis: common ion effect, pH, complexation, diverse ion effect, oxidation states (numerical problems expected).
- c) Numerical problems based on the above concepts.

UNIT III: Study of Fluids

- a) Behaviour of Real Gases. Recapitulation of ideal behaviour of gases, deviations from ideal gas behaviour, compressibility factor - Z and its variation with pressure for different gases. Causes of deviation from ideal behaviour.
- b) Van der Waal's equation of state, its derivation and application in explaining real gas behaviour (Mention of other equations of state: Berthelot, Dietrici).
- c) Isotherms of real gases and their comparison with Van der Waal's isotherms, continuity of states, critical state, experimental determination of P_c , T_c and V_c , critical constant of gas in terms of Van der Waal's constant.

Module II – Atomic structure and Periodicity

(2 Credits)

UNIT IV: Atomic Structure

- a) Bohr's theory of Hydrogen atom, wave theory
- b) Heisenberg's Uncertainty Principle
- c) Orbitals (shapes of s, p and d orbitals) and quantum numbers.

UNIT V: Periodic Table and Periodicity of Properties

- a) Arrangement of elements in the long form of the periodic table, correlation of classification of elements into s, p, d and f-block on the basis of electronic configuration, Pauli's Exclusion Principle, Aufbau Principle and Hund's Rule of maximum multiplicity, anomalies in electronic configuration.
- b) Atomic and ionic radii, ionization energy, electron affinity, effective nuclear charge and calculations using Slater's Rule, electronegativity and its determination using Mulliken's and Pauling's method (numerical problems expected), metallic and non-metallic character, oxidation states, melting / boiling points, colour, magnetic properties, polarizability. Trends in the periodic table and applications in predicting and explaining chemical behaviour.

- c) Chemistry of 's' block (Groups 1 and 2): Position of elements in the periodic table, electronic configuration, trends in the properties with respect to family relationship, physical and chemical properties, ionization potential (charge to size ratio), electronegativity, polarizing power, oxidation state, hydration energy of ions.

Anomalous behaviour of Li and Be and diagonal relationship.

UNIT VI: Principles involved in Qualitative Analysis

- a) Use of borax, sodium carbonate, cobalt nitrate, hydrogen sulphide and ammonium chloride in qualitative analysis.
- b) Solubility product and Common ion effect in QA.
- c) Detection of the following acid radicals in presence of each other: carbonate, sulphite, chloride, bromide, iodide, nitrite and nitrate.

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry

Lab Safety

Semi-Micro Inorganic Qualitative Analysis:

Inorganic mixtures containing four radicals, 2 cations and 2 anions. Preliminary dry tests, preparation of solution for analysis and wet tests for confirmation of the presence of the radicals.

Cations: Cu^{2+} , Bi^{3+} , Sb^{3+} , Al^{3+} , Fe^{2+} , Fe^{3+} , Mn^{2+} , Cr^{3+} , Zn^{2+} , Ni^{2+} , Co^{2+} , Ba^{2+} , Sr^{2+} , Ca^{2+} , Mg^{2+} , NH_4^+ , K^+

Anions: Cl^- , Br^- , I^- , NO_2^- , NO_3^- , CO_3^{2-} , SO_4^{2-} , PO_4^{3-} , CrO_4^{2-} , BO_3^{3-}

At least 5 – 6 mixtures to be analyzed with interfering radicals.

References:

1. Principles of Physical Chemistry, 4th edition by S.H. Marron and C. F. Pruton.
2. Textbook of Physical Chemistry, Samuel Glasstone.
3. Physical Chemistry, Ira Levine, 5th Edition, 2002 Tata McGraw Hill Publishing Co. Ltd.
4. Physical Chemistry, G.M. Barrow, 6th Edition, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
5. University Chemistry, Bruce Mahan.
6. Textbook of Physical Chemistry, Sharma and Puri.
7. Fundamentals of Analytical chemistry, 8th edition, Skoog, West, Holler and Crouch.

8. Concise Inorganic Chemistry, J. D. Lee, 5th edition, Oxford Press.
9. Advanced Inorganic Chemistry, Volume I, S. Prakash, G.D. Tuli, S. K. Basu, R. D. Madan.
10. Theoretical Inorganic Chemistry, C. M. Day & J. Selbin, Affiliated East West Press Pvt. Ltd., 1985.

SEMESTER II

COURSE II: CONCEPTS OF PHYSICAL AND ORGANIC CHEMISTRY I

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Interpret the first law of thermodynamics and express it mathematically; calculate energy changes, work and heat contributions in chemical systems and correlate ΔU and ΔH .
2. Differentiate between extensive and intensive properties; define spontaneous and non-spontaneous processes and correlate free energy change and spontaneity of a process
3. Examine operation of Carnot cycle in order to determine thermodynamic efficiency.
4. Define the average and instantaneous rate of a reaction, express the rate of a reaction in terms of change in concentration of either of the reactants or products with time, and differentiate between molecularity and order of a reaction.
5. Define rate constant and derive integrated rate equations for the zero, first and second order reactions.
6. Name an organic compound using IUPAC nomenclature rules and to accurately represent an organic compound given an IUPAC name.
7. Explain mechanism of organic reactions and classify reaction types and intermediates.
8. Outline the molecular attributes that generate chirality, stereoisomers, enantiomers, diastereomers, meso compounds, optical activity and racemic mixtures.

Module I – Fundamentals of Physical Chemistry

(2 Credits)

UNIT I: Chemical Thermodynamics

- a) Recapitulation of some important mathematical concepts: derivatives, rules of differentiation and partial differentiation, algebraic, logarithmic and exponential functions. Integration; rules of integration, algebraic and exponential functions (**Self-Study**). Intensive and extensive properties, state and path functions, isolated, closed and open systems, zeroth law of thermodynamics (definition only).
- b) First Law of thermodynamics: Definition, relation and comparison between heat capacities, calculations of q , w , E and H for reversible, irreversible and free expansion of ideal gases under isothermal and adiabatic conditions, limitations of first law and need for introducing new functions (numerical problems expected).
Second Law of thermodynamics: Carnot cycle, mechanical efficiency, entropy changes for

system and surroundings for reversible and irreversible processes, entropy changes for an ideal gas in isothermal, isobaric and isochoric processes, entropy changes in chemical reactions, entropy changes accompanying state change, physical significance of entropy, need for introducing new functions (numerical problems expected).

- c) Free Energy Functions: Gibbs and Helmholtz energy; variation of G and A with P , V and T ; Gibbs energy change and spontaneity, exergonic and endergonic reactions, Gibbs-Helmholtz equation, thermodynamic equation of state (numerical problems expected).

UNIT II: Chemical Kinetics

- a) Graphical representation of equations: Co-relation between mathematical functions and shapes of the graph, rules for drawing graph co-ordinates etc., equation of straight line, slope and intercept, plotting the graph from the data of chemical properties, determination of equation of line of best fit (method of averages and least squares) for $y = mx$ only and problems.
- b) Recapitulation of basic concepts: Rate law, specific rate constant, comparison between order and molecularity with examples, integrated rate equations for zero and first order reactions and their half-life (no derivations), numerical problems expected.
- c) Second order reaction: Derivation of integrated rate equation (for equal and unequal concentration of reactants), characteristics of second order reactions with suitable examples, effect of temperature on rate of reaction (no derivation expected for Arrhenius equation).

UNIT III: Catalysis and Colligative properties of Dilute Solutions

- a) Catalyst and catalysis, positive and negative catalysis, type of catalysis, characteristics of catalytic reactions, promoters, catalytic poisoning, autocatalysis. Activation energy and catalysis, theories of catalysis, active center on catalyst surface, adsorption theory and catalytic activity (theoretical aspect only). Acid-Base catalysis (theoretical aspect only) and its applications in industry.
- b) Enzyme catalysis, mechanism of enzyme catalysis, characteristics of enzyme catalysis, effect of temperature on enzyme catalysis (qualitative approach only), applications.
- c) Dilute solution, colligative properties, Raoult's law, relative lowering of vapour pressure. Elevation in boiling point of a solution, thermodynamic derivation relating elevation in the boiling point of a solution and the molar mass of the non-volatile solute. Depression in freezing point of a solution, thermodynamic derivation relating the depression in the freezing point of a solution and molar mass of the non-volatile solute.

UNIT IV: IUPAC Nomenclature and Basics of Reaction Mechanism

- a) IUPAC nomenclature: ALIPHATIC system only with multiple functional groups. Geometry and structure of sp^3 , sp^2 and sp hybridized carbon, nitrogen and oxygen atoms and some common functional groups E.g., carbonyl and cyano.
- b) Applications of electronic factors: Impact of inductive effect on pK_a and pK_b . Resonance in organic compounds. Hyperconjugation and effect on stability of carbocation and carbon radicals. Introduction of reaction mechanism including bond fission, classification of reactions, reagents and intermediates. Structure and stability of carbocations, carbanions and carbon radicals.
- Mechanism of nucleophilic substitution, S_N1 , S_N2 and S_Ni . Effect of substrate, nucleophile, leaving group and solvent on rate of reaction. Elimination Reactions E_1 and E_2 .
- c) Alkanes - mechanism of halogenation. Reactions of alkenes and cycloalkenes: hydrogenation, halogenation, addition of HX - Markownikoff and anti- Markownikoff additions with mechanism. Reactions of alkynes: hydration, addition of HX, selective hydrogenation to cis-and trans- alkenes, acidity of terminal alkynes, preparation of metal acetylides and their alkylation.

UNIT V: Isomerism and Stereochemistry

- a) Isomerism: Types of isomerism; structural isomerism (chain, position and functional) and stereoisomerism.
- b) Chirality: Configuration, chirality and enantiomers, stereogenic / chiral centre, asymmetric carbon atom, representation of configuration by flying wedge formula and projection formulae - Fischer, Newmann and Sawhorse.
- c) Stereochemistry of carbon compounds with one and two similar and dissimilar asymmetric carbon atoms, enantiomers, diastereomers and racemic mixtures and their properties; threo, erythro and meso isomers. Geometrical isomerism due to restricted rotation around carbon – carbon double bond and cycloalkanes.

UNIT VI: Polymers

- a) Polymers: Introduction, General idea of monomers, polymers and polymerization. natural and synthetic polymers. Homopolymers and Copolymers. Classification of polymers.
- b) Copolymers – alternating, block, random and graft. Mechanism of free radical, cationic and anionic addition polymerisation.
- c) Recyclable polymers: Biodegradable polymers and their uses. Biomedical uses of polymers.

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:**Volumetric Estimations:**

- (i) Determination of percentage composition of a mixture of $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$.
- (ii) Determination of percentage composition of a mixture of Oxalic acid + Potassium oxalate.
- (iii) Estimation of Fe^{2+} versus $\text{K}_2\text{Cr}_2\text{O}_7$ using an internal indicator (diphenylamine).
- (iv) Iodometry and Iodimetry:
 - (a) Estimation of iodine in tincture iodine
 - (b) Estimation of Cu^{2+}
- (v) Complexometry: Estimation of $\text{Mg}^{2+}/\text{Zn}^{2+}$, Cu^{2+} using EDTA

Chemical Kinetics:

- (i) To investigate the hydrolysis of methyl acetate in HCl and identify the rate constant graphically as well as by calculations.
- (ii) To study the reaction between KI and $\text{K}_2\text{S}_2\text{O}_8$ using equal concentrations and unequal concentrations.

References:

1. Mathematical preparation for Physical Chemistry by F. Daniel, Mc. Graw Hill publication.
2. Thermodynamics for Chemist: S. Glasstone, Affiliated East-West Press Pvt. Ltd., New Delhi.
3. Commonly Asked Questions in Thermodynamics. Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. CRC Press: NY 2011.
4. Chemical Kinetics, J. Laidler K. Pearson Education: New Delhi 2004.
5. Concise Physical Chemistry, Rogers, D. W. Wiley, 2010.
6. The Elements of Physical Chemistry: 4th Ed., P. W. Atkins, Oxford University Press, 2005.
7. Physical Chemistry, G. M. Barrow, 6th Ed, Tata McGraw Hill Publishing Co. Ltd., 2008.
8. Introduction to Principles of Heterogeneous Catalysis, Thomas J. M., and Thomas W. J., VCH Publishers, New York, 2008.
9. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008.
10. Organic Chemistry, R. T. Morrison and R. N. Boyd, 6th Edition, Pearson Education.
11. Organic Chemistry, T. W. G. Solomon and C. B. Fryhle, 8th Edition, John Wiley & Sons.
12. Polymers, D. Walton and P. Lorimer, Oxford University Press, New Delhi, Indian Edition, 2005.

SEMESTER III
COURSE III: CONCEPTS OF ANALYTICAL AND INORGANIC CHEMISTRY II

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Recognize the principles of volumetric analysis and identify the classification of volumetric methods of analysis.
2. Recognize the type of titration methods suitable under given conditions and predict the choice of indicators.
3. Examine applications of solubility and solubility product in precipitation gravimetric analysis.
4. Solve problems in quantitative analysis using concepts of gravimetry.
5. Elucidate the difference between molecular and atomic spectra and understand various types of spectroscopies.
6. Correlate the physical properties across the groups-13 to 17, compare and distinguish between halogens, halides, pseudo halogens and pseudohalides.
7. Solve problems related to screening constant, effective nuclear charge and identification of group, block and period.
8. Give an overview of manufacturing processes of bulk chemicals [ammonia and sulphuric acid], including physicochemical principles.

Module I – Quantitative Analysis and Spectroscopy

(2 Credits)

UNIT I: Types of Titrations

- a) Classification of volumetric analysis (basic concepts only).
- b) Acid base (neutralisation) titrations: Theory of indicators, theory of acid base indicators, mixed and universal indicators, explanation of the shapes of neutralization curves for strong acid - strong base, weak acid - strong base, weak base - strong acid, weak acid - weak base, choice of indicators (numerical problems expected).
Oxidation-Reduction Titration: Principle and only theoretical discussion (using suitable examples), detection of end points, numerical problems.
- c) Complexometric Titration: Principle (using suitable examples), standardisation, detection of end point.
Iodometry and Iodimetry: General discussion, detection of end point, difference between

iodometry and iodimetry.

Precipitation Titration: Principle and only theoretical discussion (using suitable examples), detection of endpoint.

UNIT II: Gravimetric Analysis

- a) Definition and Types of Gravimetric Analysis.
- b) Precipitation Gravimetry with respect to theory and practice.
 - (i) Solubility considerations: Common ion effect, diverse ion effect, pH and temperature.
 - (ii) Controlling particle size with respect to nucleation and rate of crystal growth.Treatment of precipitates in Gravimetry: Digestion, Filtration and Washing, Drying and Ignition.
- c) Use of Organic Reagents in Gravimetric analysis E.g., Dimethylglyoxime, Salicylaldehyde, Cupron, Oxine and Cupferron.

UNIT III: Introduction to Spectroscopy

- a) Physical quantities and their dimensions: International system of units, derived units, subsidiary units, prefixes for S.I. units, some important conversion factors.
- b) Interaction of low energy radiation with matter: Electromagnetic spectrum, quantisation of energy, absorption of radiation, absorption process, absorbance, transmittance, Beer's law, absorption spectrum, atomic absorption, molecular absorption, limitations of Beer's Law, Beer - Lambert's Law and its applications.
- c) Components of an optical instrument, photometer and spectrophotometer, construction and working of a single beam colorimeter.

Module II - Chemistry of 'p' block elements

(2 Credits)

UNIT IV: Groups 13 and 14

- a) Position of elements in the periodic table, electronic configuration, trends in periodic properties with respect to family relationship, physical and chemical properties, ionization potential (charge to size ratio), electronegativity, oxidation state and metallic character.
- b) Group 13: Structures of electron-deficient compounds with reference to boron hydrides, inert pair effect. Chemistry of Aluminium compounds – halides, oxides and alkyls.
- c) Group 14: Catenation and allotropy with special reference to carbon. Chemistry of silicon, preparation and uses of silicones.

UNIT V: Groups 15 and 16

- a) Physical properties of hydrides of elements of group 15 with respect to hydrogen bonding.
- b) Physical properties of hydrides of elements of group 16 with respect to hydrogen bonding.

- c) Manufacture of bulk chemicals - ammonia by Haber's process and sulphuric acid by Contact process [principles, reactions and flow chart expected].

UNIT VI: Groups 17 and 18 and the d-block elements

- a) Group 17: Pseudohalogen chemistry with respect to comparison with halogens, preparation and uses - cyanogens, thiocyanogens and selenocyanogens.
- b) Group 18: History, peculiar properties of Helium, clathrate compounds, preparation of Xenon compounds.
- c) The d-block elements: Electronic configuration, Physical properties, trends in chemical properties (oxidation state).

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:

Gravimetric Estimation:

- (i) To study the effect of heat on the following mixtures and to calculate the percentage composition of the mixture.
- (a) $\text{NH}_4\text{Cl} + \text{BaSO}_4$ and
- (b) $\text{Na}_2\text{CO}_3 + \text{NaHCO}_3$
- (ii) Precipitation Gravimetry:
- (a) Ba^{2+} as BaSO_4
- (b) Ba^{2+} as BaCrO_4
- (c) Ni^{2+} as Ni-DMG

Colorimetry:

Determination of λ_{max} for potassium permanganate solution using colorimeter, determination of unknown concentration by calibration curve method.

References:

1. D. A. Skoog, D. M. West, F. J. Holler, Fundamantal Analytical Chemistry, 7th Ed. Philadelphia, Saunders College Publishing, 1996.
2. G. D. Christian, Analytical Chemistry, 6th Ed., John Wiley & Sons, New York, 2003.

3. Basic Concepts of Analytical Chemistry, S. M. Khopkar, 3rd edition, New Age International Publication.
4. Analytical Chemistry: Problems and Solutions, S. M. Khopkar, 2002, New Age International Publication.
5. R. A. Dey & D. L. Underwood, Quantitative Analysis, 6th ed. Prentice Hall Of India Pvt. Ltd. New Delhi, 1993.
6. C. N. Banwell, Fundamentals of Molecular Spectroscopy, 5th ed., Tata McGraw Hill Publishing Co. Ltd, New Delhi
7. Theoretical Inorganic Chemistry, C. M. Day & J. Selbin, Affiliated East West Press Pvt. Ltd., 1985.
8. Inorganic Chemistry, D. F. Shriver, P. W. Atkins and C. H. Langford, 3rd edition, Oxford University Press, 1999.
9. Advanced Inorganic Chemistry, Volume I, S. Prakash, G.D. Tuli, S. K. Basu, R. D. Madan.
10. James E. Huheey, Inorganic Chemistry, 3rd edition, Harper & Row Publishers, Asia, Pvt Ltd., 1983.
11. Concise Inorganic Chemistry, J.D. Lee, 5th edition, Oxford University Press.
12. Vogel's textbook of Quantitative Chemical Analysis, J. Mendham, R.C. Denney, J. D. Barnes and M. J. K. Thomas, 6th edition.

SEMESTER IV

COURSE IV: CONCEPTS OF PHYSICAL AND ORGANIC CHEMISTRY II

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Derive Nernst equation for cell, electrode, and thermodynamic parameters associated with cell reaction.
2. Identify different electrodes used in construction of electrochemical cell and construction of workable electrochemical cell, represent the cell-cell reactions.
3. Apply Raoult's law to find total pressure and partial pressure of each component and, as well as the composition of the phases of binary mixture.
4. Explain the thermodynamic aspects of equilibria between phases and draw phase diagrams of simple one component and two component systems.
5. Interpret reactivity of various aliphatic organic compounds and their interconversions in 5 – 6 steps.
6. Outline the mechanism of reactions involving the reactive intermediates.
7. Apply Huckel's rule to recognise aromatic, non-aromatic and anti-aromatic compounds.
8. Propose the mechanism of aromatic electrophilic substitution and the effect of substituents on the orientation of an incoming electrophile.

Module I – Phase Equilibria and Electrochemistry

(2 Credits)

UNIT I: Phases in Equilibria and Two component systems

- a) Phases in Equilibria: Introduction, Phase, components, degrees of freedom, Gibb's phase rule, phase diagram (with one suitable example).
- b) Two component systems: Completely miscible liquid-liquid mixtures: Phase diagrams of ideal mixture: Vapourpressure composition and temperature composition diagrams. Raoult's law, ideal solutions. Deviation from Raoult's law, positive and negative deviations (Numerical Problems expected).
- c) Phase diagrams of non- ideal mixtures, azeotropes, distillation of azeotropic mixtures.
Partially miscible liquid-liquid mixtures: only introduction and examples.
Completely immiscible liquid-liquid mixtures: Steam distillation and its applications. Self-study: One component system: CO₂ system, breaking of azeotropes.

UNIT II: Electrochemistry

- a) Introduction to Electrolytic cell and Electrochemical cells (Galvanic /Voltaic cell).
Ion selective and ion specific electrodes, comparison, simple examples. Types of ion specific electrodes: (i) Metal-metal ion electrode (ii) Gas electrode (including S.H.E.) (iii) Metal- metal insoluble salt electrode (including reference and calomel electrode) (iv) Redox electrode (v) Amalgam electrode.
- b) Cell representation of galvanic cell from cell reactions and vice versa. Concept of combination electrode: Glass electrode - construction and working (in brief).
- c) Derivation of Nernst equation for the emf of a cell and hence for a single electrode potential, potential of glass electrode. Determination of equilibrium constant from EMF measurements. Thermodynamic parameters [ΔG , ΔH and ΔS] for the reaction taking place in a chemical cell. Introduction to electrode concentration cell and electrolyte concentration cell.

UNIT III: pH-metric Titrations

- a) Introduction to pH metric titrations. Titration curves for:
 - (i) strong acid Vs strong base
 - (ii) weak acid Vs strong base
- b) Graphical methods to determine the equivalence point. Determination of K_a for weak monobasic acid.
- c) Self-study: Numerical problems on calculation of pH of different types of acids, bases and buffer solutions.

Module II - Mechanism of Organic Reactions

(2 Credits)

UNIT IV: Functional Group Chemistry

- a) Reactions of alkyl halides with: aqueous alkali, alcoholic alkali (dehydrohalogenation), potassium cyanide, conversion of alkyl cyanide further to primary amine and carboxylic acid, ammonia, silver salt of carboxylic acid, sodium alkoxide, Wurtz reaction.
Reactions of alcohols with sodium metal, dehydration, esterification, oxidation of primary, secondary and tertiary alcohols.
- b) Reactions of aldehydes and ketones:
 - (a) Addition to carbonyl compounds:
 - (i) HCN and (ii) NaHSO₃
 - (b) Condensation reaction with hydroxylamine
 - (c) Oxidation with acidic K₂Cr₂O₇ and PCC
 - (d) Reduction of aldehydes and ketones:
 - (i) Catalytic reduction

- (ii) Clemmensen reduction
 - (iii) Reduction with LiAlH_4 and NaBH_4
 - (iv) Wolff - Kishner reduction
- c) Reactions of carboxylic acids: Formation of salt, anhydride, amide, acid halide, ester and alkane.

Reactions of amines: Acetylation of amines with acetic anhydride and acetyl chloride, action of nitrous acid on primary / secondary / tertiary amines, alkylation of primary / secondary / tertiary amines yielding quaternary ammonium salts.

Note: Each reaction should be studied with respect to compounds upto 6 carbon atoms. Based on these and the reactions of alkanes, alkenes and alkynes, multi-step synthesis of compounds having one functional group are expected, the number of carbon atoms in each being not more than six. No mechanisms are expected.

UNIT V: Reactive Intermediates

- a) Carbocations: Different types of carbocations such as alkyl, allyl, benzyl. Electrophilic addition across an olefinic double bond. Rearrangements: Wagner-Meerwein rearrangement, Pinacole-Pinacolone rearrangement.
 - b) Carbanions: Concept of carbon acid. Alkylation of carbon acids (active methylene compounds and terminal alkynes) using alkyl halides. Reactions of Grignard reagents at sp^3 carbon and carbonyl group. Aldol condensation with mechanism.
 - c) Carbon radicals: General reactions of radicals – abstraction, addition to $\text{C}=\text{C}$, combination, disproportionation. Addition of HBr to alkenes in presence of peroxide. Polymerization.
- Carbenes: Generation of carbenes through alpha elimination, from diazoalkanes, from ketenes. Structure and stability of carbenes. Reactions: insertion into C-H bond and addition to olefin.

UNIT VI: Aromatic Electrophilic Substitution Reaction

- a) Electronic structure and Huckel's Rule of aromaticity including nomenclature of aromatic systems. Concept of anti-aromaticity, non-aromaticity.
- b) General mechanism of aromatic electrophilic substitution reaction with energy profile diagram.
- c) Drawing resonance structures of mono-substituted benzenes - activated and deactivated aromatic rings. Effect of electron-withdrawing and electron-donating substituents on the orientation of an incoming electrophile on the basis of –
 - (i) electron-density distribution (ii) stability of intermediate.

Cases to be studied: Mono and disubstituted benzenes containing - alkyl, amino, hydroxyl, alkoxy, halo, acyl, nitro, carboxy groups, ortho / para ratio.

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:

Identification of an Organic Compound: The identification should be done through: preliminary tests, solubility, element detection, functional group tests, physical constant determination. The analysis should be done by micro-scale techniques. For the identification of an organic compound about 200 mg of any compound with not more than two functional/neutral groups be given belonging to the following categories: Acids (carboxylic acids/sulphonic), phenols, aldehydes/ketones, alcohols, esters, amines (primary, secondary and tertiary), carbohydrates, hydrocarbons, halo/nitro hydrocarbons.

Note: A minimum of 10 compounds be given for the identification from the categories mentioned above

References:

1. The Elements of Physical Chemistry: P.W. Atkins (1996) 2nd Ed, Oxford University Press, Oxford.
2. Physical Chemistry: G. M. Barrow 6th Ed., Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Text Book of Physical Chemistry, S. Glasstone, Affiliated East-West press Pvt. Ltd., New Delhi.
4. Phase equilibria –Reisman Arnold, Edited by Ernest M. Loebe, New York and London Academic Press.
5. Properties of Liquids and Solution: J. N. Murrell and E.A. Boucher, Wiley, 1982.
6. An Introduction to Electrochemistry – Samuel Glasstone Affiliated East-West Press.
7. Organic Reaction Mechanism, 3rd Ed., V.K. Ahluwalia and R.K. Parashar, Narosa Publications.
8. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008.
9. Organic Chemistry, R.T. Morrison and R.N. Boyd, 6th Edition, Pearson Education.
10. Organic Chemistry, T. W. G. Solomon and C. B. Fryhle, 8th Edition, John Wiley & Sons.

SEMESTER V

Course V: ANALYTICAL AND INORGANIC CHEMISTRY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

Course Outcomes:

By the end of the course, student will be able to:

1. Define and describe important terms involved in electrolytic cells.
2. Identify and study Arrhenius theory, Ostwald's dilution law and Kohlrausch's law of independent migration of ions for weak electrolytes along with their various applications
3. Explain the basic principles and experimental setup of various instrumental methods, i.e., conductometric and potentiometric titration and analyse various titration curves in conductometric titration.
4. Apply laws governing photochemistry to various photochemical reactions and photochemical transitions to interpret the basic principles of fluorescence, phosphorescence & chemiluminescence.
5. Predict the hybridization of the central atom, parent structure, approximate bond angles, and molecular shape of a molecule or polyatomic ion.
6. Draw and interpret given MO diagram as well as fill in electrons into an MO diagram to predict bond order for a compound and magnetic character.
7. Identify acids and bases using different theories.
8. Predict the products of acid-base reactions; compare strong and weak acids and bases using the concept of equilibrium.

Module I – Electrolytes and Instrumental methods

(2 Credits)

UNIT I: Solutions of Electrolytes

- a) Introduction of the terms involved: electronic and electrolytic conductors, conductivity, resistivity, specific resistivity, measurement of conductivity of solutions, conductometer, conductivity cell, cell constant, specific conductivity, molar conductivity and equivalent conductivity with their units in SI and C.G.S. systems.
- Variation of molar conductivity with change in concentration of solution for strong and weak electrolytes. Arrhenius theory and Ostwald's dilution law for weak electrolytes. Debye-Huckel theory for strong electrolytes (asymmetric and electrophoretic effect), concept of limiting molar conductivity.

- b) Kohlrausch's law of independent migration of ions. Applications of Kohlrausch's law: (i) Determination of limiting molar conductivity of weak electrolytes (ii) Determination of dissociation constant of a weak acid (iii) Determination of solubility of sparingly soluble salts.
- c) Migration of ions, transport number, determination of transport number by i) Hittorf's method using unattackable electrodes (only qualitative explanation) ii) Moving boundary method. Use of coulometer, factors affecting the transport number of ions, relation between transport number and ionic conductivity of an ion. Relationship between ionic mobility and ionic conductivity of an ion (Derivation is not expected).

Self-study: Numerical problems based on all the above concepts.

UNIT II: Use of Instrumental methods in Titrimetric analysis

- a) Conductometric titrations
Basic principles, experimental set up, titration curves in the titration of:
 - (i) strong acid Vs strong base
 - (ii) weak acid Vs strong base
 - (iii) weak acid Vs weak base
 - (iv) mixture of strong and weak acids Vs strong base
 - (v) sodium chloride Vs silver nitrate
 - (vi) barium hydroxide Vs magnesium sulphate
 Advantages and limitations.
- b) Potentiometric titration: Principle, concept of indicator electrode.
- c) Self-study: Application of analytical methods in various fields such as chemical and pharmaceutical industries, environmental analysis and monitoring.

UNIT III: Photochemistry

- a) Laws of Photochemistry, Jablonski energy level diagram – primary & secondary Photochemical processes.
- b) Radiationless transition – internal conversion & intersystem crossing. Radiative transitions – fluorescence, relation to structure. Phosphorescence- conditions for phosphorescence emission (spin – orbit coupling). Singlet and triplet.
- c) Chemiluminescence.

Module II – Theories of Chemical Bonding

(2 Credits)

UNIT IV: VSEPR and Valence Bond Theory

- a) VSEPR concept: Effect of lone pairs, effect of electronegativity, isoelectronic principle, shapes of chemical species and polarity on the basis of VSEPR theory.
- b) Hybridisation: sp^3 , sp^2 , sp hybridization of carbon and nitrogen, sp^3 and sp^2 hybridization of

oxygen in organic compounds; theory of hybridization with respect to equivalence of contributing atomic orbitals in the following examples: CH₄, NH₃ and H₂O.

- c) Energetics of hybridization, types of hybridization and extent of d-orbital participation in molecular bonding. sp, sp², sp³, sp³d, sp³d² and sp³d³ with illustrations like BeCl₂, BF₃, SiCl₄, PCl₅, SF₆, IF₇, ClF₃, ICl₂⁻, BrF₅, SO₂, SO₃. Merits and Demerits of Valence Bond Theory.

UNIT V: Molecular Orbital Theory [M.O.T.]

- a) Conditions for the formation of Molecular Orbitals.
- b) Linear Combination of Atomic Orbitals to obtain Molecular Orbitals [LCAO-MO] Approach.
- c) Application of the LCAO-MO to the formation of:
- (i) Homo- and Hetero-nuclear diatomic molecules and ions E.g., H₂, N₂, O₂, F₂, He₂, Li₂, Be₂, C₂, Ne₂, CO, NO, HCl, HF and CN⁻.
 - (ii) Occurrence of the Molecular ions O₂⁺, O₂¹⁻, O₂²⁻.

Discussion should include orbital interaction, stabilization of orbitals, bond order and correlation with stability, bond length, bond energy and magnetic properties.

UNIT VI: Theories of Acids and Bases

- a) Recapitulation of Arrhenius theory.
- b) Lowry-Bronsted concept: Bronsted acids and bases, acid-base properties of water, pH, strength of acids and bases, weak acids and acid ionization constants, weak bases and base ionization constants, relationship between ionization constants of acids and their conjugate bases, diprotic and polyprotic acids.
- Solvent levelling, solvent-system definition of acids and bases. Lux-Flood, Lewis & Usanovich concept.
- c) Lewis acid concept: Examples of Lewis acids and bases, characteristics of Lewis acids. Pearsons concept of Hard and Soft Acids and Bases (HSAB), applications of HSAB.

Module III- Internal Assessment

2 Credits

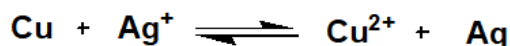
S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:

Instrumentation:

(i) Potentiometry:

- (a) Determination of E°_{cell} , free energy and equilibrium constant for a cell having cell reaction:



(ii) pH metry:

- (a) pH-metric titration of strong acid Vs strong base and to determine pKa value.
(b) pH-metric titration of weak acid Vs strong base and to determine pKa value.

(iii) Conductometry:

- (a) Conductometric titration of strong acid Vs strong base.
(b) Conductometric titration of weak acid Vs. strong base.
(c) Conductometric titration of a mixture of a strong and weak acid Vs strong base.
(d) Verification of Ostwald's dilution law for weak electrolyte (acetic acid).

References:

1. Properties of Liquids and Solutions: J. N. Murrell and E.A. Boucher, Wiley, 1982.
2. Introduction to Principles of Heterogeneous Catalysis: Thomas J. M. and Thomas W.J.
3. An Introduction to Electrochemistry – Samuel Glasstone, Affiliated East-West Press.
4. Modern Electrochemistry: J. O'M Bokris and A.K.N. Reddy, Maria Gamboa – Aldeco, 2nd Ed, 1st Indian reprint, Springer (2006).
5. Basic Concepts of Analytical Chemistry, S. M. Khopkar, 3rd edition, New Age International Publication.
6. Instrumental Methods of Chemical Analysis: Chatwal and Anand, 5th Ed., Himalaya Publication.
7. Fundamental Analytical Chemistry, D. A. Skoog, D. M. West, F. J. Holler, 8th edition.
8. Chemistry, McMurry Fay, Prentice Hall.
9. Shriver Atkins Inorganic Chemistry, P. W. Atkins, Overton, Rourke Weller, Armstrong, 5th edition, Oxford University Press.
10. Chemistry Concepts and Connections, Charles H. Corwin, Prentice Hall.
11. Chemistry, James E. Brady, Neil D. Jespersen and Alison Hyslop, 6th edition.
12. Inorganic Chemistry, P. A. Cox, Bios Scientific Publishers Ltd

SEMESTER VI

Course VI: PHYSICAL AND ORGANIC CHEMISTRY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 35

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Describe and explain different types of colloidal systems.
2. Analyse and correlate colligative properties of solutions with molar masses of solutes.
3. Differentiate between physical and chemical adsorption and correlate adsorption results on the basis of various adsorption isotherms.
4. Examine the role of catalysis in industries; apply collision theory to predict reaction rate.
5. Assess the role of electrochemistry in providing renewable sources of energy.
6. Identify modern functional materials and assess how they have impacted our lives.
7. Write functional group transformations and propose plausible mechanism for certain reactions.
8. Describe synthesis methods, reactions applications and mechanisms of aromatic nitrogen and amino compounds, aromatic aldehydes and ketones, aromatic carboxylic and sulphonic acids with mechanisms of certain reactions.

Module I - Surface Chemistry and Alternative Fuel Technologies

(2 Credits)

UNIT I: Colloids

- a) Introduction to colloidal state of matter.
- b) Origin of charge on colloidal particles. Concept of electrical double layer, zeta potential, Helmholtz and Stern mode, Electrokinetic phenomena:
 - (i) Electrophoresis
 - (ii) Electro-osmosis
 - (iii) Streaming potential
 - (iv) Sedimentation potentialColloidal electrolytes.
Donnan Membrane Equilibrium.
- c) Surfactants, micelle formation, applications of surfactants in detergents, food industry in pesticide formulations.

UNIT II: Catalysis

- a) Adsorption Physical and Chemical Adsorption, types of adsorption isotherms, Langmuir's adsorption isotherm, (postulates and derivation expected). B.E.T. equation for multilayer adsorption, (derivation not expected, significance of the terms involved in the equation is expected), determination of surface area of an adsorbent using B. E.T. equation.
- b) Catalysis: Homogeneous and heterogeneous catalysis, catalytic activity and selectivity, promoters, inhibitors, catalyst poisoning and deactivation, TON and TOF (introduction only). Acid-Base catalysis, mechanism and kinetics of acid-base catalyzed reactions, effect of pH on acid-base catalyzed reactions. Mechanisms and kinetics of enzyme catalyzed reaction (Michaelis-Menten equation).
- c) Kinetics of surface reactions, heterogeneous catalysis:
 - (i) Unimolecular surface reactions
 - (ii) Bimolecular surface reaction (relevant rate expressions expected)

UNIT III: Renewable Energy Sources and Introduction to Materials of the Future

- a) Batteries – Secondary cells, Lithium-Ion Cell.
Fuel Cells - Choice of fuel and oxidant, thermodynamic and kinetic aspect of electrochemical energy transformation, efficiency of fuel cells, Bacon's H_2 and O_2 fuel cell.
Solar cells, solar energy, photovoltaic effect, semiconductors as solar energy converters. Silicon solar cell.
- b) Biomass energy from biomass and its sources, conversion of biomass into energy by alcohol fermentation and anaerobic digestion method.
Hydrogen: fuel of the future, production of hydrogen by direct electrolysis of water and biomass gasification, advantages of hydrogen as a universal energy medium.
- c) Liquid Crystals: Classification, Molecular ordering, identification, polymeric liquid crystals, application of liquid crystals – LC displays and thermography. Organic Light Emitting Diodes.

Module II – Functional group chemistry of Aromatic compounds

(2 Credits)

UNIT IV: Aromatic Hydrocarbons, Haloarenes, Phenols and Ethers

- a) Alkyl arenes: Preparation of alkyl arenes through reforming, Friedel-Crafts alkylation using – olefins, alcohols, alkyl halides. Reactions of alkyl arenes – side-chain oxidation, ring Vs side-chain halogenation (mechanism).
Haloarenes: Preparation by halogenation of arenes – Halogenation of benzene and substituted benzenes with molecular halogens (mechanism). Reactions: Grignard reagent formation. Ullmann reaction. Applications of aromatic halogen compounds.
- b) Phenols: Preparation from (i) halobenzenes (ii) from aromatic sulfonic acids (iii) isopropyl and 2-butylbenzene by hydroperoxide method. Reactions: Acidity of phenols – effect of substituents

on acidity of phenols. Salt Formation. Etherification – direct reaction with alcohol. Williamson synthesis. O-acylation. Halogenation, Nitration, Fries rearrangement of aryl carboxylates, Claisen rearrangement of allyloxyarenes. Applications of phenols.

- c) Ethers: Preparation by dehydration of alcohols (mechanism), reactions of phenols with alcohols, Williamson synthesis (mechanism). Reactions: Acid-catalyzed cleavage – reaction with HX (mechanism). Applications: Applications of ethers, Crown ethers: Structure of 12-crown-4 and 18-crown-6 and their uses.

UNIT V: Aromatic nitro compounds, Aromatic amino compounds and Aromatic diazonium salts

- a) Aromatic nitro compounds: Preparation: Nitration using mixed acid (mechanism).
Reactions: Reduction of aromatic nitro compounds by – catalytic hydrogenation, dissolving metal reduction using – Fe-HCl, Sn-HCl and partial reduction using NaHS.
- b) Aromatic amino compounds: Preparation: Reduction of nitro compounds, amination of halobenzenes and Hoffmann bromamide reaction. Reactions: Basicity of aromatic amines, effect of substituents on basicity of aniline, salt formation, N-alkylation and N-acylation.
- c) Aromatic diazonium salts: Preparation: Diazotization of aromatic primary amines. Reactions: (i) Sandmeyer, Gattermann reaction (ii) Azo-coupling reaction with phenols/naphthols and aromatic amines

UNIT VI: Aromatic carbonyl compounds, Aromatic carboxylic acids and Aromatic sulfonic acids

- a) Aromatic carbonyl compounds: Preparation of aromatic aldehydes and ketones: Gattermann-Koch reaction, Gattermann reaction, Vilsmeier-Haack reaction, Reimer-Tiemann reaction (mechanism), oxidation of methyl arenes and Rosenmund reduction, Friedel-Crafts acylation using acid chloride and acid anhydride (mechanism). Reactions with mechanism: Knoevenagel, Claisen-Schmidt, Cannizzaro and Reformatsky reactions with applications.
- b) Aromatic carboxylic acids: Preparation of mono- and di-carboxylic acids: Side-chain oxidation of alkyl benzenes, reaction of Grignard reagents with solid carbon dioxide, hydrolysis of aryl nitriles and Kolbe-Schmidt reaction. Reactions: (i) Acidity and effect of substituents on the acidity of benzoic acid (ii) Conversions to acid chloride, amide and anhydride (iii) Reduction and (iv) Decarboxylation.
- c) Aromatic sulfonic acids: Preparation of aromatic sulfonic acids: Commonly used sulfonating agents. Sulfonation of benzene (with mechanism) and mono-substituted benzenes. Reactions: Acidity of arene sulfonic acids. Comparative acidity of carboxylic acids and sulfonic acids, salt formation, desulfonation and Ipso substitution. – SO₃H as a solubilizing and blocking group, preparation of sulfonate esters.

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:

- (i) Derivative preparation: The exercise is aimed at imbibing the concept of derivative preparation as a method of identifying a given compound from a set of compounds having the same functional group. Based on the melting point, identify the given compounds looking at the chart. About 500 mg of a suitable compound be given. The candidate will prepare the given derivative. Crystallization is expected. M.P. of the dried derivative should be taken and appropriate inference drawn. The derivative preparation should involve one of the following reactions:
- (a) Bromination of Acetanilide
 - (b) Nitration of Aromatic compounds
 - (c) N/O-Acylation
 - (d) Hydrolysis of Amides
- (ii) Estimation of an Organic Compound: The following estimations be given:
- (a) Estimation of formaldehyde by oxidation using iodine and alkali.
 - (b) Estimation of aniline by bromination using brominating solution.
 - (c) Estimation of acetamide by hydrolysis.

Note: For the estimations, the concentrations and the quantities be reduced. For dilution a standard flask of 100 cm³ capacity and for the transfer a pipette of 10 cm³ capacity be used. The concentrations of the solutions be around 0.05 N.

References:

1. Phase Rule, F. D. Ferguson and P. K. Jones, (Bitterworth Publisher).
2. Properties of Liquids and Solution, J. N. Murrell and E.A. Boucher: Wiley, 1982.
3. Adsorption and Catalysis, D. K. Chakravarty, Oxford Publishers.
4. Basic Principles of Colloid Science, D. H. Everett, Royal Society of Chemistry, 1988.
5. Introduction to Principles of Heterogeneous Catalysis, Thomas J. M. and Thomas W. J., VCH Publishers, New York, 2008.
6. Principles and Applications of Homogeneous Catalysis, Nakamura A. and M. Tsutsui,

Wiley, 1980.

7. Biomass for Renewable Energy, Fuels & Chemicals, Donald L. Klass, Academic Press, London, UK.1998.
8. Handbook of alternative fuel technologies, S. N. Lee & James G. Spergit, CRC Press.
9. Organic Chemistry, R. T. Morrison and R. N. Boyd, 6th Edition, Pearson Education.
10. Organic Chemistry, John McMurry 5th Edition, Asian Books Pvt. Ltd., New Delhi, 2000.
11. Organic Chemistry, Francis A Carey, Pearson Education, 6th Edition, Special Indian Education, 2008.
12. Organic Synthesis Special Techniques, V. K. Ahluwalia, Renu Aggarwal, Narosa Publication.

SEMESTER VII

Course VII 1: PHYSICAL CHEMISTRY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Interpret the basics of quantum chemistry & appreciate the concept of entropy as a probability factor.
2. Apply quantum chemistry concepts such as photoelectric effect, Compton effect and Schrodinger equation to understand molecular and particle behaviour.
3. Outline the selection rules for rotational and vibrational spectra and rationalize the role of the molecular dipole moment in the selection rules.
4. Identify the IR frequencies where simple functional groups absorb light.
5. Identify how nuclear spins are affected by a magnetic field, and be able to explain what happens when radiofrequency radiation is absorbed.
6. Predict the number of proton signals and splitting parameters expected from a compound given its structure.
7. Describe what happens to a compound in a mass spectrometer.
8. Identify methods of detection of various ionizing radioactive radiations, various types of nuclear reactions and differentiate between nuclear fission and fusion.

Module I – Introduction to Quantum Chemistry and Nuclear Dynamics

(2 Credits)

UNIT I: Basics of Quantum Chemistry

- a) Classical mechanics, limitations of classical mechanics, Black body radiation, photoelectric effect, Compton Effect.
Introduction to quantum theory, Planck's theory of quantization, wave particle dualism, de-Broglie equation, Heisenberg's uncertainty principle. Simple numerical problems.
- b) Progressive and standing waves, boundary conditions, Schrödinger's time independent wave equation, interpretation and properties of wave function.
- c) State function (wave function) and its significance. Concept of operators: definition, addition, subtraction and multiplication of operators, commutative and non-commutative operators, linear operator, position, momentum and energy operators. Eigen function and eigen value, eigen value equation.

UNIT II: Introduction to Nuclear Chemistry

- a) Types of nuclear radiations and their characteristics, behaviour of ion-pairs in electric field, detection and measurement of nuclear radiations using G.M. counter and scintillation counter.
- b) Kinetics of radioactive decay, units of radioactivity (Curie, Becquerel, Rutherford).
- c) Radioactive equilibrium (secular and transient) Determination of radioactive constants for radio-elements having (i) moderate half -life (ii) long half -life (iii) extremely long or short half -life.

Use of radioisotopes as tracers in:

- (i) Chemical investigations - reaction mechanism
- (ii) Age determination – dating by tritium content and by Carbon-14.

UNIT III: Nuclear Reactions

- a) Nuclear Reactions: nuclear transmutation, artificial radioactivity (suitable examples using different projectiles are expected.), Q-value of nuclear reaction threshold energy.
- b) Fissile and fertile material, nuclear fission, chain reaction, factors controlling fission process (multiplication factor and critical size or mass of fissionable material), nuclear power reactor and breeder reactor.
- c) Nuclear fusion, characteristics of nuclear fusion, thermonuclear reactions occurring in stellar bodies.

Module II - Molecular Spectroscopy

(2 Credits)

UNIT IV: Rotational and Vibrational Spectroscopy

- a) Dipole moment: Polarization of a bond, bond moment, dipole moment and Molecular structure.
- b) Rotational / Microwave Spectroscopy: Rotational spectrum of a diatomic molecule, rigid rotor, moment of inertia, energy levels, limitations of rotational spectra, selection rule, nature of spectrum, determination of inter nuclear distance and isotopic shift.
- c) Vibrational (IR) Spectroscopy: Vibrational motion, degrees of freedom, modes of vibration, vibrational spectrum of a diatomic molecule, simple harmonic oscillator, energy levels, zero-point energy, conditions for obtaining vibrational spectrum, selection rule, nature of spectrum. Anharmonic Oscillator: energy levels, selection rule, fundamental band, overtones.

UNIT V: Vibration-Rotation Spectroscopy and Raman Spectroscopy

- a) Vibration-Rotation Spectroscopy of diatomic molecules: Vibrating rotor, energy levels, selection rule, nature of spectrum, R and P branches.
- b) Applications of vibration-rotation spectrum: (i) Force constant, determination and significance (ii) determination of inter-nuclear distance, isotopic shift. Introduction to infrared spectra of

simple molecules like H_2O and CO_2 .

- c) Raman Spectroscopy: Scattering of electromagnetic radiation, Rayleigh scattering, Raman scattering, nature of Raman spectrum, Stoke's lines, anti-Stoke's lines, Raman shift, quantum theory of Raman scattering, comparative study of IR and Raman spectra, rule of mutual exclusion (example of CO_2 molecule).

UNIT VI: Nuclear Magnetic Resonance and Electron Spin Resonance Spectroscopy

- a) Nuclear Magnetic Resonance Spectroscopy: Nuclear spin, magnetic moment, nuclear 'g' factor, energy levels, Larmor precession. Relaxation processes in NMR (spin-spin relaxation and spin-lattice relaxation)
- b) NMR spectrometer, chemical shift, shielding and de-shielding of protons, low resolution NMR spectrum of methanol and ethanol, fine structure of NMR - nuclear spin-spin interaction with reference to methanol and ethanol.
- c) Electron Spin Resonance Spectroscopy (introductory concepts): Derivative curves & g-values, Hyperfine splitting with respect to methyl radical and benzene radical. Applications of ESR Spectroscopy.

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:

Physical Chemistry: Non-Instrumental Experiments:

- (i) **Partition Coefficient:** To determine the partition co-efficient of I_2 between CCl_4 . H_2O and to determine the equilibrium constant for the reaction $\text{KI} + \text{I}_2 = \text{KI}_3$ by partition method.
- (ii) **Chemical Kinetics:** To study the effect of ionic strength (KCl) on the reaction between $\text{K}_2\text{S}_2\text{O}_8$ and KI.
- (iii) **Adsorption Experiment:** To study the adsorption of acetic acid / oxalic acid on charcoal.
- (iv) **Phase Rule:** To determine the phase diagram for the system water, chloroform, acetic acid at room temperature.
- (v) **Solubility Measurement:** To determine the solubility product of calcium hydroxide at room temperature.
- (vi) **Viscosity:** To determine the molecular weight of polyvinyl alcohol by viscosity measurements.

References:

1. The Elements of Physical Chemistry: 4th ed. P. W. Atkins, Oxford University Press, 2005
2. Physical Chemistry: 6th Ed, G. M. Barrow, Tata McGraw Hill Publishing Co. Ltd., 2008.
3. Text Book of Physical Chemistry, 2nd ed, Glasstone, Affiliated East-West press Pvt. Ltd., New Delhi.
4. Physical Chemistry: 2nd ed. C.B.S,K. J. Laidler and J. H. Meiser, First Indian ed. Publishers and Distributors, New Delhi, 1999
5. Nuclear and Radiochemistry, Friedlander, Kennedy and Joseph W., John Wiley & Sons, New York, 1955.
6. Essentials of Nuclear Chemistry: 4th Ed., Arnika H. J., New Age International Ltd., Publishers, New Delhi.1955.
7. Nuclear Chemistry, Maheshwar Sharon & Madhuri Sharon, Ane Books (P), Ltd. 2009.
8. Quantum Chemistry, Donald A. McQuarrie, Viva Books Pvt Ltd, 2003.
9. Quantum Chemistry: 3rd ed., R. K. Prasad, New Age International (P) Ltd., Publishers, New Delhi.2000.
10. A Textbook of Physical Chemistry, (Vol 1 – 5) K.L. Kapoor, Macmillan India Ltd, 2008.
11. Fundamentals of Molecular Spectroscopy: 4th ed. C. N. Banwell & E.M. Mc Cash, Tata McGraw Hill Publication, 1995.
12. Organic Spectroscopy, William Kemp, MacMillan Publisher, London, 1975.

SEMESTER VII

Course VII 2: INORGANIC CHEMISTRY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Assign IUPAC names of coordination compounds; deduce the stereochemistry and identify types of isomerism in transition metal complexes.
2. Apply 18-electron rule using the neutral atom and oxidation state method for electron counting.
3. Describe bonding and stabilization energies in coordination complexes using molecular orbital theory and crystal field theory and compare the two.
4. Use the properties of Lanthanides and Actinides to identify their real-world applications in domestic, medical, industrial and military uses.
5. Specify atomic planes, directions, and families of planes and directions within a given crystal structure using Miller indices.
6. Analyse the structure of materials and interpret unit cell, types of crystal lattices, atomic packing factor and coordination number.
7. Explain types of superconductors and their applications.
8. Classify solvents and compare characteristics of non-aqueous solvents.

Module I - Co-ordination Chemistry

(2 Credits)

UNIT I: Introduction to Co-ordination Compounds

- a) Distinction between Double salts and Co-ordination compounds. Terms involved in Co-ordination Chemistry: Co-ordination Compound, central metal atom or ions, complex compound, Complex ion, Ligand: Definition, Classification, Chelates and chelating agents, Co-ordination Sphere, Co-ordination Number, Charge of the complex ion, calculation of oxidation and coordination number of metal, etc.
- b) Werner's Theory – postulates.
IUPAC nomenclature of Co-ordination compounds.
Sidwick Model (Eighteen electron rule), EAN rule limitations.
Isomerism in Co-ordination compounds: Structural isomerism (ionization, hydrate, linkage, ligand, coordination position) and Geometrical isomerism and optical isomerism.

- c) Bonding in Co-ordination Compounds
 Pauling's Valence Bond Theory – Assumptions, concept of hybridization, Limitations and Drawbacks.
 Bonding in tetrahedral, square planar, trigonal bipyramidal and octahedral complexes with examples. Inner and outer orbital complexes.
 Electroneutrality principle and Back (Multiple) bonding.

UNIT II: Crystal Field Theory (CFT)

- a) Basic tenets of Crystal Field Theory and effect of Crystal Field on central metal valence orbitals.
 b) Splitting of d orbitals in octahedral, tetrahedral and square planar complexes and Jahn-Teller Effect.
 c) Crystal field splitting energy ($10Dq/\Delta_o$) for octahedral complexes and factors affecting the magnitude of Δ_o . Crystal field stabilization energy (CFSE), calculation of CFSE for octahedral and tetrahedral complexes with d_1 to d_{10} metal ion configurations, high-spin and low-spin complexes.

UNIT III: Molecular Orbital Theory (MOT) of Coordination Complexes

- a) Application to octahedral complexes in case of (i) $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ (ii) Fluoro complexes of Fe (II) and Co (III) (iii) Cyano complexes of Fe (III) and ammine complexes of Co (III).
 b) Effect of pi-bonding on ligand field splitting parameter in $M \rightarrow L \pi$ - and $L \rightarrow M \pi$ - interactions.

Module II – Solid-state and Solution Chemistry

(2 Credits)

UNIT IV: Lanthanides and Actinides

- a) Chemistry of lanthanides with reference to i) Occurrence of Lanthanides (ii) lanthanide contraction (iii) oxidation states (iv) magnetic properties (v) color and spectra (f-f transition spectra).
 b) Chemistry of Uranium and Plutonium with reference to occurrence, extraction (solvent extraction method), properties and applications.
 c) Comparative chemistry of lanthanides and actinides.

UNIT V: Structures of Solids

- a) Importance of solid-state chemistry. Crystals: size and shape of crystals, interfacial angles in crystals, symmetry and elements of symmetry in crystals. Designation of planes in crystals: Miller indices.
 b) Classification of solids on the basis of bonding. Explanation of terms viz. crystal lattice, lattice

points, unit cells and lattice constants. Closest packing of rigid spheres (hcp, ccp) packing density in simple cubic, bcc, fcc and hcp lattices (numerical problems expected).

- c) Structures of metallic solids. Tetrahedral and octahedral interstitial voids in ccp lattice, tetrahedral holes, limiting radius ratios for different coordination numbers and their significance, calculation of ionic radii and limiting radius ratio for co-ordination number 4. Structures of sodium chloride, cesium chloride and fluorite. Structure of zinc chloride and failure of radius ratio rule (directional bonding), structure of wurtzite.

UNIT VI: Superconductivity and Chemistry in Non-aqueous solvents

- a) Superconductivity, Meissner effect. Different superconducting materials viz., conventional superconductors, organicsuperconductors, alkali metal fullerenes (A_3C_{60}) and high temperature superconductors. Applications of superconducting materials.
- b) Chemistry in Non-aqueous solvents: Classification of solvents and importance of non-aqueous solvents.
- c) Characteristics of study of liquid ammonia, liquid sulphur dioxide.

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:

Inorganic Preparations:

- (i) Synthesis of complexes:
- Tris-(ethylenediamine) nickel (II)thiosulphate.
 - Bis-(acetylacetonato) copper (II).
 - Nickel dimethyl glyoxime.
 - Tetrammine Copper (II) Sulphate hydrate $[Cu (NH_3)_4] SO_4 \cdot H_2O$.

Titrimetric Analysis:

- Determination of the calcium and magnesium content of a Dolomite sample.
- Analysis of calcium tablet.
- Determination of metal content in Tris(ethylenediamine) nickel (II)thiosulphate.

References:

- Inorganic Chemistry, James E. Huheey, 3rd Ed., Harper & Row Publishers, Asia, Pvt. Ltd., 1983.

2. D. F. Shriver and P.W. Atkins, Inorganic Chemistry, 3rd Ed., Oxford University Press, 1999.
3. Symmetry in Chemistry, H. H. Jaffee and M. Orchin, New Delhi, Wiley Eastern, 1965
4. Symmetry in Chemistry, J. M. Hollas, Chapman and Hall, NY, 1972.
5. Chemical Application of Group Theory, 2nd Ed., F. A. Cotton, Wiley Eastern Ltd., New Delhi, 1976.
6. Molecular Orbital Theory, C. J. Ballhausen and H. B. Gray, McGraw-Hill, New York, 1965.
7. Solid State Chemistry and its Applications, A. R. West, John Wiley & Sons, Singapore, 2008.
8. Solid State Chemistry – Introduction, 2nd Edition, Lesley Smart and Elaine Moore, Nelson Thornes Ltd., UK, 1996.
9. Principles of the Solid State, H. V. Keer, New Age International, 1993.
10. Fundamentals of Crystal Chemistry, R. N. Kutty and J. A. K. Tareen, Universities Press India, Ltd.
11. Chemistry in Non-aqueous Solvents, H. Sisler, Reinhold Publ., New York, 1961.
12. The Chemistry of Non-aqueous Solvents, J. J. Lagowski, Academic Press, New York

SEMESTER VIII
COURSE VIII 1: ANALYTICAL CHEMISTRY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Identify sources of errors estimates the types errors in chemical analysis.
2. Define the confidence limit, compare the experimental mean with a true value, identify the detection limit and interpret statistical tests.
3. Comprehend the concept of uncertainty in measurements; identify the difference between uncertainty and error; and solve numerical problems based on the same.
4. Categorize and define the sampling methods.
5. Categorize the types and define the basic parameters of chromatography.
6. Evaluate strengths and limitations of different chromatographic separation and detection methods in relation to the properties of the sample.
7. Define principles of liquid-liquid extraction and ion exchange.
8. Identify and illustrate principles of thermoanalytical techniques.

Module I – Errors in Chemical Analyses

(2 Credits)

UNIT I: Errors

- a) Types of errors, determinate and indeterminate errors, minimization of errors, constant and proportionate errors.
- b) Accuracy and precision, measures of dispersion and central tendency: mean, median, average deviation, relative average deviation, standard deviation, variance, coefficient of variation (Numerical problems expected).
- c) Distribution of random errors, Gaussian curve, student's t, confidence limits and confidence interval.

UNIT II: Uncertainty and Errors

- a) Criteria for rejection of result: 2.5 d rule, 4.0 d rule, Q test, testing for significance, null hypothesis, F test.
- b) Graphical representation of data: Method of averages, least squares method.
- c) Basic concept of uncertainty in a measurement (only introduction), difference between uncertainty and errors (Numerical problems expected).

UNIT III: Sampling

- a) Sampling techniques, equipments used in sampling of gases.
- b) Methods and equipments used in sampling of homogeneous and heterogeneous liquids, sampling of static and flowing liquids.
- c) Samplers used in sampling of solids, importance of particle size and sample size, method of reduction in sample size. Collection, preservation and dissolution of the sample.

Self-Study: Terms involved in sampling, importance and objectives of sampling.

Module II - Separation Techniques

(2 Credits)

UNIT IV: Solvent Extraction and Chromatography

- a) Physico-chemical aspects of solvent extraction: Nernst distribution law: Partition coefficient and distribution ratio, solute undergoing association and dissociation (Numerical Problems expected).
- b) Role of complexing agents in solvent extraction, chelation, Ion pair formation, solvation, types of solvent extraction: batch, continuous.
- c) Introduction to chromatographic techniques, basic principles, classification of Chromatographic techniques.

UNIT V: Types of Chromatography

- a) Planar chromatography: Principle, techniques and applications of Paper Chromatography and Thin layer chromatography.
- b) Gas Chromatography and High - Performance Liquid Chromatography: Principle, instrumentation and applications. HPTLC: Instrumentation and Applications.
- c) Electro-chromatography: Electrophoresis.

UNIT VI: Ion exchange Chromatography and Thermal methods

- a) Ion exchange chromatography: Types of ion exchangers, mechanism of ion exchange, selectivity coefficients and separation factors, ion exchange capacity and its determination, factors affecting the separation of ions, applications.
- b) Thermal methods: Classification of thermal methods - TGA and DTA: Basic principles, instrumentation, factors affecting the TG curve and applications.
- c) Ion Selective Electrodes: Classification of ion selective electrodes, construction and working of Fluoride ion selective electrode.

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:**Analytical Chemistry:****Non-Instrumental Experiments:**

- (i) Determination of Vitamin C by titration with potassium bromate.
- (ii) Thin layer chromatographic separation of organic compound.
- (iii) Chemical Oxygen Demand (COD) of water sample.

Instrumental Experiments:

- (i) Determination of the amount of fluoride in the given solution colorimetrically.
- (ii) Estimation of Vitamin C content of a tablet by using pH meter.
- (iii) To determine percentage composition of a mixture of weak acid and strong acid by conductometric titration.
- (iv) Determination of the amount of iron present in the given vitamin tablet colorimetrically.

References:

1. Fundamentals of Analytical Chemistry, 8th Ed. D. A. Skoog, D. M. West, F. J. Holler, Philadelphia, Saunders College Publishing, 1996.
2. Analytical Chemistry, 6th Ed. G. D. Christian, John Wiley & Sons, Singapore, 2004.
3. Basic Concepts of Analytical Chemistry, 3rd Ed., M. Khopkar, New Age International Publishers, 2008.
4. Quantitative Analysis, 6th Ed. R. A. Dey & D. L. Underwood, Prentice Hall of India Pvt. Ltd. New Delhi, 1993.
5. Textbook of Quantitative Chemical Analysis, 6th Ed, A. I. Vogel, Pearson Education, 2002.
6. Separation methods in Chemical Analysis, J. M. Miller, John Wiley, 1975.
7. Introduction to Instrumental methods of Analysis, R. D. Braun, McGraw Hill, 1987.
8. Instrumental methods of Analysis, 7th Ed. H. H. Willard, L. L. Merritt and J. A. Dean; CBS Publishers, 1986.
9. Ion exchange separation in analytical chemistry, 2nd Ed. O Samuelson, John Wiley, 1963.
10. Ion exchange chromatography, H. F. Walton Howden, Hutchenson and Rossing, 1976.

11. Thermal methods of Analysis, P. J. Haines, Blackie Academic & Professional, London (1995).
12. Thermal Analysis, 3rd Ed. W. W. Wendlandt, John Wiley, N.Y. (1986).

SEMESTER VIII
COURSE VIII 2: ORGANIC CHEMISTRY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

COURSE OUTCOMES:

By the end of the course, student will be able to:

1. Apply the Cahn-Ingold-Prelog Rules to assign stereochemical configuration to perspective drawings, Newman projections and Fischer projection.
2. Assign E/Z configuration to an alkene, draw the E or Z-isomer of a given alkene and identify different types of strains in conformations of cycloalkanes.
3. Predict the fragmentation patterns expected to arise in the mass spectrum of alkanes, alkyl halides, ethers, alcohols, and ketones.
4. Solve structural problems based on UV-Vis, IR, ^1H NMR, and mass spectral data.
5. Propose plausible mechanisms involved in some named reactions and molecular rearrangements.
6. Recall reagents and predict products for a defined set of organic reactions.
7. Draw or describe the structure of amino acids, proteins, enzymes, chemical messengers, carbohydrates, lipids, and nucleic acids.
8. Define carbohydrates and the groups of saccharides in chemical and descriptive terms.

Module I – Stereochemistry and Reaction Mechanisms

(2 Credits)

UNIT I: Stereochemistry of Organic Compounds

- a) Assigning stereo descriptors to chiral centres: Cahn-Ingold-Prelog (CIP) Rules of assigning absolute configuration (R and S) to stereogenic centres. Assigning absolute configuration to molecules having maximum two chiral carbon atoms. E and Z stereo descriptors to geometrical isomers. Chemical Resolution of enantiomers.
- b) Conformational analysis of cyclohexane: Angle, eclipsing and transannular strain in small, medium and large cycloalkanes (4- and 5- membered rings). Mono- and di- alkyl cyclohexanes and their relative stabilities.
- c) Stereochemistry and reaction mechanisms:
 - (i) Substitution reactions - $\text{S}_{\text{N}}1$
 - (ii) Elimination reactions – E_1 and E_2
 - (iii) Addition reactions to olefins – Catalytic hydrogenation and Bromination

UNIT II: Catalysts and Reagents

Study of the following catalysts and reagents with respect to functional group transformations and selectivity (no mechanism).

- a) **Catalysts:** Catalysts for hydrogenation: Raney Ni, Pt and PtO_2 : $\text{C}=\text{C}$, CN , NO_2 , aromatic ring; Pd/C : $\text{C}=\text{C}$, COCl CHO
- b) **Reagents:**
- (i) LiAlH_4 : Reduction of CO , COOR , CN , NO_2
 - (ii) NaBH_4 : reduction of CO
 - (iii) NBS: allylic and benzylic bromination and bromination of position alpha to CO

UNIT III: Named Reactions and Molecular Rearrangements

- a) Mechanism of the following reactions with one synthetic application:
- (i) Claisen Condensation
 - (ii) Michael Reaction
 - (iii) Stobbe Condensation
 - (iv) Wolff-Kishner Reduction
- b) Mechanism of rearrangements with examples:
- (i) Baeyer-Villiger
 - (ii) Wolff
 - (iii) Beckmann
 - (iv) Hofmann

Module II – Organic Spectroscopy and Chemistry of Biomolecules

(2 Credits)

UNIT IV: Spectroscopy of Organic Molecules

- a) UV-Visible Spectroscopy: Basic theory, solvents, nature of UV-VIS spectrum, concept of chromophore, auxochrome, bathochromic shift, hypsochromic shift, hyperchromic effect and hypochromic effect. Chromophore - chromophore and chromophore - auxochrome interactions. IR Spectroscopy: Basic theory, nature of IR spectrum, selection rule, fingerprint region.
- b) PMR Spectroscopy: Basic theory of NMR, nature of PMR spectrum, chemical shift (δ unit), standard for PMR and solvents used. Chemical shift, Spin-spin coupling and coupling constant.
- c) Mass Spectrometry: Basic theory, nature of mass spectrum, general rules of fragmentation. Importance of: molecular ion peak, isotopic peaks, base peak, Nitrogen rule, McLafferty rearrangement.
- Problems on structure elucidation of simple organic compounds using individual or a combination of spectra mentioned above (index of hydrogen deficiency should be the first step in solving the problems).

UNIT V: Carbohydrates

- a) Introduction: Sources, Classification, reducing and non-reducing sugars, D and L- notation
- b) Structures of Monosaccharides: Open chain structures of aldoses and ketoses, ring structures of aldohexoses, aldopentoses and ketohexoses. Determination of open chain configurations of

Monosaccharides: Configuration of D (+) Glucose and D (-) Fructose.

c) Reactions of D-Glucose and D-Fructose:

- (i) osazone formation
- (ii) reduction with NaBH_4 and Ni / H_2
- (iii) oxidation with bromine water, conc. HNO_3 and HIO_4
- (iv) interconversion of D (+) Glucose to D (-) Fructose and D (-) Fructose to D (+) Glucose
- (v) acetylation
- (vi) methylation [(v) and (vi) with cyclic pyranose form].

Introduction to disaccharides and structures of sucrose and maltose.

UNIT VI: Amino acids, Proteins and Nucleic acids

- a) Amino acids: Introduction, Classification, Properties. Polypeptides: Introduction, peptide bond, Merrifield's solid phase peptide synthesis.
- b) Proteins: Structure of proteins, classification of proteins, properties of proteins, denaturation of proteins.
- c) Nucleic Acids: Introduction, classification of nucleic acids. Structures of sugars and bases in nucleic acids. Structures of nucleosides and nucleotides in DNA and RNA.
Structure of DNA: Chargaff's rule of DNA configuration, Watson-Crick model of DNA.
Structure of RNA, types of RNA.

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Practical Chemistry:

- **Types:** Solid + Solid (no carbohydrates to be given), Volatile Liquid + Solid, Volatile Liquid + Non-volatile Liquid
- **Separation of a binary mixture:** Type of mixture, Separation and Identification (microscale) of both the components through systematic scheme of identification.
- **Mass of Solid:** 3-4 g.
- **Volume of Liquid:** Volatile ~ 6-8 mL, Non-volatile ~ 4-6 mL
- At least 5 separations to be done.

References:

1. Organic Chemistry, Francis A Carey, Pearson Education, 6th Edition, Special Indian Education, 2008.
2. Organic Chemistry, Paula Y. Bruice, Pearson Education, 2008.
3. Organic Chemistry, L. G. Wade Jr. and M. S. Singh, 6th Edition, Pearson Education, New Delhi, 2008.
4. Organic Reaction Mechanism, 3rd Ed., V. K. Ahluwalia and R.K. Parashar, Narosa Publications.
5. Stereochemistry of Carbon Compounds, L. Eliel, Tata Mc Graw Hill, New Delhi.
6. Stereochemistry, conformation and mechanism, 7th Ed., P.S. Kalsi, New Age International Ltd., 2008.
7. Essentials of Biochemistry, 2nd Edition, U. Satyanarayana and U. Chakrapani, Books and Allied (Pvt.) Ltd., 2013.
8. Spectroscopy of Organic compounds, P.S. Kalsi, New Age International Ltd., 1995.
9. Williams and Fleming, Spectroscopic methods in Organic Chemistry, 5th Edition, McGraw Hill, 1995.
10. W. Kemp, Organic Spectroscopy, 3rd Edition, Palgrave, Indian Edition, 2005.
11. Advanced Practical Organic Chemistry, 2nd Edition, N. K. Vishoi, Vikas Publications.

BIOLOGY

Revised Framework for B.Sc. Subjects - Biology

Details of B.Sc. B.Ed. Course

Semester	B.Sc. B.Ed. Course
Semester 1	Botany- 1
Semester 2	Zoology- 2
Semester 3	Botany -3
Semester 4	Zoology -4
Semester 5	Botany -5
Semester 6	Zoology -6
Semester 7	Botany -7
	Zoology- 8
Semester 8	Botany – 9
	Zoology-10

SEMESTER I
COURSE I: BOTANY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Course Outcome

By the end of the course, student will be able to:

1. explain the fundamental concepts /diversity related to different Microorganisms and Algae.
2. evaluate the significance of algae and fungi, its different types and their adaptive strategies.
3. discuss about bryophytes, analyze the anatomy and reproduction in Riccia
4. explain the ultrastructure and functions of the cell organelles and cell division
5. interpret ecological adaptations, biogeochemical cycles and Concept of environmental factors

Module I: Plant Diversity

2 Credits

Unit I: Plant Diversity-1

- a) Microorganisms in the living World: Groups of Microorganisms- Viruses, Bacteria, Rickettsiae, Mycoplasma, algae, Archaeobacterium, Actinomycetes, fungi, Protozoa. Distribution of Microorganisms in Nature
- b) Classification of plant kingdom: Outline of Classification of Algae according to G.M. Smith and general characters of the classes
- c) Life cycle of : Nostoc, Spirogyra

Unit II: Plant Diversity-2

- a) Classification of plant kingdom 1: Outline of Classification of Fungi according to G.M. Smith and general characters of all classes
- b) Life cycle of : Rhizopus, Aspergillus
- c) Economic importance of algae and fungi

Unit III : Plant Diversity-3

- a) Classification of plant kingdom 2: Outline of Classification of Bryophyta according to G.M. Smith and general characters of all classes
- b) Life cycle of Ricci
- c) Economic importance of Bryophyta

Module II: Ecology

- 2 Credits

Unit IV: Ecology-I

- a) Types of ecosystems, Food-chain, Food-web, Energy transfer, Biogeochemical cycles
- b) Study of ecological adaptations: Hydrophytes

- c) Study of ecological adaptations: Xerophytes

Unit V: Ecology-II

- a) Study of ecological adaptations: Mesophytes and Epiphytes
b) Study of ecological adaptations: Halophytes.
c) Concept of environmental factors. Soil composition, types of soil, soil formation, soil profile, soil conservation

Unit VI: Cytology

- a) Cell, Cell organelles, Cell division: Prokaryotic and eukaryotic cell structure,
b) General structure of plant cell: cell wall, chloroplasts and glyoxysomes
d) Mitosis and Meiosis

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- To study bacteria using Gram staining method
- Study of stages in the life cycle of Nostoc and Spirogyra, Rhizopus, Aspergillus, Riccia
- Study of stages in the life cycle of Riccia
- Ecological adaptations of hydrophytes, hygrophytes, xerophytes and halophytes
- Mitosis and meiosis

References:

- Pelczar M. J, Chan E.C., Krieg, N. R.1993. Microbiology by Pelczar Chan and Krieg 5th ed.
- College Botany Volume I and II. 2006. Gangulee, Das and Dutta latest edition. Central Education enterprises.
- Smith, G.M. 1938. Cryptogamic Botany, vol. 1. Algae and fungi.
- Smith, G.M. 1955. Cryptogamic Botany, vol. 2. Bryophytes and P teridophytes.
- Sharma O.P. 2010. A text book of fungi. S.Chand's Publication.
- De Robertis and De Robertis. 8th Edition. 2017. Cell and Molecular Biology.
- Odum E. P 1983. Basic Ecology, Saunders, Philadelphia.

SEMESTER II

COURSE II: ZOOLOGY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Course Outcome

By the end of the course, student will be able to:

1. explain Taxonomy, Systematics and classification of animals, its objectives and importance.
2. describe classification of non-chordate animal
3. describe the concept of Hotspot, biodiversity values, threats to biodiversity, conservation and management of biodiversity.
4. explain conservation and conserve locally found flora and fauna
5. explain basic principles, causes, effects and preventive measures of different types of pollution

Module I: Animal Diversity

2 Credits

Unit I: Animal Diversity 1

- a) General principles of taxonomy, International Code of Zoological Nomenclature (ICZN), Binomial Nomenclature
- b) Taxonomic procedures – collection, preservation and process of identification of biological species.
- c) Criteria of classification: symmetry, coelom, segmentation, Germ layers, body plan, exo and endo skeleton,

Unit II: Animal Diversity 2

- a) Salient features with examples for phyla, sub-phyla and classes mentioned below; Phylum Protozoa, Porifera and Coelenterata
- b) Salient features with examples for phyla, sub-phyla and classes mentioned below; Phylum Platyhelminthes, Nematelminths and Annelida
- c) Salient features with examples for phyla, sub-phyla and classes mentioned below; Phylum Arthropoda, Mollusca and Echinodermata

Unit III: Biodiversity 1

- a) Introduction to Biodiversity: Definition, Concepts and Scope and Significance
- b) Values of biodiversity: Direct and Indirect use value
- c) Levels of Biodiversity: Introduction to Genetic, Species and Ecosystem Biodiversity

Module II: Biodiversity**2 Credits****Unit IV: Biodiversity 2**

- a) Hotspots and PAN, Threats to Biodiversity: Man- Wildlife conflict, any two case studies pertaining to this issue.
- b) Conservation Biology: ex situ and in situ methods, National Parks and Sanctuaries
- c) People's Biodiversity Register, The Biological Diversity Act, 2002

Unit V: Pollution 1

- a) Air Pollution: Types and sources of air pollutants, its effects and Control measures
- b) Noise Pollution: Types and sources of air pollutants, its effects and Control measures
- c) Climate change and Global warming, Bioremediation

Unit VI: Pollution 2

- a) Water Pollution: Types and sources of air pollutants, its effects and Control measures
- b) Soil Pollution and Solid waste Pollution: Types and sources of air pollutants, its effects and Control measures
- c) Radioactive pollution

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- 1) Levels of organization:
 - Symmetry - Ameoba, Sea anemone, Liverfluke, Planaria
 - Coelom – Planaria, Ascaris, Earthworm
 - Segmentation – Tapeworm and Earthworm
 - Cephalization - Cockroach
- 2) Mounting of Foraminiferan shells
- 3) Estimation of population density of animals by line transect method (frequency distribution&

through Pie diagram only)

- 4) Estimation of population density of animals by quadrant method (frequency distribution & through Pie diagram only).
- 5) Detection of heavy metal (Lead) from the given sample of water.

References:

1. Jordan and Verma. Invertebrate Zoology Volume II, S. Chand and Co
2. R. L. Kotpal. Invertebrates, Modern Textbook of Zoology.
3. E. P. Odum. Fundamentals of Ecology, Sunders Publication
4. Gurdeep R. Chatwal, Harish Sharma, Madhu Arora, A Textbook of Environmental Studies, Himalaya Publication.
5. P. D. Sharma. Ecology and Environment, R. K. Rastogi Publications

SEMESTER III
COURSE III: BOTANY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Course Outcome

By the end of the course, student will be able to:

1. classify Pteridophytes, Gymnosperms, Angiosperms and explain salient features and their economic importance
2. apply principles underlying Bentham & Hooker's system of classification and identify plants from prescribed families.
3. distinguish between different types of fruits and seeds
4. explain the fundamental concepts of phytochemistry
5. outline the fundamental concepts of plant anatomy and palynology
6. summarize Sustainable Development Goals

Module I: Plant Diversity

2 Credits

Unit I: Plant Diversity –4

- a) Classification of plant kingdom 3: : Classification of plant kingdom: Outline of Classification of Pteridophytes (G.M. Smith) and general characters of all classes
- b) Life cycle study: Nephrolepis
- c) Economic importance of Pteridophytes

Unit II: Plant Diversity –5

- a) Classification of plant kingdom 4: Classification of plant kingdom: Outline of Classification of Gymnosperms (Chamberlain) and general characters of all classes
- b) Life cycle study: Cycas
- c) Economic importance of Gymnosperms

Unit III: Plant Diversity –6

- a) Definition of taxonomy, systematic botany, concepts of taxonomy,
- a) aims of taxonomy, Systematics: Categories and taxonomic hierarchy
- b) Structural organization: Morphology: inflorescence and flower.
- c) Structural organization: fruits and seeds

Module II: Plant Diversity, Anatomy and Medicinal Botany**2 Credits****Unit IV: Plant Diversity –7**

- a) Family: Malvaceae and Rutaceae
- b) Family: Leguminosae- Caesalpinaceae, Papilionaceae and Mimosae
- c) Family: Solanaceae and Amaryllidaceae

Unit V: Anatomy

- a) Structural organization: Anatomy: Tissue system, Primary structure of dicot and monocot root, stem and leaf (Kranz anatomy), Wood anatomy
- b) Types of Stomata
- c) Palynology: Structure of pollen grain, factors affecting pollen germination

Unit VI: Medicinal Botany

- a) Medicinal Botany: Study of secondary metabolites: Alkaloids, glycosides, phenolics, gums and resins.
- b) Ethnobotany: Ethnic communities, Ethnomedicinal plants
- c) Sustainable Development Goals

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

Practical:

1. Life cycle study: Nephrolepis
2. Life cycle study: Cycas
3. Families: Malvaceae, Rutaceae, Leguminosae- Caesalpinaceae, Papilionaceae and Mimosae Solanaceae, Amaryllidaceae
4. Primary structure of dicot and monocot root, stem and leaf
5. Chemical tests for secondary metabolites Alkaloids, glycosides, phenolics,

6. Identification of gums and resins.

References:

1. Smith, G.M. (1955). Cryptogamic Botany, vol. 2. Bryophytes and Pteridophytes.
2. .Chamberlain C.J. 1998. Gymnosperms: Structure and evolution. CBS Publishers, New Delhi
3. Esau K. 1993. Plant Anatomy. Wiley Eastern Ltd. New Delhi.
4. Daniel, M. 1991. Methods in Plant Chemistry and Economic Botany. Kaiyani Publishers, Ludhiana, India.
5. Sinha, Rajiv, K and S. Sinha. 2001. Ethnobiology. Sura Publications, Jaipur, India.

SEMESTER IV
COURSE IV: ZOOLOGY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Course Outcome

By the end of the course, student will be able to:

1. apply principles of classification to classify a chordate animal up to class.
2. calculate Natality, Mortality and fecundity of a population and identify different population graphs and survivorship curves.
3. apply scientific knowledge of ecology to analyse social and environmental issues
4. calculate the concentration of different solutions.
5. comprehend the data and also prepare correct graphical presentation for it.

Module I: Animal Diversity

2 Credits

Unit I: Animal Diversity- 3

- a) Salient features with examples for phyla, sub-phyla and classes mentioned below;
Phylum Hemichordata with examples
- b) Salient features with examples for phyla, sub-phyla and classes mentioned below;
Phylum Chordata; sub-phylum Urochordata and sub-phylum Cephalochordata with examples,
- c) Salient features with examples for phyla, sub-phyla and classes mentioned below;
Sub-phylum Vertebrata, Superclass Agnatha, Class: Cyclostomata with examples

Unit II: Animal Diversity- 4

- a) Salient features with examples for phyla, sub-phyla and classes mentioned below;
Superclass Gnathostomata
Class: Pisces and Amphibia with examples
- b) Salient features with examples for phyla, sub-phyla and classes mentioned below;
Superclass Gnathostomata
Class: Reptilia and Aves
- c) Salient features with examples for phyla, sub-phyla and classes mentioned below;

Superclass: Gnathostomata

Class: Mammalia with examples

Unit III: Ecology 1

- a) Light: Relation to terrestrial and aquatic habitat, photoperiodism, diurnal migration.
- b) Temperature: range, tolerance, effects of temperature on living organisms. Concept of population and community:
- c) Edaphic: Soil formation, Components of Soil, Types of soil and Soil Profile.

Module II: Ecology

2 Credits

Unit IV: Ecology 2

- a) Population - Natality, mortality, population growth, survivorship curve, density age and sex composition
- b) Community (Forest, grassland & pond) - Ecological niche, ecological succession (different seral stages), ecological climax (significance)
- c) Concept of animal interaction: Symbiosis, Mutualism, Commensalisms, Parasitism and predation, Antibiosis

Unit V: Lab safety, Units and Measurements

- a) Introduction to good laboratory practices, Use of safety symbols: Concept, Types of hazards and Precautions
- b) Units of measurement: Calculations and related conversions of each:
 - I. Metric system- length (meter to micrometer)
 - II. Weight (gram to microgram)
 - III. Volumetric (Cubic measures)
 - IV. Units of measurement: Calculations and related conversions of each: Temperature: Celsius, Fahrenheit, Kelvin
- c) Concentrations: Percent solutions, ppt, ppm, dilutions, Normality, Molarity and Molality, Problems based on the calculations of Concentrations

Unit VI: Biostatistics

- a) Biostatistics: Introduction and scope
- b) Sampling and its types, Central Tendencies (mean, median, mode)
- c) Tabulation and Graphical representations (Histograms, bar diagrams, pie diagrams)

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- 1) Interpretation of safety symbols (toxic, corrosive, explosive, flammable, skin irritant, oxidizing, compressed gases, aspiration hazards and Biohazardous infectious material, Radioactivity, Environmental toxicity)
- 2) Calculation of Normality and Molarity
- 3) Calculation of Natality, Mortality, Population density from given data
- 4) Interpretation of Growth curves (Sigmoid and J shaped)
- 5) Problems and graphs based on Biostatistics
- 6) Study of Central tendencies and plotting of Bar diagram, histogram and pie diagram

References:

1. Jordan and Verma. Vertebrate Zoology Volume I, S. Chand and Co.
2. Dharmi P. S. and. Dharmi J. K. Chordate Zoology, R. Chand and Co.
3. Eugene P. Odum and Grey W. Barrett. Fundamentals of Ecology - Brook Cole/ Cengage learning.
4. Dash M. C. Fundamentals of Ecology -Tata McGraw Hill company Ltd, New Delhi
5. Mahajan B. K. Methods in Biostatistics, Jaypee Publications
6. Shukla, Mathur, Upadhyay, Prasad. Economic Zoology, Biostats and Animal Behaviour - Rastogi Publications.

SEMESTER V
COURSE V: BOTANY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Course Outcome

By the end of the course, student will be able to:

1. apply the basic concepts and significance of macromolecules in various fields of plant science
2. demonstrate the use of instruments like different types of microscopes, pH meter, colorimeter, and chromatography techniques
3. comprehend different fundamental concepts related to plant vegetative & reproductive growth, and role of various plant growth regulating substances
4. evaluate plants and plant products in human welfare
5. execute the techniques of plant propagation
6. assess Green tourism in India

Module I: Biochemistry and Instrumentation

2 Credits

Unit I: Biochemistry

- a) Biomolecules: structures of carbohydrates.
- b) Biomolecules: structures of amino acids, lipids
- c) Biomolecules: structures of nucleic acids

Unit II: Instrumentation-I

- a) Instrumentation and techniques: Microscopy: Simple and Compound microscopes, Phase contrast microscopes
- b) Electron microscopy, pH meter,
- c) Colorimeter

Unit III: Instrumentation-II

- a) Chromatography: Paper chromatography,
- b) TLC, HPTLC
- c) HPLC

Module II – Plant Growth**2 Credits****Unit IV: Physiology-I**

- a) Plant growth and Development: Vegetative growth: General phases of growth, Growth Curves, Factors affecting growth – External (environmental) and internal (genetic, hormonal, nutritional);
- b) Role of plant growth regulating substances – Auxins, Cytokinins, Gibberellins and abscisic acid and their commercial applications
- c) Reproductive growth: Photoperiodism: Phytochrome Response and vernalization with reference to flowering in higher plants, Physico-chemical properties of phytochrome, Pr-Pfr interconversion, role of phytochrome in flowering of SDPs and LDPs;

Unit V: Medicinal Botany-II

- a) Food and Nutrition: Microbes in human welfare
- b) Plants in Human Health: Diet, Role of antioxidants.
- c) Benefits of phytochemicals in disease prevention: Sources and therapeutic efficacy

Unit VI: Horticulture

- a) Horticulture: Branches, Plant propagation techniques(Cutting, Layering, Grafting, Budding)
- b) protected cultivation methods(Greenhouse Technology- Soilless cultivation)
- c) Green Tourism: Concept, scope, Green tourism in India- Case study

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

1. Test for carbohydrates, amino acids, lipids
2. Separation of Amino acids by paper chromatography
3. Study of Hill's reaction
4. Identification of plants in human health for Diabetes, Immunity booster, Fever, Arthritis and skin disorders
5. Plant propagation by Cutting
6. Plant propagation by Layering, Grafting and Budding

References:

1. Garry D Christian, James E O'reilvy. 1986. Instrumentation analysis. Alien and Bacon, Inc.
2. Wilson K and Walker JM.1994. Principles and techniques of practical biochemistry
3. Peter K. V. (2009). Basics of Horticulture. New India Publ. Agency.
4. Manay, S. and Shadaksharaswami, M.2004. Foods: Facts and Principles, New Age Publishers
5. Noggle and Fritz. 2002. Introduction to Plant Physiology. Prentice Hall Publisher.
6. Taiz, L. and Zeiger, E. 2006. Plant Physiology.4th Edition. Sinauer Associates. Sunderland, Massachusetts, USA.

SEMESTER VI
COURSE VI: ZOOLOGY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Course Outcome

By the end of the course, student will be able to:

1. distinguish between the characters of Prokaryotic and Eukaryotic cell.
2. describe the structure and function of different cell organelles.
3. explain the evolution of increasing complexity of physiology of all life processes and its evolutionary hierarchy.
4. correlate between the habit and habitat with the structures involved in all the physiologic processes in different classes of organisms
5. explain the evolutionary concepts including homology and homoplasy, and detailed discussions of major organ systems.

Module I –Cell Biology

2 Credits

Unit I: Cell Biology I

- a) Cell theory, Generalized prokaryotic, eukaryotic cell: size, shape and structure, Plant Cell and Animal cell
- b) Nucleus: Size, shape, number and position, Structure and functions of interphase nucleus, Ultrastructure of nuclear membrane and pore complex, Nucleolus: general organization, chemical composition and functions
- c) Plasma membrane: Fluid Mosaic Model and Membrane receptor

Unit II: Cell Biology 2

- a) Origin, Ultrastructure and functions: Endoplasmic reticulum and Lysosomes
- b) Origin, Ultrastructure and functions: Golgi bodies and Mitochondria
- c) Animal Tissue: Definition, Types and Functions (Epithelium, Connective tissue, Nervous tissue and Cardiac Tissue)

Unit III: Animal Type: Invertebrate

- a) Phylum- Annelid e.g. Earthworm: Systematic position, habit and habitat, Structure and Histology of Body wall and Locomotion.
- b) Type of nutrition, Structure of respiratory system and Physiology of respiration, Structure of Excretory system and Physiology of excretion & excretory system,
- c) Structure of Reproductive system and Nervous system, Regeneration in earthworm

Module II: Animal Physiology**- 2 Credits****Unit IV: Animal Physiology 1**

- a) Comparative study of Nutritional Apparatus with reference to feeding adaptations -Structure and functions:
- Invertebrates- eg: Amoeba- Pseudopodia, Cockroach-biting and chewing, Vertebrates-Fish, Digestive system and physiology of digestion with respect to Man
- a) Comparative Study of Excretory and Osmoregulatory systems of:
- Amoeba - Contractile vacuoles, Planaria -Flame cells, Earthworm –Nephridia, Cockroach- Malpighian tubules,
- b) Categorization of animals based on principal nitrogenous excretory products, Structure of kidney and nephron in Man, Uriniferous tubule and physiology of urine formation in Man

Unit V: Animal physiology 2

- a) Comparative study of Respiratory systems - Structure and Function with reference to Earthworm, Rohu, Structure of lungs and physiology of respiration in man
- b) Comparative study of Circulatory systems: Open and closed, single and double, Comparative study of Hearts (Structure and function) with reference to Cockroach, Frog and Pigeon, Structure and working of Human Heart
- c) Comparative study of Nervous systems: Nerve net in Hydra, Nerve ring and nerve cord in earthworm, Types of neurons on the basis of structure and function, Structure and function of Human Brain and spinal cord, Synaptic transmission – Chemical and Electrical, Endocrine regulation: Hormones as chemical messengers in Man.

Unit VI. Animal type: Vertebrate

- a) Class – Amphibian e.g. Frog: Systematic position, Habit and habitat, External characters and sexual dimorphism
- b) Digestive system, food and feeding, physiology of digestion, Urinogenital System of Male and Female Frog
- c) Respiratory system- Mechanism of respiration, Circulatory system and its mechanism, Nervous system of Frog

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- 1) Urine analysis—Normal and abnormal constituents
- 2) Detection of Creatinine in urine.
- 3) Study of permeability of cell through plasma membrane (Osmosis in blood cells).
- 4) Measurement of cell diameter by occulometer (by using permanent slide)
- 5) Mounting of Septal Nephridia of Earthworm
- 6) Mounting of any Plant and Animal cell and its observation.

References:

1. Kotpal R. L., Modern Textbook of Zoology, Invertebrates, (2016), Rastogi Publication.
2. Jordan and Verma, Invertebrate Zoology Volume II, (1963), S. Chand and Co.
3. Jordan and Verma, Vertebrate Zoology Volume I, (2004), 2nd edition S. Chand and Co.
4. De Robertis E.D.P and Robertis E.M.R, Cell and molecular Biology, CBS Publishers and Distributors.
5. Gupta P.K and Pawar C.B., Cell Biology, Himalaya publication.

SEMESTER VII
COURSE VII -1 :BOTANY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcome

By the end of the course, student will be able to:

- 1) explain the physiological aspects of plant life with reference to water relations, mineral nutrition and translocation of solutes
- 2) illustrate the concept of essential oils, fatty oils and vegetable oils and their value addition
- 3) explain different fundamental concepts related to photosynthesis & respiration and principles governing bioenergetics
- 4) explain the industrial relevance of botanicals with respect to current demands in industry
- 5) explain the economic and commercial value of botanical products

Module I: Physiology and Economic Botany
Credits

2

Unit I: Physiology-II

- a) Plant Physiology: Plant in relation to water: Osmosis, Diffusion, Water potential and its components and their measurement, transport of water and inorganic solutes.
- b) Mineral nutrition: role of macro and micro nutrients and their deficiency symptoms in plants,
- c) Translocation of solutes: composition of phloem sap, girdling experiments, phloem loading and unloading, mechanism of sieve tube translocation.

Unit II: Economic Botany-I

- a) Economic Botany: Essential Oils: Extraction, perfumes, perfume oils- Patchouli, Citronella.
- b) Fatty oils : Drying oil (l soybean oil), semidrying oils (sesame oil) and non-drying oils (peanut oil)
- c) Vegetable Fats: Coconut , Kokkam butter, Cocoa butter

Unit III: Economic Botany-II

- a) Aromatherapy- Introduction, Botanical source and uses: Calendula, Lemon, Jasmine
- a) Industry based on plant products: Fibre yielding plants, Paper yielding plants
- b) Spices and condiments: Cardamom (*Elettaria cardamomum*), Jaivetri and Jaiphal (*Myristica fragrans*)

Module II: Physiology and Modern Trends
Credits

2

Unit IV: Physiology-III

- a) Photosynthesis: Plant pigments and their interaction with light, Light reactions, photolysis of water, cyclic and non-cyclic photophosphorylation, carbon fixation phase (C3, C4 and CAM pathways).
- b) Respiration: Aerobic: Glycolysis, TCA Cycle, ETS and Energetics of respiration; Mechanism of photorespiration,
- c) Energetics and significance of photorespiration, anaerobic respiration.

Unit V: Current Trends-I

- a) Industry based on plant products: Botanicals and nutraceuticals- Spirulina, Vanillin, Garcinia indica/ Garcinia cambogia, Stevia
- b) Industrial enzymes: Extraction methods and application: Cellulases, Papain, Bromelain.
- c) Plants as sources of natural colorants- Bixa, Turmeric, Madder, Anthocyanin, Indigo.

Unit VI: Current Trends-II

- a) Role of antioxidants in cosmetology – Antioxidants, their functions, sources, antioxidant enzymes.
- a) Collection and processing of herbal material.
- b) Preparation of ayurvedic cosmetic formulations and its validation

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

1. Determine the solute potential of plant tissues by plasmolytic method
2. Identification of Fibre yielding plants & Paper yielding plants as given in theory
3. Identification of Spices and condiments as given in theory
4. Study of Hill's reaction

5. Extraction of papain
6. Preparation of ayurvedic cosmetic formulations and its validation.

References:

1. Sambamurthy, A.V.S.S. and Subramanyam, N.S. 1989. A Text of Economic Botany Wikes. Eastern Ltd., New Delhi, India.
2. Salisburyand Ross. 2007. Plant Physiology.CBS Publishers & Distributers New Delhi-110002 (India).
3. Vimaladevi, M. 2019. Textbook of Herbal Cosmetics, 1st edition, CBS (e- book)
4. Panda,H. 2015.Herbal Cosmetics Hand Book, 3rd Revised edition, Asia Pacefic Business Press inc. (e-book)
5. Daniel, M. and S.D. Sabnis .1990.A Phytochemical Approach to Economic Botany.Kaiyani Publishers, Ludhiana, India

SEMESTER VII
COURSE VII-2: ZOOLOGY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcome

By the end of the course, student will be able to:

1. explain the cytological basis for variations, applications of genetics, sex determination, sex linked inheritance, gene expression and regulation.
2. analyze the chemical composition of DNA and RNA and give a comparative account of the same.
3. explain origin of life and will know about the different theories of evolution
4. analyze and identify different mechanisms of speciation.
5. explain the biology of behavior which is an important basis for adaptive capacities of animals and the needs of animals

Module I – Genetics and Hereditary

2 Credits

Unit I: Genetics

- a) Genetics: Definition, scope and importance of genetics
- b) Human genetics: Study of syndromes: Genetic basis and symptoms of Turner's, Klinefelter's, Down's, Cri-du chat, Patau's, Edwards
- c) Human Pedigree analysis with symbols, Autosomal dominant and autosomal recessive, X-linked dominant, and X-linked recessive. Significance of genetic counselling (Can include case studies)

Unit II: Chromosomes and Heredity

- a) Chromosomes: Introduction to morphology of chromosome, Chromosome structure- Heterochromatin, Euchromatin
 - I. Classification based on the position of centromere
 - II. Types of Chromosomes- Autosomes and Sex chromosomes
- b) Sex determination: Chromosomal Mechanisms: XX-XO, XX-XY, ZZ-ZW.
 - I. Sex determination in honey bees- Haplodiploidy
 - II. Gynandromorphs
 - III. Parthenogenesis
- c) Role of environmental factors in Sex determination- Bonellia, Crocodile and Turtle.
 - I. Lyon hypothesis and Barr bodies formation in mammals

II. Mechanisms of Dosage compensation in *Drosophila* and *C. elegans*

Unit III: Nucleic acids

- a) Griffith's transformation experiments, Avery-Macleod and McCarty, Hershey and Chase experiment of Bacteriophage infection.
 - b) Chemical composition and structure of nucleic acids.
 - I. Double helix nature of DNA, Solenoid model of DNA.
 - II. Types of DNA – A, B, Z & H forms.
 - c) DNA in Prokaryotes -chromosomal and plasmid and Extra nuclear DNA –mitochondria and chloroplast.
- RNA as a genetic material in viruses and Types of RNA (Structure and function).

Module II: Evolution

- 2 Credits

Unit IV: Evolution

- a) Origin of universe, Chemical evolution - Miller-Urey experiment, Haldane and Oparin theory, Origin of eukaryotic cell, Theory of Lamarck.
- b) Evidence in favor of Evolution: Morphology and comparative anatomy: Homology, Analogy and Vestigial organs, Embryology: Homology of early development, Geographical distribution, Paleontology, Connecting links, Physiology, Genetics.
- c) Evolution of Man

Unit V: Population genetics and evolution

- a) Definition and Brief explanation of the following terms: Population, gene pool, Allele frequency, Genotypic frequency
- b) Natural Selection, Sewall Wright effect, Founder effect, Mutation and Migration, effect of these forces on gene frequency
- c) Species Concept - Biological species concept and evolutionary species concept. Speciation and Isolating mechanisms – Definition and Modes of speciation (Allopatric, Sympatric, Parapatric and Peripatric), Geographical isolation, Reproductive isolation and its isolating mechanisms (Pre-zygotic and Postzygotic)

Unit VI: Ethology

- a) Introduction to Ethology: Definition, History and Scope of Ethology
- b) Animal behavior - Innate and Learned behavior
- c) Types of learning -Habituation, Imprinting and types of imprinting (filial and Sexual), Classical conditioning, Instrumental learning and insight learning, Communication in Bees and Ants, Mimicry and colouration, Displacement activities, Ritualization

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- 1) Genetic disorders (Show karyotype spread pictorial)
- 2) Detection of blood groups and Rh factor
- 3) Problems in genetics: Multiple alleles, X- linked inheritance
- 4) Study of bleeding time and clotting time
- 5) Study of Eukaryotic cells (WBCs) from blood smear by Leishman's stain.
- 6) Identification and study of fossils: Trilobite, Ammonite, Archaeopteryx

References:

1. E.D.P De Robertis and E.M.R Robertis, Cell and molecular Biology, CBS Publishers and Distributors.
2. Gupta P.K and Pawar C.B., Cell Biology, Himalaya publication
3. Strickberger, Evolution, CBS publication
4. Benjamin Pierce, Genetics: A conceptual approach, W. H. Freeman; 5th edition (December 27, 2013)
5. David McFarland, Animal Behaviour: Psychobiology, Ethology and Evolution, (1998), 3rd edition, Benjamin Cummings publication.

SEMESTER VIII
COURSE VIII-1: BOTANY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcome

By the end of the course, student will be able to:

1. discuss Mendelian Genetics, genetic basis of loci and alleles and sex linked inheritance
2. explain the core concepts and fundamentals of plant tissue culture and its applications
3. describe the fundamentals of R-DNA technology
4. outline the fundamentals of molecular biology
5. explain the concept of databases and its applications
6. demonstrate the technique of plant microtechnique

Module I – Genetics and Biotechnology

2 Credits

Unit I: Genetics-I

- a) Mendelian Genetics, Brief explanation of the following terms: Allele, wild type and mutant alleles, locus, dominant and recessive traits, homozygous and heterozygous, genotype and phenotype, genome.
- b) Exceptions to Mendelian Inheritance: Incomplete dominance, Codominance, Lethal alleles, Epistasis -Recessive, Double recessive, dominant and double dominant, non epistatic interactions;
- c) Concept of multiple alleles: Coat colour in rabbit, ABO and Rh blood group systems and its medico-legal importance.

Unit II: Biotechnology-I

- a) Plant Biotechnology: Plant tissue culture: Totipotency, Morphogenesis, Types of cultures- Micropropagation
- b) Production of Haploids
- c) Protoplast isolation and somatic hybridization

Unit III: Biotechnology-II

- a) Transcription in prokaryotes and eukaryotes: promoter sites, initiation, elongation and termination.
- b) Genetic Code, Translation in prokaryotes and eukaryotes
- c) R-DNA technology: Gene cloning, Enzymes involved in Gene cloning, Vectors used for Gene cloning.

Module II: Genetics and Bioinformatics

2 Credits

Unit IV: Genetics-II

- a) Chromosomal Methods heterogametic males and heterogametic females. Sex determination in monoecious and dioecious plants.
- b) Genic Balance Theory of sex determination in Drosophila, Lyon's Hypothesis of X chromosome inactivation,
- c) Sex linked inheritance - eye colour in Drosophila, Haemophilia, colour blindness, Sex influenced inheritance: baldness in man

Unit V: Plant Microtechniques

- a) Staining procedures, Classification and chemistry of stains
- b) Tissue preparation: living, fixed, coagulating and non-coagulating fixatives, tissue dehydration using graded solvent series, paraffin infiltration
- c) Microtomy and staining permanent sections

Unit VI: Bioinformatics

- a) Introduction to bioinformatics and its applications
- b) Introduction and Bioinformatics resources:
Bioinformatics resources: NCBI, EMBL- EBI, DDBJ, PIR and SWISSPROT
- c) Knowledge of various databases - Organization of biological data- Primary, secondary and tertiary
Structure database, sequence database, Literature database

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- 1) Preparation of stock solutions and Preparation of MS medium
- 2) Seed/ any explant sterilization and inoculation technique & Callus induction
- 3) To find out the amino acid sequence of the given mRNA strand.
- 4) Demonstration: Microtomy
- 5) Use of bioinformatics resources and databases
- 6) Basic and advanced search methods w.r.t Biological databases, use of Entrez

References:

1. De Robertis and De Robertis. 8th Edition. 2017. Cell and Molecular Biology.
2. Gupta, P.K. 1999. A Text Book of Cell and Molecular Biology. Rastogi Publication, Meerut. India
3. Westhead. 2002. Instant Notes on Bioinformatics. Taylor Francis Publications
4. Berlyn GP and Miksche JP. 1976. Botanical micro-techniques and cytochemistry
5. Hexter W and Yost Jr. H T .1977. The Science of Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Kumar, U. 2000. Methods in Plant Tissue Culture, Agrobios, Jodhpur. India.
7. Bhojwani. S.S. & Razdan. M.K. 1996. Plant Tissue Culture: Theory and Practice (Rev.Ed.). Elsevier Science Publishers, New York.

SEMESTER VIII
COURSE VIII-2: ZOOLOGY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcome

By the end of the course, student will be able to:

1. recall different structures of locomotory organs, muscle fibers and reproductive systems of different invertebrates and vertebrates.
2. compare and contrast between different egg types, blastulae types and sperms in different animals and interrelate it with their developmental process.
3. describe types of transgenesis methods, gene therapy, principle of DNA finger printing and its applications and application of biotechnology in animal husbandry and Medicine.
4. develop the research aptitude and gain experience at reading and evaluating the scientific literature.
5. develop skills, concept and experience to understand the ethical aspects of research.

Module I: Animal Physiology

2 Credits

Unit I: Animal Physiology 3

- a) Movement and Locomotion: Locomotory organs (Structures and Functions) -Pseudopodia in Amoeba (sol gel theory), Cilia in Paramecium, Tube feet in Starfish
- b) Structure and function of Striated muscle fiber in human and sliding filament theory, Structure of Non striated and Cardiac Muscle fiber and functions
- c) Chemical composition, Structure and function of Cartilage and Bone, Axial Skeleton: Vertebral Column, Rib cage, Appendicular Skeleton: Pectoral and Pelvic Girdle and Limbs.

Unit II: Animal Physiology 4

- a) Reproductive system: Anatomy of human male and female reproductive system
- b) Menstrual cycle in Female, Hormonal regulation of Reproduction and Impact of age on reproduction
- c) Menopause and Andropause

Unit III: Embryology

- a) Embryology: Structure of Sperm and Ovum,
- b) Types and Patterns of Cleavage, Types of Blastula (Amphioxus, Frog, Aves, Chick.), Gastrulation
- c) Coelom–Formation and types, Extra embryonic membranes, Types of Placentae (Based on histology, morphology and implantation)

Module II: Animal Biotechnology

2 Credits

Unit IV: Animal Biotechnology

- a) Biotechnology: Scope and achievements of Biotechnology (Fishery, Animal Husbandry, Medical, Industrial)
- b) Transgenesis: Retro viral method, nuclear transplantation method, DNA microinjection method, Embryonic stem cell method
- c) Cloning (Natural and Artificial), Natural cloning - Planaria, Identical twins (monozygotic) and non-identical twins (dizygotic), Artificial cloning -Dolly and Macaque monkey. Applications of Biotechnology: Blotting techniques- Southern, Northern and Eastern, DNA fingerprinting - Technique in brief and its application in forensic science (Crime Investigation), Recombinant DNA in medicines (recombinant insulin), Gene therapy: Ex-vivo and In-vivo, Severe Combined Immunodeficiency (SCID), and Cystic Fibrosis, Ethical issues of transgenic and cloned animals

Unit V: Research Methodology

- a) Research methodology: The Scientific method - Deductive reasoning and inductive reasoning, Critical thinking, Role of chance in scientific discovery
- b) Scientific Research - Definition, difference between method and methodology characteristics, types, Steps in the Scientific Method - Identification of research problem, Formulation of research hypothesis, Testing the hypothesis using experiments or surveys, preparing research/study design including methodology and execution (Appropriate controls, sample size, technically sound, free from bias, repeat experiments for consistency), Documentation of data, Data analysis and interpretation, Results and Conclusions
- c) Scientific writing: Structure and components of a research paper (Preparation of manuscript for publication of research paper) - Title, Authors and their affiliations, Abstract, Keywords and Abbreviations, Introduction, Material and Methods, Results, Discussion, Conclusions, Acknowledgement, Bibliography; Figures, Tables and their legends

Unit VI: Plagiarism and Intellectual Property Rights

- a) Plagiarism: Concept, its types and different ways of committing plagiarism and Ethics and prevention, Detection of plagiarism
- b) Introduction to IPR, Types of Intellectual properties: Industrial property, Artistic and literary Property, Need for IPR, Impact of IPR on development, health, agriculture and genetic resources, IPR in India.
- c) Introduction to Patents, Trade marks and copyrights

Module III- Internal Assessment**2 Credits**

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- 1) To demonstrate immobilization of Enzyme and its activity
- 2) Study of striated and non- striated muscle fibre
- 3) Study of permanent slides on topic of Reproduction: T.S. of mammalian testis
- 4) Study of permanent slides on topic of Reproduction: T.S. of mammalian ovary,
- 5) Study of permanent slides on topic of Reproduction: T.S of Mammalian Blastula
- 6) Bibliography and Abstract writing.

References:

1. Berril N.J., Developmental Biology, Tata McGraw –Hill Publication.
2. Miller S. A. and Harley J. B, Zoology., (2005), 6th edition, Tata McGraw Hill.
3. E. L. Marieb, Human Anatomy and Physiology, Pearson Education Low Price Edition
4. A. Borem, D. Bowe. Understanding biotechnology, Low price edition –Pearson Publication
5. RC. Kothari, Research Methodology, Methods and Techniques, Wiley Eastern Ltd. Mumbai
6. Paul D Leedy, Practical research planning and design, 2nd edition, Macmilan Publication

SCIENCE FOUNDATION COURSES –
BIOLOGY
SEMESTER I AND SEMESTER II

SEMESTER - I
SCIENCE FOUNDATION COURSE I : BOTANY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcome

By the end of the course, student will be able to:

1. classify Algae, Fungi and Bryophytes
2. explain the characteristics of gymnosperm
3. compare the characteristics between Dicots and Monocots
4. explain the structure of flower
5. explain the concept of microbiology

Module I: Introduction to Study of Life

2 Credits

Unit I: Study of Life Forms: I

- a) Algae: Classification of Algae up to class. (G. M. Smith's Classification). Salient features of algae. Study of one alga from each class as an Example (only morphology)
- b) Fungi: Classification of true fungi up to class. Salient features of fungi. Study of Rhizopus as representative organism (Thallus structure at asexual stage).
- c) Bryophytes: Salient features of bryophytes. Type study of Funaria as an example of moss (only morphology), Pteridophytes: Salient features of pteridophytes. Type study of Nephrolepis as an example of ferns.

Unit II: Study of Life Forms: II

- a) Gymnosperms: Important characteristics of gymnosperms. Study of Cycads and Conifers with one example of each i.e. Cycas and Pinus (only morphology)
- b) Angiosperms: Distinguishing features of angiosperms. Comparison between Dicots and Monocots
- c) Flower: Structure of a typical flower. Floral parts and their functions.

Unit III: Plant Cells, Tissues and Organs

- a) Study of typical plant cell and cell organelles
- b) Types of cells. Simple and compound tissues, Organs of plants: Study of roots, stem and leaves in higher plants w.r.t. their structural details and functions
- c) Plant Functions: Importance of water in plants, Absorption of water and minerals (General account), Photosynthesis: general outline of the process and its importance, Respiration: general outline of the process and its importance, Reproduction in plants (basic explanations of sexual and asexual methods)

Module II: Introduction of Plant Science

2 Credits

Unit IV: Branches of Botany

- a) Fundamental Branches of Botany: Introduction of Phycology, Mycology, Plant Morphology, Plant Anatomy, Plant Physiology, Plant Genetics, Plant Cytology, Palynology and Plant Embryology.
- b) Allied and Interdisciplinary Branches of Botany: Introduction of Plant Histology Plant Taxonomy, Plant Breeding, Plant Ecology, Phyto-geography, Paleobotany, Plant Pathology, Medicinal Botany Bioinformatics and Ethnobotany
- c) Productive Branches: Introduction of Agriculture, Horticulture, Forestry and Organic Farming.

Unit V: Applied Botany

- a) Aesthetic Botany: Study of Ornamental Plants - Common flowering and foliage plants used

- in private and public gardens. Common indoor and outdoor plants
- b) Healing Botany: Study of common medicinal plants w.r.t. their source, parts used and therapeutic uses. Eg. Turmeric, Tulsi, Aloe, Ginger, Lemon, Amla, Clove, Pepper and Mint
- c) Experimental Botany: Introduction to and applications of - Plant Tissue Culture (PTC) and GM (Genetically Modified) Crops

Unit VI: Study of Fungi (Microbiology)

- a) Fungal Physiology, Structure and Symbioses
 - i. Nutrition and Physiology
 - ii. Fungal Morphology, Spores and Cell Walls
 - iii. Symbioses and Pathogenesis
- b) Some Fungi of Special Interest
 - i. Synchytrium
 - ii. Saprolegnia
 - iii. Mucor
 - iv. Schizosaccharomyces
 - v. Saccharomyces
 - vi. Neurospora
 - vii. Agaricus
 - viii. Filobasidiella neoformans
 - ix. Aspergillus
 - x. Penicillium
 - xi. Candida
- c) Medicinally important fungi and fungal diseases, Economic effects of Fungi

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

- 1) Study of habit/morphology of: Spirogyra, Rhizopus, Funaria and Nephrolepis
- 2) Study of habit/morphology of: Cycas and Pinus
- 3) To study a typical flower and floral parts in detail
- 4) To observe a typical plant cell and basic types of tissue
- 5) To study medicinal uses of Turmeric, Tulsi, Aloe, Ginger, Lemon, Amla, Clove, Pepper and Mint
- 6) To stain and observe morphology of Yeast (*Saccharomyces cerevisiae*) by monochrome staining.

Assignments:

1. Study of forest types
2. Importance of organic farming
3. Industrial uses of fungi
4. Study of ornamental plants
5. Traditional herbal medicines
6. Survey of genetically modified crops etc.

References:

1. College Botany, Volume I by Dr. B. P. Pandey, S. Chand Publication
2. College Botany, Volume II by Dr. B. P. Pandey, S. Chand Publication
3. Plant Anatomy by A. Fahn
4. Horticulture: Principles and Practices by George Acquaah, Pearson Edition
5. Handbook on Indian Medicinal Plants by M. C. Joshi, Scientific Publishers
6. Brock Biology of microorganisms, 13th edition, Madigan et al Pg 601-603
7. Microbiology by Pelczar, 5th edition, pg no 352-361
8. Microbiology an introduction by Tortora pg no 331-334

SEMESTER - II
SCIECNE FOUNDATION COURSE II: ZOOLOGY

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Course Outcome

By the end of the course, student will be able to:

1. describe the level of organization
1. explain the characteristics of multicellular organization
2. elaborate the characteristics of aquatic vertebrate animals
3. explain the concept of ecosystem
4. discuss the importance of application of Microscopy

Module I : Diversity of Animal Kingdom

2

Credits

Unit I: Diversity of Animal Kingdom I

- a) Level of organization: -
 - a) Unicellularity, Multi cellularity, Division of labour, Organization of tissue,
 - b) Development of Coelom, symmetry, segmentation and cephalization.
 - c) Unicellular organization: - Protozoa
- b) Multicellular organization
 - a) Colonization level of- Phylum- Porifera
 - b) Division of labour- Phylum-coelenterata
 - c) Triploblastic acoelomate and pseudocoelomate organization: Acoelomate organization - Phylum Platyhelminthe
 - d) Pseudocoelomate organization – Phylum Nematelminthes.
- c) Triploblastic coelomate organization:
 - a) Animals with metameric segmentation- Phylum Annelida.
 - b) Animals with jointed appendages- Phylum Arthropoda

Unit II: Diversity of Animal Kingdom II

- a) Animals with mantle: Phylum Mollusca , Animals with enterocoel: Phylum Echinodermata
- b) Phylum Hemichordata
- c) Phylum: - Chordate
 - a. Subphylum Urochordata
 - b. Subphylum Cephalochordata

Unit III: Diversity of Animal Kingdom III

- a) Diversity of Animal Kingdom aquatic vertebrate animals (Different characteristic features and Classification)
 - a. Subphylum Vertebrata
 - b. Super class: Agnatha- Class Cyclostomata
 - c. Super class: Gnathostomata
 - d. Class Pisces (Cartilaginous and bony fish)
- b) Diversity of Animal Kingdom in terrestrial vertebrate animals (Different characteristic features and Classification)
 - a. Subphylum Vertebrata
 - b. Class Amphibia
 - c. Class Reptilia
- c) Diversity of Animal Kingdom in terrestrial vertebrate animals (Different characteristic features and Classification)
 - a. Subphylum Vertebrata
 - b. Class Aves

- c. Class Mammalia

Module II: Ecosystem

2 Credits

Unit IV: Ecosystem

- a) Concepts of ecosystem, food chain and food web, Concept of biogeochemical cycles:
 - a. carbon
 - b. oxygen
 - c. water cycles
- b) Concept of Ecosystem, Major and Minor ecosystems, Natural and Artificial Ecosystems
- c) Concepts of animal interactions, Symbiosis: Mutualism, commensalism, parasitism, predation and Antibiosis

Unit V: Concept of Ethology

- a) Introduction to Ethology - Definition, History and Scope of Ethology, Animal behaviour - Innate and Learned behaviour
- b) Ethology II - Types of learning -Habituation, Imprinting and types of imprinting -filial and sexual, Classical conditioning, Instrumental learning and insight learning.
- c) Aspects of animal behaviour- Communication in Bees and Ants, Mimicry and colouration, Migration in fish and schooling behaviour.

Unit VI: Application of Microscopy

- a) Microscopy: - Applications in biological sciences, Principle, instrumentation and working for— Bright field microscope (Parts refractive index , focal length, types of lens ,microscope resolution), Basic staining methods: - Monochrome staining & vital staining
- b) Major Biomolecules of cells - Carbohydrates
 - a. Nomenclature, isomerism and classification, Functions of carbohydrates, Glycosidic bond
 - b. Types of carbohydrates: structure of Monosaccharides: Glucose and fructose.
 - c. Disaccharides: Sucrose and lactose
 - d. Polysaccharides: Starch and glycogen
 - e. Oxidation reaction of CHO gps- Benedicts test

Lipids

- a. Definition, classification of lipids with one examples, Ester linkage
- b. Functions of Lipids, Physical and Chemical properties of lipids
- c. Saturated and Unsaturated fatty acids (one example each)
- d. Phospholipids; general structure, amphiphatic nature and formation of Phospholipid bilayer ,
- c) Major Biomolecules of cells II- Proteins
 - a) Amino acids: Types based on carboxylic, amino and aromatic group with 3 eggs of each type
 - b) Peptide bond, General study of structure of proteins: Primary, secondary, tertiary, and quaternary structure, with one example
 - c) Properties of proteins (solubility , MWt ,Shape, Isoelectric pH, precipitation by salting out , Biuret reaction) Biologically important protein Insulin (structure and Function

Nucleic acids and Nucleotides

- a) Nucleosides and Nucleotides , Watson and Cricks model of DNA , Chargaffs rule , A,B and Z form of DNA .
- b) Types of RNA (m RNA,tRNA,rRNA)and their Functions

Module III- Internal Assessment

2 Credits

S.No	Task	Marks
1	One Assignment /Class test	10 marks
2	Practical and Journal Submission (Any Six Experiments)	30 marks
	Total	40 marks

Any Six Experiments

1. Levels of organization in Animal kingdom
 - a. Symmetry: i) Asymmetric organization: Amoeba, Radial symmetry: Sea anemone, Aurelia and Bilateral symmetry: Planaria / liver fluke
 - b. Acoelomate: T.S. of Planaria / liver fluke
 - c. Pseudocoelomate: T.S. of Ascaris
 - d. Coelomate : T.S. of Earthworm
 - e. Segmentation i) Pseudosegmentation: Tapeworm, Metamerism: Earthworm, Specialization of body parts for division of labour: Head, thorax and abdomen - Insect
 - F) Cephalization i) Cockroach – Head
2. Animal Diversity
 - a) Protozoa : Porifera: Coelenterate:
 - b) Platyhelminthes:
 - c) Nematelminthes: Annelida: Arthropoda:
 - d) Prawn/ crab – Cephalothorax
 - e) Amoeba, Paramecium, Euglena, Plasmodium Leucosolenia, bath sponge, Hydra, Aurelia, sea anemone and any one coral, Planaria, liver fluke and tapeworm, Ascaris- male and female, Nereis, earthworm and leech, Crab, lobster, Lepisma, beetle, dragonfly, butterfly, moth, spider, centipede, millipede
3. Animal Diversity
 - a) Mollusca: Chiton, Dentalium, Pila, bivalve, Sepia and Nautilus
 - b) Echinodermata: Starfish, brittle star, sea urchin, sea cucumber, feather star
 - c) Hemichordata: Balanoglossus
 - d) Urochordata: Herdmania
 - e) Cephalochordata: Amphioxus
 - f) Cyclostomata: Petromyzone/Myxine
 - g) Pisces: Chondrichthyes: - Shark, skates,
 - h) Osteichthyes: - Sciaena,
 - i) Amphibia: Frog, toad, caecilian, salamander
 - j) Reptalia: Chameleon, Calotes, turtle/tortoise, snake, alligator/crocodile.
 - k) Aves: Kite, kingfisher, duck
 - l) Mammalia: Shrew, hedgehog, guinea pig, bat.
4. Study of animal interaction:
 - a) Commensalism: Hermit crab and sea anemone, Echinus and shark
 - b) Mutualism: Termite and Trichonympha
 - c) Antibiosis: Effect of antibiotic on bacterial growth on a petri plate
 - d) Parasitism: Ectoparasite – head louse and bed bug
 - e) Endoparasite: Trichinella spiralis
 - f) Predation: Praying mantis and spider.
5. Study of Honey Bee: -
 - a) Life Cycle of Honey Bee and Bee Hive
 - b) Mouthparts of Honey Bee
 - c) Legs of Honey Bee
 - d) Sting Apparatus of Honey Bee
6. Study of ethological aspects:
 - a) Warning Colouration
 - b) Mimicry
 - c) Communication in animals: Chemical signals and sound signals.
7. Study of parts of Compound microscope and its handling
8. Qualitative detection test - Detection of reducing sugar using Benedicts test, Detection of proteins by Biuret test
9. Field visit

References

1. Biological science, 3rd edition – D.J. Taylor, N. P. O. Green, G. W. Stout. Cambridge University press, Low priced edition.
2. Zoology – S. A. Miller and J. B. Harley, Tata McGraw hill
3. Modern textbook of Zoology: Vertebrates by Kotpal
4. Modern Textbook of Zoology, Invertebrates, Kotpal R. L
5. Vertebrate Zoology Volume I- Jordan and Verm , S. Chand and Co.
6. Invertebrate Zoology Volume II- Jordan and Verma , S. Chand and Co.
7. Invertebrate Zoology- Dhami P. S. and Dhami J. K., R. Chand and Co.
8. Principles of ecology – Odum
9. Ecology – Principle and application – J. L. Chapman and M. J. Reiss, Cambridge University press, Low priced edition.
10. Animal behaviour – David Mc Farland
11. An introduction to animal behaviour, 4th edition - Aubrey Manning and M. S. Dawkins. Cambridge University press, Low priced edition.
12. Animal behaviour – Mohan Arora. Himalaya publication.
13. Animal Behaviour- David McFarland
14. Animal Behaviour- Mohan Arora
15. Animal Behaviour- Reena Mathur
16. An introduction to Animal Behaviour- Dawkins 5. Animal Behaviour-Agarwal
17. Animal Behaviour- Tinbergen
18. Principles of Biochemistry and Molecular biology by Keith Wilson and John Walker.
19. Research Methodology, Methods and Techniques- by C.R. Kothari, Wiley Eastern Ltd. Mumbai
20. Essentials of Ecology, 3rd edition – G. Tyler and Miller Jr. Thompson Books
21. Biodiversity: S.V .S. Rana, Prentice Hall Publications.
22. Principles of Biochemistry, 2005, 2nd and 3rd edn. Lehninger A.L. Nelson D.L. and Cox M.M ,
23. Biochemistry, Dushyant Kumar Sharma, 2010, Narosa Publishing house PVT.Ltd.
24. Fundamentals of Biochemistry, Dr AC Deb, 1983, New Central Book Agency Ltd.
25. A Textbook of Biochemistry, 9th edition, Dr. Rama Rao A.V.S.S and Dr A Suryalakshmi.
26. Text book of biochemistry for medical students , by D M Vasudevan, Sreekumari S, Kanan Vaidyanathan, Sixth ed, 2011, Jaypee brothers medical publishers (p) ltd
27. Biochemistry- G Zubay, Addison Wesley, 1983
28. Biochemistry, L Stryer, 3rd/4th/5th ed, 1989, Freeman and Co. NY
29. Fundamentals of Biochemistry by J.L. Jain, Sunjay Jain and Nitin Jain
30. Prescott, Harley, and Klein's Microbiology, Seventh ed, 2008, Published by McGraw-Hill

(UNIVERSITY OF MUMBAI)

Syllabus for: B. Sc. B. Ed. (Mathematics)

Course Structure

Semester	Module	Title
I	1	Real Numbers
	2	Discrete Mathematics I
	3	Practicals
II	1	Single Variable Calculus I
	2	Statistical Methods and Applications
	3	Practicals
III	1	Ordinary Differential Equations
	2	Linear Algebra I
	3	Practicals
IV	1	Single Variable Calculus II
	2	Linear Algebra II
	3	Practicals
V	1	Multivariable Calculus I
	2	Linear Algebra III
	3	Practicals
VI	1	Multiple Integration
	2	Group Theory
	3	Practicals

Semester	Paper	Module	Title
VII	Paper I	1	Complex Analysis
		2	Discrete Mathematics II
		3	Practicals
	Paper II	4	Metric Topology I
		5	Metric Topology II
		6	Practicals
VIII	Paper I	1	Single Variable Calculus III
		2	Numerical Methods
		3	Practicals
	Paper II	4	Elementary Number Theory
		5	Graph Theory
		6	Practicals

Foundation Course

Semester	Module	Title
I	1	Arithmetic, commercial arithmetic, basic algebra
	2	Linear equations and graphing, Mensuration, Elementary statistics
	3	Practicals
II	1	Set theory, functions, logarithmic and exponential functions
	2	polynomials, lines and planes, statistics
	3	Practicals

SEMESTER I
COURSE I: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment Theory: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Module 1 Real Numbers

Learning Outcomes:

Learner will understand the basic properties of real numbers. Real numbers forms the foundation of many advanced concepts in mathematics.

Unit I Real Number System

- (a) Real number system $\mathbb{R}$ and order properties of $\mathbb{R}$, absolute value $||$ and its properties.
- (b) Intervals and neighbourhoods. deleted neighbourhood interior points, Hausdorff property.
- (c) Bounded sets, statements of I.u.b. axiom and its consequences, supremum and infimum, maximum and minimum, Archimedean property(only statement) and its applications, density of rationals. (only statement)

Unit II Sequences of real numbers

- (a) Definition of a sequence and examples, Convergence of sequences, boundedness of sequences. Every convergent sequences is bounded. Limit of a convergent sequence and uniqueness of limit. Divergent sequences.
- (b) Convergence of standard sequences like $\left(\frac{1}{1+na}\right) \forall a > 0$, $(b^n) \forall b, 0 < b < 1$, $(c^{\frac{1}{n}}) \forall c > 0$, & $(n^{\frac{1}{n}})$ (without proof).
- (c) Algebra of convergent sequences, sandwich theorem, monotone sequences, monotone convergence theorem (without proof) and consequences, convergence of $\left(\left(1 + \frac{1}{n}\right)^n\right)$.

Unit III Series of real numbers

- (a) Infinite series in $\mathbb{R}$. Definition of convergence and divergence. Basic examples including geometric series. Elementary results such as if $\sum_{n=1}^{\infty} a_n$ is convergent, then $a_n \rightarrow 0$ but converse not true. Cauchy Criterion. Algebra of convergent series.
- (b) Tests for convergence(only statements): Comparison Test, Limit Comparison Test, Ratio Test proof), Root Test. Examples. The decimal expansion of real numbers. Convergence of $\sum_{n=1}^{\infty} \frac{1}{n^p}$ ($p > 1$). Divergence of harmonic series $\sum_{n=1}^{\infty} \frac{1}{n}$.
- (c) Alternating series. Leibnitz's Test. Examples. Absolute convergence, absolute convergence implies convergence but not conversely. Conditional Convergence.

Reference Books:

1. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.

-
2. K. G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.
 3. R. G. Bartle- D. R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.
 4. Sudhir Ghorpade and Balmohan Limaye, A course in Calculus and Real Analysis, Springer International Ltd, 2000.
 5. G. F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill, 1972.
 6. E. A. Coddington , An Introduction to Ordinary Differential Equations. Prentice Hall, 1961.
 7. W. E. Boyce, R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiley, 2013.

Additional Reference Books

1. T. M. Apostol, Calculus Volume I, Wiley & Sons (Asia) Pte, Ltd.
2. Richard Courant-Fritz John, A Introduction to Calculus and Analysis, Volume I, Springer.
3. James Stewart, Calculus, Third Edition, Brooks/ cole Publishing Company, 1994.
4. D. A. Murray, Introductory Course in Differential Equations, Longmans, Green and Co., 1897.
5. A. R. Forsyth, A Treatise on Differential Equations, MacMillan and Co., 1956.

Module 2 Discrete Mathematics I

Learning Outcomes:

Learner will understand the behaviour of integers. Learner will also study how to establish different types of relations between any two sets.

Unit IV Integres and Divisibility

- (a) Statements of well-ordering property of non-negative integers, Principle of finite induction (first and second) as a consequence of Well-Ordering Principle.
- (b) Divisibility in integers, division algorithm, greatest common divisor (g.c.d.) and least common multiple (l.c.m.) of two non zero integers, basic properties of g.c.d. such as existence and uniqueness of g.c.d. of two non zero integers a & b and that the g.c.d. can be expressed as $ma + nb$ for some $m, n \in \mathbb{Z}$. Euclidean algorithm.
- (c) Primes. Euclid's lemma. Fundamental Theorem of arithmetic (only statement). The set of primes is infinite. There exists infinitely many primes of the form $4n - 1$ or of the form $6n - 1$.
- (d) Congruence, definition and elementary properties. Results about linear congruence equations. Examples.

Unit V Relations and functions

-
- (a) Definition of a relation. Definition of a function. Domain, co-domain and range of a function. Composite functions. Examples. Direct image $f(A)$ and inverse image $f^{-1}(B)$ for a function f . Injective, surjective, and bijective functions. Invertible functions. Bijective functions are invertible and conversely. Examples of functions including constant, identity.
 - (b) Equivalence relation.
Equivalence classes. Properties such as two equivalence classes are either identical or disjoint. Definition of partition. Every partition gives an equivalence relation and vice versa.
 - (c) Congruence is an equivalence relation on $\mathbb{Z}$, Residue classes and partition of $\mathbb{Z}$, Addition modulo n , Multiplication modulo n , examples.

Unit VI Polynomials

- (a) Definition of a polynomial, polynomials over F where $F = \mathbb{Q}, \mathbb{R}$ or $\mathbb{C}$. Algebra of polynomials. Degree of a polynomial. Division algorithm in $F[X]$ (without proof). G.C.D of two polynomials.
- (b) Roots of a polynomial. Relation between roots and coefficients. Multiplicity of a root. Elementary consequences such as the following.
 - (i) Remainder theorem, Factor theorem.
 - (ii) A polynomial of degree n has at most n roots (without proof).
 - (iii) Complex and non-real roots of a polynomials in $\mathbb{R}[X]$ occur in conjugate pairs. (without proof)
 (Emphasis on examples and problems in polynomials with real coefficients).
- (c) Necessary condition for a rational number $\frac{p}{q}$ to be a root of a polynomial with integer coefficients (viz. p divides the constant coefficient and q divides the leading coefficient). Simple consequence such as the irrationality is necessarily of $\sqrt{p}$ for any prime number p . Irreducible polynomials in $\mathbb{Q}[x]$,. Unique Factorisation Theorem (without proof). Examples.

Reference Books:

1. David M. Burton, Elementary Number Theory, Seventh Edition, McGraw Hill Education (India) Private Ltd.
2. Norman L. Biggs, Discrete Mathematics, Revised Edition, Clarendon Press, Oxford 1989.

Additional Reference Books

1. I. Niven and S. Zuckerman, Introduction to the theory of numbers, Third Edition, Wiley Eastern, New Delhi, 1972.
2. G. Birkoff and S. MacLane, A Survey of Modern Algebra, Third Edition, Mac Millan, New York, 1965.
3. N. S. Gopalkrishnan, University Algebra, Ne Age International Ltd, Reprint 2013.
4. I .N. Herstein, Topics in Algebra, John Wiley, 2006.

-
5. P. B. Bhattacharya S. K. Jain and S. R. Nagpaul, Basic Abstract Algebra, New Age International, 1994.
 6. Kenneth Rosen, Discrete Mathematics and its applications, Mc-Graw Hill, International Edition, Mathematics Series.

Module 3

(A) Suggested Practical topics

- (1) Algebraic and Order Properties of Real Numbers and Inequalities, Hausdorff Property and LUB Axiom of $\mathbb{R}$, Archimedian Property.
- (2) Convergence and divergence of sequences, bounded sequences, Sandwich Theorem. Monotonic sequences, non-monotonic sequences.
- (3) Examples of convergent / divergent series and algebra of convergent series. Tests for convergence of series.
- (4) Mathematical induction, Division Algorithm, Euclidean algorithm in $\mathbb{Z}$, Examples on expressing the gcd. of two non zero integers a & b as $ma + nb$ for some $m, n \in \mathbb{Z}$. Primes and the Fundamental theorem of Arithmetic. Euclid's lemma. There exists infinitely many primes of the form $4n - 1$ or of the form $6n - 1$.
- (5) Functions, Bijective and Invertible functions. Compositions of functions. Equivalence Relations, Partition and Equivalence classes.
- (6) Polynomials.

XXXXXX

Task

- | | |
|-------|---|
| 1 | One Assignment /Class test - 10 marks |
| 2 | Practical and Journal Submission (Six Practical) 30 marks |
| Total | 40 marks |

SEMESTER II
COURSE II: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment Theory: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Module 1 Single Variable Calculus I

Learning outcomes:

Learners will understand the concept of rate of change in the motion of an object and its applications.

Unit I Limits and continuity

- (a) Graphs of some standard functions such as $|x|$, e^x , $\log x$, $ax^2 + bx + c$, $\frac{1}{x}$, x^n $n \geq 3$, $\sin x$, $\cos x$, $\tan x$, $\sin\left(\frac{1}{x}\right)$, $x^2 \sin\left(\frac{1}{x}\right)$ over suitable intervals of $\mathbb{R}$.
- (b) $\varepsilon - \delta$ definition of Limit of a function at a point in a domain containing a deleted neighbourhood of that point. Uniqueness of limit if it exists. Algebra of limits. Limits of composite function. Sandwich theorem. Left-hand-limit $\lim_{x \rightarrow a^-} f(x)$, right-hand-limit $\lim_{x \rightarrow a^+} f(x)$, non-existence of limits, $\lim_{x \rightarrow -\infty} f(x)$, $\lim_{x \rightarrow \infty} f(x)$ and $\lim_{x \rightarrow a} f(x) = \pm\infty$.
- (c) Continuous functions: Continuity of a real valued function at a point and on a set using $\varepsilon - \delta$ definition. Examples. Continuity of a real valued function at end points of the domain using $\varepsilon - \delta$ definition. f is continuous at a if and only if $\lim_{x \rightarrow a} f(x)$ exists and equals to $f(a)$. Sequential continuity (without proof). Examples. Algebra of continuous functions. Discontinuous functions. Examples.

Unit II Differentiability

- (a) Differentiation of real valued function of one variable: Definition of differentiability of a function at a point of an open interval. Examples of differentiable and non differentiable functions. Differentiable functions are continuous but not conversely. Algebra of differentiable functions.
- (b) Chain rule, Higher order derivatives. Leibniz rule.
- (c) Derivative of inverse functions(only examples). Implicit differentiation (only examples)

Unit III Applications of differentiability

- (a) Rolle's Theorem, Lagrange's and Cauchy's Mean Value Theorems and their applications and examples. Monotone increasing and decreasing functions. Examples.
- (b) L-Hospital rule (without proof). Examples of indeterminate forms. Taylor's theorem with Lagrange's form of remainder (only statement), Taylor polynomial and applications.
- (c) Definition of critical point. Local maximum/minimum and necessary condition. Stationary points. Second derivative test. Examples. Concave/convex functions. Point of inflection.

Reference Books:

-
1. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.
 2. K. G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.
 3. R. G. Bartle- D. R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.
 4. Sudhir Ghorpade and Balmohan Limaye, A course in Calculus and Real Analysis, Springer International Ltd, 2000.
 5. G. F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill, 1972.
 6. E. A. Coddington , An Introduction to Ordinary Differential Equations. Prentice Hall, 1961.
 7. W. E. Boyce, R. C. DiPrima, Elementary Differential Equations and Boundary Value Problems, Wiley, 2013.

Module 2 Statistical Methods and Applications

Learning outcomes:

Learner will know how to study a data available to him/her using the statistical techniques.

Unit I Descriptive Statistics and random variables

- (a) Measures of location (mean, median, mode), Partition values and their graphical locations.
- (b) Measures of dispersion, skewness and kurtosis. Exploratory Data Analysis (Five number summary, Box Plot, Outliers)
- (c) Random Variables (discrete and continuous). Expectation and variance of a random variable.

Unit II Probability Distributions and Correlation

- (a) Discrete Probability Distribution (Binomial, Poisson).
- (b) Continuous Probability Distribution: (Uniform, Normal).

Unit III Correlation

- (a) Correlation, Karl Pearson's Coefficient of Correlation, Concept of linear Regression.
- (b) Fitting of a straight line and curve to the given data by the method of least squares, relation between correlation coefficient and regression coefficients.

Reference Books

1. Fundamentals of Mathematical Statistics, 12th Edition, S. C. Gupta and V. K. Kapoor, Sultan Chand & Sons, 2020.
2. Statistics for Business and Economics, 11th Edition, David R. Anderson, Dennis J. Sweeney and Thomas A. Williams, Cengage Learning, 2011.
3. Introductory Statistics, 8th Edition, Prem S. Mann, John Wiley & Sons Inc., 2013.

-
4. A First Course in Statistics, 12th Edition, James McClave and Terry Sincich, Pearson Education Limited, 2018.
 5. Introductory Statistics, Barbara Illowsky, Susan Dean and Laurel Chiappetta, OpenStax, 2013.
 6. Hands-On Programming with R, Garrett Grolmund, O'Reilly.

Module 3

(A) Suggested Practical topics

- (1) Limit of a function and Sandwich theorem, Continuous and discontinuous function. Algebra of limits and continuous functions,
- (2) Properties of differentiable functions, Higher order derivatives, Leibniz Rule, derivatives of inverse functions and implicit functions.
- (3) Mean value theorems and its applications, L'Hospital's Rule, Increasing and Decreasing functions. Maxima-minima, 2nd derivative test. Taylor's Polynomial.
- (4) Descriptive Statistics, Random Variables.
- (5) probability Distributions.
- (6) Correlation and Regression.

Task

1	One Assignment /Class test - 10 marks
2	Practical and Journal Submission (Six Practical) 30 marks
Total 40 marks	

XXXXX

SEMESTER III
COURSE III: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment Theory: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Module 1 Ordinary Differential Equations

Learning Outcomes: Learner will be able to classify and solve the ordinary differential equations according to the order. Learner will be able to apply the concepts of ODE to biological sciences and physics.

Unit I First order first degree differential equations

- (a) Definition of a differential equation, order, degree, ordinary differential equation and partial differential equation, linear and non linear ODE. Solution of homogeneous and non-homogeneous differential equations of first order and first degree.
- (b) Exact Equations: General solution of Exact equations of first order and first degree. Necessary and sufficient condition for $Mdx + Ndy = 0$ to be exact. Non-exact equations: Rules for finding integrating factors (without proof) for non exact equations, such as :
 - i) $\frac{1}{Mx + Ny}$ is an I.F. if $Mx + Ny \neq 0$ and $Mdx + Ndy = 0$ is homogeneous.
 - ii) $\frac{1}{Mx - Ny}$ is an I.F. if $Mx - Ny \neq 0$ and $Mdx + Ndy = 0$ is of the form $f_1(x, y) y dx + f_2(x, y) x dy = 0$.
 - iii) $e^{\int f(x) dx}$ (resp $e^{\int g(y) dy}$) is an I.F. if $N \neq 0$ (resp $M \neq 0$) and $\frac{1}{N} \left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x} \right)$ (resp $\frac{1}{M} \left(\frac{\partial M}{\partial y} - \frac{\partial N}{\partial x} \right)$) is a function of x (resp y) alone, say $f(x)$ (resp $g(y)$).
- (c) Linear equations of first order, Bernoulli's equations. Applications to orthogonal trajectories, population growth, and finding the current at a given time.

Unit II Second order Linear Differential equations

- 1. Homogeneous and non-homogeneous second order linear differentiable equations: The space of solutions of the homogeneous equation as a vector space. Wronskian and linear independence of the solutions. The general solution of homogeneous differential equations. The general solution of a non-homogeneous second order equation. Complementary functions and particular integrals.
- 2. The homogeneous equation with constant coefficients. auxiliary equation. The general solution corresponding to real and distinct roots, real and equal roots and complex roots of the auxiliary equation.
- 3. Non-homogeneous equations: The method of undetermined coefficients. The method of variation of parameters.

Unit III Higher order linear differential equations

- (a) The general n -th order linear differential equations, Linear independence, Existence and uniqueness theorem, Classification: homogeneous and non-homogeneous. Wronskian. Properties of Wronskian. General solution of homogeneous and non-homogeneous LDE, The Differential operator and its properties. (proofs can be done for $n = 2$)

-
- (b) Higher order homogeneous linear differential equations with constant coefficients, the auxiliary equations, Roots of the auxiliary equations: real and distinct, real and repeated, complex and complex repeated.
- (c) The inverse differential operator and particular integral. Evaluation of $\frac{1}{f(D)}$ for the functions like $e^{\alpha x}$, $\sin ax$, $\cos ax$, x^m , $e^{\alpha x}V$ and xV where V is any function of x where $f(D)$ is a differential operator with constant coefficients. Cauchy's equation: $a_0x^3\frac{d^3y}{dx^3} + a_1x^2\frac{d^2y}{dx^2} + a_2x\frac{dy}{dx} + a_3y = f(x)$, $a_0, a_1, a_2, a_3 \in \mathbb{R}$.

Reference Books

1. E.D. Rainville and P.E. Bedient; Elementary Differential Equations; Macmillan.
2. Raisinghania; Ordinary and Partial Differential Equations; S. Chand.
3. G.F. Simmons; Differential Equations with Applications and Historical Notes; Taylor's and Francis.
4. Elementary Differential Equations and Boundary Value Problems; Boyce DiPrima; John Wiley & Sons (Asia) Pte Ltd.

Module 2 Linear algebra I

Learning Outcomes:

Learner will be able to examine existence and uniqueness of solutions of system of equations and apply them to real life problems. Learner will be exposed to concept of dimensions of vector space

Unit IV System of Equations, Matrices

- (a) Parametric equation of lines and planes. System of homogeneous and non-homogeneous linear equations. The solution of system of m homogeneous linear equations in n unknowns by elimination and their geometrical interpretation for $(n, m) = (1, 2), (1, 3), (2, 2), (2, 3), (3, 3)$. Definition of n -tuples of real numbers, sum of two n -tuples and scalar multiple of an n -tuple.
- (b) Matrices with real entries; addition, scalar multiplication and multiplication of matrices; transpose of a matrix, types of matrices: zero matrix, identity matrix, scalar matrices, diagonal matrices, upper triangular matrices, lower triangular matrices, symmetric matrices, skew-symmetric matrices, Invertible matrices; identities such as $(AB)^t = B^tA^t$, $(AB)^{-1} = B^{-1}A^{-1}$.
- (c) System of linear equations in matrix form, elementary row operations, row echelon matrix, Gaussian elimination method, to deduce that the system of m homogeneous linear equations in n unknowns has a non-trivial solution if $m < n$.

Unit V Vector space over $\mathbb{R}$

- (a) Definition of a real vector space. Examples such as $\mathbb{R}^n$, $\mathbb{R}[X]$, $M_{mn}(\mathbb{R})$, space of all real valued functions on a non empty set. Subspace: definition, examples such as lines, planes passing through origin as sub-spaces of $\mathbb{R}^2$, $\mathbb{R}^3$ respectively. Upper triangular matrices, diagonal matrices, symmetric matrices, skew-symmetric matrices as subspaces

of $M_n(\mathbb{R})$ ($n = 2, 3$); $P_n(X) = \{a_0 + a_1x + \dots + a_nx^n \mid a_i \in \mathbb{R}, 0 \leq i \leq n\}$ as a subspace $\mathbb{R}[X]$. The space of all solutions of the system of m homogeneous linear equations in n unknowns as a subspace of $\mathbb{R}^n$.

- (b) Properties of a subspace. Necessary and sufficient condition for a non empty subset to be a subspace of a vector space. Arbitrary intersection of sub-spaces of a vector space is a subspace. Union of two subspaces is a subspace if and only if one is a subset of the other.
- (c) Finite linear combinations of vectors in a vector space. The linear span $L(S)$ of a non-empty subset S of a vector space. S is a generating set for $L(S)$. $L(S)$ is a vector subspace of V . Linearly independent/linearly dependent subsets of a vector space. A subset $\{v_1, v_2, \dots, v_k\}$ of a vector space is linearly dependent if and only if there is $i \in \{1, 2, \dots, k\}$ such that v_i is a linear combination of the other vectors v_j .

Unit VI Basis and dimension

- (a) Basis of a vector space, maximal linearly independent subset of a vector space is a basis of a vector space. Minimal generating set of a vector space is a basis of a vector space. Any two bases of a vector space have the same number of elements. Dimension of a vector space. Any set of n linearly independent vectors in an n -dimensional vector space is a basis. Any collection of $n + 1$ linearly independent vectors in an n -dimensional vector space is linearly dependent.
- (b) if W_1, W_2 are two subspaces of a vector space V then $W_1 + W_2$ is a subspace of the vector space V of dimension $\dim(W_1) + \dim(W_2) - \dim(W_1 \cap W_2)$. Extending any basis of a subspace W of a vector space V to a basis of the vector space V .
- (c) Row space, column space of a matrix, row rank and column rank of a matrix, Equivalence of the row and the column rank, Invariance of rank upon elementary row or column operations.

Reference books

1. Howard Anton, Chris Rorres, Elementary Linear Algebra, Wiley Student Edition).
2. Serge Lang, Introduction to Linear Algebra, Springer.
3. S Kumaresan, Linear Algebra - A Geometric Approach, PHI Learning.
4. Sheldon Axler, Linear Algebra done right, Springer.
5. Gareth Williams, Linear Algebra with Applications, Jones and Bartlett Publishers.
6. David W. Lewis, Matrix theory.

Module 3

(A) Suggested Practical topics

- (1) Solving exact and non-exact, first order first degree linear differential equations, Bernoulli's equations.
- (2) Solving second order linear differential equations with constant coefficients, solving second order differential equations using UDC method and method of variation of parameter.

-
- (3) Solving higher order differential equations using differential operators. Solving non-homogeneous differential equations using inverse operator. Solving Cauchy's equation.
 - (4) Systems of homogeneous and non-homogeneous linear equations. Elementary row/column operations and Elementary matrices.
 - (5) Vector spaces, Subspaces, Linear Dependence/independence.
 - (6) Finding basis of a vector space/subspace. Finding dimension of a vector space/subspace.

xxxxx

Task

- | | |
|----------------|---|
| 1 | One Assignment /Class test - 10 marks |
| 2 | Practical and Journal Submission (Six Practical) 30 marks |
| Total 40 marks | |

SEMESTER IV
COURSE IV: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment Theory: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Module 1 Single Variable Calculus II

Learning outcomes:

Learner will be able to identify Riemann integrable functions and test the convergence of improper integrals. Also will be exposed to some applications of integration.

Unit I Unit I Riemann Integration

- (a) Idea of approximating the area under a curve by inscribed and circumscribed rectangles. Partitions of an interval. Refinement of a partition. Upper and Lower sums for a bounded real valued function on a closed and bounded interval. Riemann integrability and the Riemann integral. Criterion for Riemann integrability (only statement). Characterization of the Riemann integral as the limit of a sum (only statement). Examples.
- (b) Algebra of Riemann integrable functions. Also, basic results such as if $f : [a, b] \rightarrow \mathbb{R}$ is integrable, then (i) $\int_a^b f(x) dx = \int_a^c f(x) dx + \int_c^b f(x) dx$. (ii) $|f|$ is integrable and $\left| \int_a^b f(x) dx \right| \leq \int_a^b |f|(x) dx$ (iii) If $f(x) \geq 0$ for all $x \in [a, b]$ then $\int_a^b f(x) dx \geq 0$.
- (c) Riemann integrability of a continuous function, and more generally of a bounded function whose set of discontinuities has only finitely many points. Riemann integrability of monotone functions.

Unit II Applications of Integrations

- (a) Area between the two curves. Lengths of plane curves. Surface area of surfaces of revolution.
- (b) Continuity of the function $F(x) = \int_a^x f(t) dt, x \in [a, b]$, when $f : [a, b] \rightarrow \mathbb{R}$ is Riemann integrable. First and Second Fundamental Theorems of Calculus.
- (c) Mean value theorem. Integration by parts formula. Leibnitz's Rule.

Unit III Improper Integrals

- (a) Definition of two types of improper integrals. Necessary and sufficient conditions for convergence.
- (b) Absolute convergence. Comparison and limit comparison tests for convergence.
- (c) Gamma and Beta functions and their properties. Relationship between them (without proof).

1. Sudhir Ghorpade, Balmohan Limaye; A Course in Calculus and Real Analysis (second edition); Springer.

-
2. R.R. Goldberg; Methods of Real Analysis; Oxford and IBH Pub. Co., New Delhi, 1970.
 3. Calculus and Analytic Geometry (Ninth Edition); Thomas and Finney; Addison-Wesley, Reading Mass., 1998.
 4. T. Apostol; Calculus Vol. 2; John Wiley.

Additional Reference Books

1. Ajit Kumar, S.Kumaresan; A Basic Course in Real Analysis; CRC Press, 2014
2. D. Somasundaram and B.Choudhary; A First Course in Mathematical Analysis, Narosa, New Delhi, 1996.
3. K. Stewart; Calculus, Booke/Cole Publishing Co, 1994.
4. J. E. Marsden, A.J. Tromba and A. Weinstein; Basic Multivariable Calculus; Springer.
5. R.G. Brtles and D. R. Sherbert; Introduction to Real Analysis Second Ed. ; John Wiley, New York, 1992.
6. M. H. Protter; Basic Elements of Real Analysis; Springer-Verlag, New York, 1998.

Module 2 Linear Algebra II

Learning Outcomes:

A learner will study linear transformations, matrices and determinants and their applications.

Unit IV Linear Transformations

- (a) Definition of a linear transformation of vector spaces; elementary properties. Examples. Sums and scalar multiples of linear transformations. Composites of linear transformations.
- (b) A Linear transformation of $V \longrightarrow W$, where V, W are vector spaces over $\mathbb{R}$ and V is a finite-dimensional vector space is completely determined by its action on an ordered basis of V .
- (c) Null-space (kernel) and the image (range) of a linear transformation. Nullity and rank of a linear transformation. Rank-Nullity Theorem (Fundamental Theorem of Homomorphisms).

Unit V Matrix associated with a linear transformation, Rank of a matrix

- (a) Matrix associated with linear transformation of $V \longrightarrow W$ where V and W are finite dimensional vector spaces over $\mathbb{R}$. Matrix of the composite of two linear transformations. Invertible linear transformations (isomorphisms)
- (b) Linear operator, Effect of change of bases on matrices of linear operator.
- (c) Equivalence of the rank of a matrix and the rank of the associated linear transformation.
- (d) Row space and column space of a matrix, row rank and column rank of a matrix, equivalence of the row rank and the column rank, invariance of rank upon elementary row or column operations.

-
- (e) $\mathbb{R}^n$ is the space of column vectors $x = \begin{pmatrix} x_1 \\ x_2 \\ \vdots \\ x_n \end{pmatrix}$ where each $x_j \in \mathbb{R}, 1 \leq j \leq n$. Equivalence of rank of an $n \times n$ matrix and rank of the linear transformation $L_A : \mathbb{R}^n \rightarrow \mathbb{R}^n (L_A(x) = Ax \text{ for all } x \in \mathbb{R}^n)$. The dimension of the solution space of the system of linear equations $Ax = 0$ equals $n - \text{rank}(A)$.
- (f) The solutions of non-homogeneous system of linear equations represented by $Ax = b$; existence of a solution when $\text{rank}(A) = \text{rank}(A, b)$; the general solution of the system is the sum of a particular solution of the system and the solutions of the associated homogeneous system.

Unit VI Determinants

- (a) Determinant $A(A^1, A^2)$ of order 2 and its properties: Determinant is a function of column vectors. Determinant is a linear function. If the two columns are identical, then the determinant is equal to 0. If I is the unit matrix, $I = (E^1, E^2)$ then $D(E^1, E^2) = 1$.
- (b) Results on Determinants of order 2:
- (a) If one adds a scalar multiple of one column to the other column, then the value of the determinant does not change.
 - (b) The determinant of A is equal to the determinant of its transpose.
 - (c) Two vectors A^1, A^2 of $\mathbb{R}^2$ are linearly dependent if and only if the determinant $D(A^1, A^2) = 0$.
 - (d) Let ϕ be a function of variables $A^1, A^2 \in \mathbb{R}^2$ such that ϕ is bilinear (i.e. ϕ is linear in each variable), $\phi(A^1, A^1) = 0$ for all $A^1 \in \mathbb{R}^2$ and $\phi(E^1, E^2) = 1$ where $E^1 = \begin{pmatrix} 1 \\ 0 \end{pmatrix}, E^2 = \begin{pmatrix} 0 \\ 1 \end{pmatrix}$ are the standard unit vectors of $\mathbb{R}^2$, then $\phi(A^1, A^2)$ is the determinant $D(A^1, A^2)$.
- (c) Determinants of order $3 \times 3, \dots, n \times n$ as the expansion of the determinant according to i -th row. Results (without proof): For two $n \times n$ matrices $A, B, \det(A) = \det(A^t), \det(AB) = \det A \cdot \det(B)$.
- (d) Linear dependence and independence of vectors in $\mathbb{R}^n$ using determinants. The existence and uniqueness of the system $AX = B$, where A is an $n \times n$ matrix with $\det A \neq 0$. Cofactors and minors, Adjoint of an $n \times n$ matrix. Basic results such as $A \text{adj}(A) = \det(A)I_n$ (without proof). An $n \times n$ real matrix is invertible if and only if $\det A \neq 0, A^{-1} = \frac{1}{\det(A)} \text{adj}(A)$ for an invertible matrix A (without proof). Cramer's rule.

Reference books

1. Howard Anton, Chris Rorres, Elementary Linear Algebra, Wiley Student Edition).
2. Serge Lang, Introduction to Linear Algebra, Springer.
3. Kenneth Hoffman, Ray Kunze, Linear Algebra, Pearson Education
4. S Kumaresan, Linear Algebra - A Geometric Approach, PHI Learning.
5. Sheldon Axler, Linear Algebra done right, Springer.

-
6. Gareth Williams, Linear Algebra with Applications, Jones and Bartlett Publishers.
 7. David W. Lewis, Matrix theory.

Module 3

(A) Suggested Practical topics

- (1) Calculation of upper sum, lower sum and Riemann integral, Problems on properties of Riemann integral.
- (2) Problems on fundamental theorem of calculus, mean value theorems, integration by parts, Leibnitz rule.
- (3) Convergence of improper integrals, different tests for convergence. Beta Gamma Functions.
- (4) Rank-Nullity Theorem. System of linear equations.
- (5) Computation of row rank and column rank of 3×3 matrices. Calculating determinants of matrices, triangular matrices using definition.
- (6) Finding inverse of matrices using adjoint.

xxxxxx

Task

- | | | |
|---|--|-----------------|
| 1 | One Assignment /Class test - 10 marks | |
| 2 | Practical and Journal Submission (Six Practical) | 30 marks |
| | Total | 40 marks |

SEMESTER V
COURSE V: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment Theory: 40 (Practical 30+ Class Test / Assignment - 10)

External Assessment Practical: 30

Module 1 Multivariable Calculus I

Learning Outcomes:

Learner will be able to compare properties of functions of several variables with those of functions of one variable and will be able to apply the concept of differentiability to other sciences.

Unit I Functions of Several Variables

- (a) Real-valued functions of several variables (Scalar fields). Examples. Vector valued functions of several variables (Vector fields). Component functions. Examples.
- (b) Sequence in $\mathbb{R}^n$ [with emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$] and their limits. Neighbourhoods in $\mathbb{R}^n$. Limits and continuity of scalar fields. Composition of continuous functions. Sequential characterizations. Algebra of limits and continuity (Results with proofs). Iterated limits. Limits and continuity of vector fields. Algebra of limits and continuity vector fields. (without proofs).
- (c) Partial and Directional Derivatives of scalar fields: Definitions of partial derivative and directional derivative of scalar fields (with emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$).

UNIT II Differentiation of Scalar Fields

- (a) Differentiability of scalar fields (in terms of linear transformation). The concept of (total) derivative. Basic properties including (i) continuity at a point of differentiability, (ii) existence of partial derivatives at a point of differentiability, and (iii) differentiability when the partial derivatives exist and are continuous.
- (b) Gradient. Relation between total derivative and gradient of a function. Chain rule. Geometric properties of gradient.
- (c) Higher order partial derivatives. Mixed Partial Theorem ($n=2$).

UNIT III Applications of Differentiation of Scalar Fields and Differentiation of Vector Fields

- (a) Applications of Differentiation of Scalar Fields: The maximum and minimum rate of change of scalar fields. Notions of local maxima, local minima and saddle points. First Derivative Test. Examples.
- (b) Hessian matrix. Second Derivative Test for functions of two variables. Examples. Method of Lagrange Multipliers.
- (c) Applications of Differentiation of Vector Fields: Jacobian matrix. Relationship between total derivative and Jacobian matrix. The chain rule for derivative of vector fields (statements only).

Module 2 Linear Algebra III

Learning Outcomes:

Learner will be able to identify inner product spaces, understand the geometry of vectors and will be able to outline properties of inner products. Learner will also be able to compute Eigen values and Eigen vectors of a matrix and use these ideas to explore some geometric ideas.

UNIT IV Inner Products

- (a) Inner product spaces (over $\mathbb{R}$). Examples, including the Euclidean space $\mathbb{R}^n$ and the space of real valued continuous functions on a closed and bounded interval. Norm associated to an inner product. Cauchy-Schwarz inequality. Triangle inequality.
- (b) Angle between two vectors. Orthogonality of vectors. Pythagoras theorem and some geometric applications in $\mathbb{R}^2$. Orthogonal sets, Orthonormal sets. Gram-Schmidt orthogonalization process.
- (c) Orthogonal basis and orthonormal basis for a finite-dimensional inner product space. Orthogonal complement of any set of vectors in an inner product space. Orthogonal complement of a set is a vector subspace of the inner product space. Orthogonal decomposition of an inner product space with respect to its subspace. Orthogonal projection of a vector onto a line (one dimensional subspace). Orthogonal projection of an inner product space onto its subspace.

Unit V Eigenvalues and eigenvectors

- (a) Eigenvalues and eigenvectors of a linear transformation of a vector space into itself and of square matrices. The eigenvectors corresponding to distinct eigenvalues of a linear transformation are linearly independent. Eigen spaces. Algebraic and geometric multiplicity of an eigenvalue.
- (b) Characteristic polynomial. Properties of characteristic polynomials (only statements). Examples. Cayley-Hamilton Theorem (only statement) and its applications.
- (c) Invariance of the characteristic polynomial and eigenvalues of similar matrices. Minimal Polynomial of a matrix, Examples.

Unit VI Diagonalisation

- (a) Diagonalisable matrix. A real square matrix A is diagonalisable if and only if there is a basis of $\mathbb{R}^n$ consisting of eigenvectors of A . (Statement only - $A_{n \times n}$ is diagonalisable if and only if sum of algebraic multiplicities is equal to sum of geometric multiplicities of all the eigenvalues of $A = n$). Procedure for diagonalising a matrix. Examples of non diagonalizable matrices.
- (b) Diagonalisation of a linear transformation $T : V \rightarrow V$, where V is a finite dimensional real vector space and examples. Orthogonal diagonalisation.
- (c) Quadratic Forms. Diagonalisation of real Symmetric matrices, Examples. Applications to real Quadratic forms. Rank and Signature of a Real Quadratic form.

Module 3

(A) Suggested Practical topics

- (1) Limits and continuity of scalar fields and vector fields, using "definition and otherwise", Computing directional derivatives, partial derivatives.
- (2) Differentiability of scalar field, Total derivative, gradient. Chain rule. Higher order partial derivatives and mixed partial derivatives of scalar fields.
- (3) Maximum and minimum rate of change of scalar fields. Finding Hessian/Jacobian matrix. Differentiation of a vector field at a point. Finding maxima, minima and saddle points. Second derivative test for extrema of functions of two variables and method of Lagrange multipliers.
- (4) Inner product spaces, examples. Gram-Schmidt method.
- (5) Eigen Values & Eigen Vectors of a linear Transformation/ Square Matrices. Similar Matrices. Minimal Polynomial.
- (6) Diagonalisation of a matrix, Orthogonal Diagonalisation and Quadratic Forms.

xxxxx

Task

- | | |
|---|---|
| 1 | One Assignment /Class test - 10 marks |
| 2 | Practical and Journal Submission (Six Practical) 30 marks |
| | Total 40 marks |

SEMESTER VI
COURSE VI: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment Theory: 60

Internal Assessment Theory: 40 (Practical 30+ Class Test / Assignment
- 10)

External Assessment Practical: 30

Module 1 Multiple Integration

Learning Outcomes:

Learner will be able to apply concepts of multiple integrals, Line and Surface integrals in other disciplines like Physics.

Unit I Unit I: Multiple Integrals

- (a) Definition of double (respectively: triple) integral of a function bounded on a rectangle (respectively: box). Geometric interpretation as area and volume.
- (b) Fubini's Theorem over rectangles and any closed bounded sets, Iterated Integrals. Basic properties of double and triple integrals (only statements) such as; Integrability of the sums, scalar multiples, products, and (under suitable conditions) quotients of integrable functions. Formulae for the integrals of sums and scalar multiples of integrable functions. Integrability of continuous functions. More generally, integrability of bounded functions having finite number of points of discontinuity, Domain additivity of the integral. Integrability and the integral over arbitrary bounded domains.
- (c) Change of variables formula (Statement only), Polar, cylindrical and spherical coordinates and integration using these coordinates.

Unit II Line Integrals

- (a) Review of Scalar and Vector fields on $\mathbb{R}^n$. Vector Differential Operators, Gradient Paths (parametrized curves) in $\mathbb{R}^n$ (emphasis on $\mathbb{R}^2$ and $\mathbb{R}^3$). Smooth and piecewise smooth paths. Closed paths. Equivalence and orientation preserving equivalence of paths.
- (b) Definition of the line integral of a vector field over a piecewise smooth path. Basic properties of line integrals (only statements) including linearity, path-additivity and behaviour under a change of parameters. Examples.
- (c) Line integrals of the gradient vector field, Fundamental Theorem of Calculus for Line Integrals, Necessary and sufficient conditions (only statement) for a vector field to be conservative, Green's Theorem (only statement). Applications to evaluation of line integrals.

Unit III Surface integrals

- (a) Parameterized surfaces. Smoothly equivalent parameterizations, Area of such surfaces.
- (b) Definition of surface integrals of scalar-valued functions as well as of vector fields defined on a surface.
- (c) Curl and divergence of a vector field, Elementary identities involving gradient, curl and divergence. Examples.

Module 2 Group Theory

Learning Outcomes:

Learner will be able to examine properties of groups, subgroups, cyclic groups and explore some applications of Lagrange's theorem.

Unit I Groups

- (a) Definition of a group, abelian group, order of a group, finite and infinite groups. Order of a group.
- (b) Examples of groups including: $\mathbb{Z}_n$, the set of residue classes modulo n under addition, $U(n)$, the group of prime residue classes modulo n under multiplication, the symmetric group S_n , the Dihedral group D_n , Klein 4-group. Matrix groups $M_{n \times n}(\mathbb{R})$ under addition of matrices, $GL_n(\mathbb{R})$, the set of invertible real matrices, under multiplication of matrices.
- (c) Cyclic groups. Every cyclic group is abelian. Finite cyclic groups. Infinite cyclic groups. Generators of a cyclic group.

Unit II Subgroups

- (a) Definition of a subgroup. Examples of subgroups. The center $Z(G)$ of a group is a subgroup.
- (b) Intersection of two (or a family of) subgroups is a subgroup. Union of two subgroups is not a subgroup in general. Union of two subgroups is a subgroup if and only if one is contained in the other. If H and K are subgroups of a group G then HK is a subgroup of G if and only if $HK = KH$.
- (c) Cyclic subgroups of a group.

Unit III Lagrange's Theorem and Group homomorphism

- (a) Definition of Coset and its properties. Lagrange's theorem and consequences such as Fermat's Little theorem, Euler's theorem and if a group G has no nontrivial subgroups then order of G is a prime and G is Cyclic.
- (b) Group homomorphisms and isomorphisms, automorphisms. Kernel and image of a group homomorphism. If $f : G \rightarrow G'$ is a group homomorphism then $\ker f < G$. If $f : G \rightarrow G'$ is a group homomorphism then $\ker f = \{e\}$ if and only if f is 1-1.
- (c) $f : G \rightarrow G'$ is a group homomorphism then
 - (i) G is abelian if and only if G' is abelian.
 - (ii) G is cyclic if and only if G' is cyclic.

Module 3

(A) Suggested Practical topics

- (1) Evaluation of double and triple integrals. Change of variables in double and triple integrals and applications
- (2) Line integrals of scalar and vector fields.
- (3) Evaluation of surface integrals.
- (4) Examples and properties of groups. S_n . Cyclic groups.
- (5) Subgroups, cyclic subgroups, finding generators of every subgroup of a cyclic group.
- (6) Left and right cosets of a subgroup, Lagrange's Theorem. Group homomorphisms, isomorphisms.

xxxxxxx

Task

- | | |
|-------|---|
| 1 | One Assignment /Class test - 10 marks |
| 2 | Practical and Journal Submission (Six Practical) 30 marks |
| Total | 40 marks |

SEMESTER VII
COURSE VII - 1: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Paper I

Module 1 Complex Analysis

Learning Outcomes:

Learner will be able to elaborate on properties of complex numbers, Mobius transforms and singularities.

Unit I Unit I: Introduction to Complex Analysis

- (a) Review of complex numbers: Complex plane, polar coordinates, exponential map, powers and roots of complex numbers, De Moivre's formula. Bounded and unbounded sets. Point at infinity-extended complex plane.
- (b) Limit at a point. theorems on limits (only statements), convergence of sequences of complex numbers and results using properties of real sequences (only statements). Functions $f : \mathbb{C} \rightarrow \mathbb{C}$, real and imaginary part of functions, continuity at a point and algebra of continuous functions.
- (c) Derivative of $f : \mathbb{C} \rightarrow \mathbb{C}$, comparison between differentiability in real and complex sense. Cauchy-Riemann equations. Sufficient conditions for differentiability. Analytic function, f, g analytic then $f + g, f - g, fg$ and f/g are analytic, chain rule. If $f(z) = 0$ everywhere in a domain D , then $f(z)$ must be constant throughout D
Harmonic functions and harmonic conjugate.

Unit II Unit II: Cauchy Integral Formula

- (a) Explain how to evaluate the line integral $\int f(z) dz$ over $|z - z_0| = r$ and prove the Cauchy integral formula : If f is analytic in $B(z_0, r)$ then for any w in $B(z_0, r)$ we have
$$f(w) = \frac{1}{2\pi i} \int \frac{f(z)}{z - w} dz, \text{ over } |z - z_0| = r.$$
- (b) Taylor's theorem for analytic function (only statement), Mobius transformations: definition and examples.
- (c) Exponential function, its properties, trigonometric function, hyperbolic functions.

Unit III Complex power series, Laurent series and isolated singularities

- (a) Power series of complex numbers, radius of convergences, disc of convergence, uniqueness of series representation, examples.
- (b) Definition of Laurent series. Definition of isolated singularity. Existence of Laurent series expansion in neighbourhood of an isolated singularity(only statement). Types of isolated singularities viz. removable, pole and essential defined using Laurent series expansion, examples.

-
- (c) Residue theorem(statement only). Calculation of residue.

Module 2 Discrete Mathematics II

Learning Outcomes:

Learner will be able to experiment with addition and multiplication principle, solve relation problems and will be able to extend notions of counting to multisets.

Unit IV Preliminary Counting

- (a) Finite and infinite sets. Addition and multiplication Principle. Counting sets of pairs, two ways counting.
- (b) Stirling numbers of second kind. Simple recursion formulae satisfied by $S(n, k)$ for $k = 1, 2, \dots, n-1, n$.
- (c) Pigeonhole principle simple and examples, its applications to geometry.

Unit V Advanced Counting

- (a) Binomial and Multinomial Theorem. Pascal identity. Examples of standard identities such as the following with emphasis on combinatorial proofs.

$$\begin{aligned} \bullet \sum_{k=0}^r \binom{m}{k} \binom{n}{r-k} &= \binom{m+n}{r} & \bullet \sum_{i=0}^k \binom{k}{i}^2 &= \binom{2k}{k} \\ \bullet \sum_{i=r}^n \binom{i}{r} &= \binom{n+1}{r+1} & \bullet \sum_{i=0}^n \binom{n}{i} &= 2^n \end{aligned}$$

- (b) Permutation and combination of sets and multisets. Circular permutations, emphasis on solving problems.
- (c) Principal of inclusion and exclusion, its applications. Derangements, explicit formula for d_n . Deriving formula for Euler's function $\phi(n)$.

Unit VI Permutations

- (a) Permutation of objects, S_n , composition of permutations.
- (b) Results such as every permutation is a product of disjoint cycles, every cycle is a product of transpositions,
- (c) Signature of a permutation, even and odd permutations, cardinality of S_n , A_n .

Module 3

(A) Suggested Practical topics

- (1) Limit continuity and derivatives of functions of complex variables. Analytic function. Finding harmonic conjugate,
- (2) Cauchy Integral Formula ,Mobius transformations. Taylors Theorem , Exponential , Trigonometric, Hyperbolic functions.
- (3) Power Series , Radius of Convergence, Laurents Series. Finding isolated singularities-removable, pole and essential, Cauchy Residue theorem.

(4) Counting principles, Two way counting. Stirling numbers of second kind, Pigeon hole principle.

(5) Multinomial theorem. Identities. Permutation and combination. Inclusion-Exclusion principle. Euler phi function.

(6) Composition of permutations, signature of permutation, inverse of permutation.

Task

1	One Assignment /Class test - 10 marks	
2	Practical and Journal Submission (Six Practical)	30 marks
	Total	40 marks

SEMESTER VII

COURSE VII - 2: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Learning Outcome:

Module 1 Metric Topology

Learner will be able to construct examples of metrics, and will be able to compare properties of open/closed intervals, sequences, continuity and completeness property of $\mathbb{R}$ with an arbitrary metric space.

Unit I Metric spaces

- (a) Definition, examples of metric spaces $\mathbb{R}, \mathbb{R}^2$, Euclidean space $\mathbb{R}^n$ with its Euclidean, sup and sum metric, $\mathbb{C}$ (complex numbers), the spaces l^1 and l^2 of sequences and the space $C[a, b]$, of real valued continuous functions on $[a, b]$. Discrete metric space. Distance metric induced by the norm, translation invariance of the metric induced by the norm. Metric subspaces, Product of two metric spaces.
- (b) Open balls and open set in a metric space, examples of open sets in various metric spaces. Hausdorff property. Interior of a set. Properties of open sets. Structure of an open set in $\mathbb{R}$. Equivalent metrics.
- (c) Distance of a point from a set, between sets, diameter of a set in a metric space and bounded sets.

Unit II Closed sets and sequences in a metric space

- (a) Closed ball in a metric space, Closed sets, examples. Limit point of a set, a closed set contains all its limit points. Closure point of a set. Closure of a set and boundary of a set.
- (b) Sequences in a metric space, Convergent sequence in metric space, Cauchy sequence in a metric space, subsequences, examples of convergent and Cauchy sequence in finite metric spaces, $\mathbb{R}^n$ with different metrics and other metric spaces.
- (c) Characterization of limit points and closure points in terms of sequences, Definition and examples of relative openness/closeness in subspaces. Dense subsets in a metric space and Separability.

Unit III Complete metric spaces

- (a) Definition of complete metric spaces, Examples of complete metric spaces, Completeness property in subspaces.
- (b) Nested Interval theorem in $\mathbb{R}$, Cantor's Intersection Theorem.
- (c) Applications of Cantors Intersection Theorem:
 - (i) The set of real Numbers is uncountable.

-
- (ii) Density of rational Numbers(Between any two real numbers there exists a rational number)
 - (iii) Intermediate Value theorem: Let $f : [a, b] \rightarrow \mathbb{R}$ be continuous, and assume that $f(a)$ and $f(b)$ are of different signs say, $f(a) < 0$ and $f(b) > 0$. Then there exists $c \in (a, b)$ such that $f(c) = 0$.

Module 2 Metric Topology

Learning Outcomes:

Learner will be able to understand concepts like continuity, connectedness and compactness in a metric space.

Unit IV Continuous functions on metric spaces

- (a) Epsilon-delta definition of continuity at a point of a function from one metric space to another. Characterization of continuity at a point in terms of sequences, open sets and closed sets and examples.
- (b) Algebra of continuous real valued functions on a metric space. Continuity of composite continuous function.
- (c) Uniform continuity in a metric space, definition and examples (emphasis on $\mathbb{R}$). Let (X, d) and (Y, d') be metric spaces and $f : X \rightarrow Y$ be continuous. Contraction mapping and fixed point theorem, Applications.

Unit V Connected sets

- (a) Separated sets- Definition and examples, disconnected sets, disconnected and connected metric spaces, Connected subsets of a metric space.
- (b) Connected subsets of $\mathbb{R}$. A subset of $\mathbb{R}$ is connected if and only if it is an interval.
- (c) A continuous image of a connected set is connected. Characterization of a connected space, viz. a metric space is connected if and only if every continuous function from X to $\{1, -1\}$ is a constant function.

Unit VI Compact sets

- (a) Definition of compact metric space using open cover, examples of compact sets in different metric spaces $\mathbb{R}, \mathbb{R}^2, \mathbb{R}^n$.
- (b) Properties of compact sets: A compact set is closed and bounded, (Converse is not true). Every infinite bounded subset of compact metric space has a limit point. A closed subset of a compact set is compact. Union and Intersection of Compact sets. Equivalent statements for compact sets in $\mathbb{R}$:
 - (i) Sequentially compactness property.
 - (ii) Heine-Borel property: Let I be a closed and bounded interval. Let $\mathcal{F}$ be a family of open intervals such that $I \subset \bigcup \mathcal{F}$. Then there exists a finite subset $\mathcal{F}_0$ such that $I \subset \bigcup \mathcal{F}_0$, that is, I is contained in the union of a finite number of open intervals of the given family.
 - (iii) Closed and boundedness property.
 - (iv) Bolzano-Weierstrass property: Every bounded sequence of real numbers has a convergent subsequence.

-
- (c) Continuous image of compact set is compact. If (X, d) is compact metric, then $f : X \rightarrow Y$ is uniformly continuous.

References for Units I, II, III:

1. S. Kumaresan, Topology of Metric spaces.
2. E. T. Copson. Metric Spaces. Universal Book Stall, New Delhi, 1996.
3. Robert Bartle and Donald R. Sherbert, Introduction to Real Analysis, Second Edition, John Wiley and Sons.
4. Ajit Kumar, S. Kumaresan, Introduction to Real Analysis
5. R.R. Goldberg, Methods of Real Analysis, Oxford and International Book House (IBH) Publishers, New Delhi.

Other references :

1. W. Rudin, Principles of Mathematical Analysis.
2. T. Apostol. Mathematical Analysis, Second edition, Narosa, New Delhi, 1974
3. E. T. Copson. Metric Spaces. Universal Book Stall, New Delhi, 1996.
4. R. R. Goldberg Methods of Real Analysis, Oxford and IBH Pub. Co., New Delhi 1970.
5. P.K.Jain. K. Ahmed. Metric Spaces. Narosa, New Delhi, 1996.
6. W. Rudin. Principles of Mathematical Analysis, Third Ed, McGraw-Hill, Auckland, 1976.
7. D. Somasundaram, B. Choudhary. A first Course in Mathematical Analysis. Narosa, New Delhi
8. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hi, New York, 1963.
9. Sutherland. Topology.

Module 3

(A) Suggested Practical topics

- (1) Examples of metric spaces, one sets, open balls. Hausdorff property.
- (2) Closed sets, sequences.
- (3) Complete metric spaces
- (4) Continuity in a Metric Spaces, Uniform Continuity, Contraction maps.
- (5) Connected Spaces, Continuity and Connectedness.
- (6) Compact spaces.

Task

1	One Assignment /Class test - 10 marks	
2	Practical and Journal Submission (Six Practical)	30 marks
	Total	40 marks

XXXXX

SEMESTER VIII
COURSE VIII - 1: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Module 1 Single Variable Calculus

Learning Outcomes:

Learner will be able to elaborate on properties of sequences and series of functions and will be able to compute radius of convergence of power series.

Unit I Sequence of functions

- (a) Sequence of functions - pointwise and uniform convergence of sequences of real-valued functions. Examples. Uniform convergence implies pointwise convergence. Example to show converse not true.
- (b) M_n test. Examples.
- (c) Properties of uniform convergence: Continuity of the uniform limit of a sequence of continuous function. Conditions under which integral and the derivative of sequence of functions converge to the integral and derivative of uniform limit on a closed and bounded interval (only statements).

Unit II Series of functions

- (a) Series of functions, convergence of series of functions. Examples
- (b) Weierstrass M-test. Examples.
- (c) Conditions for term by term differentiation and integration (only statements). Examples.

Unit III Power series

- (a) Power series in $\mathbb{R}$ centered at origin and at some point in $\mathbb{R}$. Radius of convergence, region (interval) of convergence.
- (b) Uniform convergence. Term by-term differentiation and integration of power series. Examples.
- (c) Uniqueness of series representation. functions represented by power series, classical functions defined by power series such as exponential, cosine and sine functions, the basic properties of these functions.

Reference Books:

1. R. R. Goldberg, Methods of Real Analysis, Oxford and IBH, 1964.
2. K. G. Binmore, Mathematical Analysis, Cambridge University Press, 1982.
3. R. G. Bartle- D. R. Sherbert, Introduction to Real Analysis, John Wiley & Sons, 1994.
4. Sudhir Ghorpade and Balmohan Limaye, A course in Calculus and Real Analysis, Springer International Ltd, 2000.

Paper I. Module VIII.2 Numerical Methods

Learning outcomes:

Learner will learn different types of Numerical methods to apply in different fields of mathematics.

Unit IV Numerical Solution of initial value problems of first order ordinary differential equations

- (a) Numerical Solution of of initial value problems of first order ordinary differential equations using:
 - (i) Taylor's series method,
 - (ii) Picard's method for successive approximation and its convergence,
 - (iii) Euler's method and error estimates for Euler's method,
 - (iv) Modified Euler's Method,
 - (v) Runge-Kutta method of second order.
 - (vi) Runge-Kutta fourth order method.

Unit V Solution of Algebraic and Transcendental Equations

- (a) Measures of Errors: Relative, absolute and percentage errors, Accuracy and precision: Accuracy to n decimal places, accuracy to n significant digits or significant figures. Rounding and Chopping of a number. Types of Errors: Inherent error, Round-off error and Truncation error.
- (b) Iteration methods based on first degree equation: Newton-Raphson method. Secant method. Regula-Falsi method.
Derivations and geometrical interpretation and rate of convergence of all above methods to be covered.
- (c) General Iteration method: Fixed point iteration method.

Unit VI Interpolation, Numerical Integration

- (a) Interpolation: Lagrange's Interpolation. Finite difference operators: Forward Difference operator, Backward Difference operator. Shift operator. Newton's forward difference interpolation formula. Newton's backward difference interpolation formula.
- (b) Numerical Integration: Trapezoidal Rule. Simpson's 1/3 rd Rule. Simpson's 3/8th Rule. Derivations all the above three rules to be covered.

Reference Books:

1. Kendall E. and Atkinson; An Introduction to Numerical Analysis; Wiley.
2. M. K. Jain, S. R. K. Iyengar and R. K. Jain; Numerical Methods for Scientific and Engineering Computation; New Age International Publications.
3. S. Sastry; Introductory methods of Numerical Analysis; PHI Learning.
4. An introduction to Scilab-Cse iitb.

Additional Reference Books

-
1. S.D. Comte and Carl de Boor; Elementary Numerical Analysis, An algorithmic approach; McGrawHill International Book Company.
 2. Hildebrand F.B.; Introduction to Numerical Analysis; Dover Publication, NY.
 3. Scarborough James B.; Numerical Mathematical Analysis; Oxford University Press, New Delhi.

Module 3

(A) Suggested Practical topics

1. Pointwise and uniform convergence of sequence functions, properties
2. Point wise and uniform convergence of series of functions and properties.
3. Power series.
4. Finding the numerical solution of initial value problems using Taylor's series method, Picard's method, modified Euler's method, Runge-Kutta method of second order and fourth order.
5. Newton-Raphson method, Secant method. Regula-Falsi method, Iteration Method..
6. Interpolating polynomial by Lagrange's Interpolation, Newton forward and backward difference Interpolation, Trapezoidal Rule, Simpson's 1/3rd Rule, Simpson's 3/8th Rule.

Task

1	One Assignment /Class test - 10 marks	
2	Practical and Journal Submission (Six Practical)	30 marks
	Total	40 marks

Semester VIII

COURSE VIII - 2: MATHEMATICS

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

Module 1: Elementary Number Theory

Learning Outcomes:

Learner will be able to understand various properties of integers like divisibility, congruences, primes and prime factorization and will be able to apply these concepts in the field of Cryptography.

Unit I Congruences and Factorization

- (a) Congruences: Definition and elementary properties.
- (b) Complete residue system modulo m , Reduced residue system modulo m , Fermat's Little Theorem, Euler's generation for Fermat's Little Theorem.
- (c) Wilson's Theorem, Linear congruence, The Chinese Remainder Theorem.

Unit II Arithmetic Functions and Special Numbers

- (a) Arithmetic functions of number theory: Euler's function and its properties. $d(n)$ (or $\tau(n)$), $\sigma(n)$ and their properties $\mu(n)$ and the Mobius inversion formula.
- (b) Special Numbers: Fermat numbers, Mersenne numbers, Perfect numbers, Amicable numbers, Pseudo primes, Carmichael numbers.

Unit III Primitive Roots and Cryptography

- (a) Order of an integer and Primitive Roots.
- (b) Basic notions such as encryption (enciphering) and decryption (deciphering), Cryptosystems, symmetric key cryptography, Simple examples such as shift cipher, Affine cipher, Hill's cipher, Vigenere cipher.
- (c) Concept of Public Key Cryptosystem; RSA Algorithm.

Reference Books:

1. David M. Burton, An Introduction to the Theory of Numbers. Tata McGraw Hill Edition.
2. Niven, H. Zuckerman and H. Montgomery, An Introduction to the Theory of Numbers, John Wiley and Sons. Inc. M. Artin, Algebra, Prentice Hall.
3. K. Ireland, M. Rosen, A classical introduction to Modern Number Theory, Second edition Springer Verlag.

Module 2: Graph Theory

Learning Outcomes: Learner will be able to apply the concepts of graphs and trees to the field of chemistry, physics and biological sciences.

Unit I Basics of Graphs

- (a) Definition of general graph, Directed and undirected graph, Simple and multiple graph, Types of graphs- Complete graph, Null graph, Complementary graphs, Regular graphs Sub graph of a graph, Vertex and Edge induced sub graphs, Spanning sub graphs.
- (b) Basic terminology- degree of a vertex, Minimum and maximum degree, Walk, Trail, Circuit, Path, Cycle. Handshaking theorem and its applications.
- (c) Isomorphism between the graphs and consequences of isomorphism between the graphs, Self complementary graphs, Connected graphs, Connected components. Matrices associated with the graphs – Adjacency and Incidence matrix of a graph- properties, Bipartite graphs and characterization in terms of cycle lengths. Degree sequence and Havel-Hakimi theorem.

Unit II Trees

- (a) Cut edges and cut vertices and relevant results, Characterization of cut edge.
- (b) Definition of a tree and its characterizations, Spanning tree, Recurrence relation of spanning trees and Cayley formula for spanning trees of K_n .
- (c) Algorithms for spanning tree-BFS and DFS, Binary and m-ary tree, Prefix codes and Huffman coding. Weighted graphs and minimal spanning trees - Kruskal's algorithm for minimal spanning trees.

Unit II Eulerian and Hamiltonian graphs

- (a) Eulerian graph and its characterization- Fleury's Algorithm-(Chinese postman problem).
- (b) Hamiltonian graph, Necessary condition for Hamiltonian graphs using $G-S$ where S is a proper subset of $V(G)$, Sufficient condition for Hamiltonian graphs.
- (c) Ore's theorem and Dirac's theorem.

Recommended Books.

1. Bondy and Murty Graph, Theory with Applications.
2. Balkrishnan and Ranganathan, Graph theory and applications.
3. Douglas B. West, Introduction to Graph theory. Pearson Education.

Additional Reference Book.

1. Behzad and Chartrand Graph theory.
2. Choudam S. A., Introductory Graph theory.

Module 3

Suggested Practicals

- (A) Congruences. Linear congruences and congruences of higher degree
- (B) Linear Diophantine equations. Pythagorean triples and sum of squares. Arithmetic functions.
- (C) Cryptosystems (Private Key). Cryptosystems (Public Key) and primitive roots.
- (D) Handshaking Lemma and Isomorphism. Degree sequence.
- (E) Trees, Cayley Formula. Applications of Trees
- (F) Eulerian Graphs. Hamiltonian Graphs.

xxxxx

Task

1	One Assignment /Class test - 10 marks	
2	Practical and Journal Submission (Six Practical)	30 marks
	Total	40 marks

Learning Outcomes

I.1 Real Numbers.

Learner will understand the basic properties of real numbers. Real numbers form the foundation of many advanced concepts in mathematics.

I.2 Discrete Mathematics I.

Learner will understand the behaviour of integers. Learner will also study how to establish different types of relations between any two sets.

II.1 Single Variable Calculus I.

Learners will understand the concept of rate of change in the motion of an object and its applications.

II.2 Statistical Methods and Applications.

Learner will know how to study a data available to him/her using the statistical techniques.

III.1 Ordinary Differential Equations.

Learner will be able to classify and solve the ordinary differential equations according to the order. Learner will be able to apply the concepts of ODE to biological sciences and physics.

III.2 Linear Algebra I.

Learner will be able to examine existence and uniqueness of solutions of system of equations and apply them to real life problems. Learner will be exposed to concept of dimensions of vector space.

IV.1 Single Variable Calculus II.

Learner will be able to identify Riemann integrable functions and test the convergence of improper integrals. Also will be exposed to some applications of integration.

IV.2 Linear Algebra II.

A learner will study linear transformations, matrices and determinants and their applications.

V.1 Multivariable Calculus I.

Learner will be able to compare properties of functions of several variables with those of functions of one variable and will be able to apply the concept of differentiability to other sciences.

V.2 Linear Algebra III.

Learner will be able to identify inner product spaces, understand the geometry of vectors and will be able to outline properties of inner products. Learner will also be able to compute Eigen values and Eigen vectors of a matrix and use these ideas to explore some geometric ideas.

VI.1 Multiple Integration.

Learner will be able to apply concepts of multiple integrals, Line and Surface integrals in other disciplines like Physics.

VI.2 Group Theory.

Learner will be able to examine properties of groups, subgroups, cyclic groups and explore some applications of Lagrange's theorem.

VII.1 Complex Analysis.

Learner will be able to elaborate on properties of complex numbers, Mobius transforms and singularities

VII.2 Discrete Mathematics II.

Learner will be able to experiment with addition and multiplication principle, solve relation problems and will be able to extend notions of counting to multisets.

VII.4 Metric Topology I.

Learner will be able to construct examples of metrics, and will be able to compare properties of open/closed sets, sequences, continuity and completeness in different metric spaces.

VII.5 Metric Topology II.

Learner will be able to understand concepts like continuity, connectedness and compactness in a metric space.

VIII.1 Single Variable Calculus III.

Learner will be able to elaborate on properties of sequences and series of functions and will be able to compute radius of convergence of power series

VIII.2 Numerical Methods.

Learner will be able to apply numerical methods to solve differential equations and evaluate integration. They will also be able to use the methods to solve algebraic and transcendental equations.

VIII.4 Elementary Number Theory.

Learner will be able to understand various properties of integers like divisibility, congruences, primes and prime factorization and will be able to apply these concepts in the field of Cryptography.

VIII.5 Graph Theory.

Learner will be able to examine properties of groups, subgroups, cyclic groups and explore some applications of Lagrange's theorem.

**MATHEMATICS FOUNDATION
COURSES –SEMESTER I AND
SEMESTER II**

Semester – I
Mathematics and Statistics Foundational Course - I

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)
Total Marks: 100
External Assessment: 60 (40 Theory + 20 Practical)
Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

MODULE 1

UNIT 1 ARITHMETIC

Number System. H.C.F and L.C.M. Fractions (including Decimals, Rounding off and Significant Figures). Squares and Squares Roots. Ratio and Proportion and some applications.

UNIT 2 COMMERCIAL ARITHMETIC

Unitary Method (including Time and Work). Speed, Distance & Time. Percent and Percentage. Profit, Loss and Discount. Interest (simple and Compound)

UNIT 3 BASIC ALGEBRA

Fundamental Concepts (including Operations on Algebraic Expressions). Linear Equations in one Variable (with Problems based on Linear equations). Solve Equations with Fraction or Decimal coefficients, A General Strategy to solve Linear Equations. Simultaneous Equations.

MODULE 2

UNIT 4 LINEAR EQUATION AND GRAPHING

Rectangle Coordinate System. Graph of Linear Equations in Two Variables. Graph with Intercepts, Slope of a line, Slope-Intercept form of an equation of a line. Equations involving mid-point and length of a line. Condition for two lines to be parallel or perpendicular, including finding the equation of perpendicular bisectors.

UNIT 5 MENSURATION

Triangles, Congruency of Triangles (including Isosceles Triangles and Pythagoras Theorem). Polygons, Quadrilaterals and their general properties. Area Propositions. Perimeter and Area of Plane Figure. Volume and Surface Area (Cuboid and Cube).

UNIT 6 ELEMENTARY STATISTICS

Collection, classification and Tabulation of Data. Graphical Representation of Statistical Data. Construct and interpret bar charts, pie charts and pictograms. Simple frequency distributions, histograms with equal intervals and scatter diagrams.

MODULE 3

Practicals based on module 1 and module 2.

1. Examples on finding L.C.M. and H.C.F. of two numbers. Examples on Ratio and proportion.
2. Examples on Profit, Loss, discount, Interest (simple and compound)
3. Solving linear equations in one variable. Solving two simultaneous equations.
4. Drawing graphs of linear equations in two variables. Examples on equations of straight lines.

5. Examples on congruency of triangles, examples on properties of quadrilaterals. Volume and surface area of cube, cuboid, cylinder, cone.
6. Examples on graphical representation of statistical data. Drawing histograms.

Task

- | | |
|---|---|
| 1 | One Assignment /Class test - 10 marks |
| 2 | Practical and Journal Submission (Six Practical) 30 marks |
| | Total 40 marks |

Semester II

Mathematics and Statistics Foundational Course - II

Total Credits: 06 (1 Credit = 12 hours, Total 72 hours)

Total Marks: 100

External Assessment: 60 (40 Theory + 20 Practical)

Internal Assessment: 40 (10 Marks Internal Class test /Assignment + Practical: 30 Marks)

MODULE 1

UNIT 1 SET THEORY

Sets and Venn-Diagrams. Ordered Pair; Cartesian Product. Relations and Mappings.

UNIT 2 FUNCTIONS

Function, domain, range (image set). Notations like: $f(x) = \sin x$, $f^{-1}(x)$ and $f^2(x) = f(f(x))$ Identity function, one to one functions and onto functions. Bijective Functions. Algebraic operations on functions. Composite Functions and Inverse of a function.

UNIT 3 LOGARITHMIC AND EXPONENTIAL FUNCTIONS

Properties and graphs of the logarithmic and exponential functions including $\ln x$ and e^x . Laws of logarithms (including change of base of logarithms). Solve equations of the form $a^x = b$.

MODULE 2

UNIT 4 POLYNOMIALS

Add and Subtract and Multiplication of Polynomials. Division of Polynomials, Division Algorithm, Greatest Common Factor and Factor by grouping. Factors of polynomial. Remainder and factor theorems, Find factors of polynomials. Solve quadratic and cubic equations - conditions for $f(x) = 0$ to have:

- (i) two real roots (ii) two equal roots (iii) no real roots

UNIT 5 LINES AND PLANES

Different forms equation of line. Condition for perpendicular and parallel planes. Distance of a point from a plane. Equation of a plane in different forms, Angle between two intersecting planes. Find the angle between a line and a plane.

UNIT 6 STATISTICS

Arithmetic-Mean, Mode and Median and range for individual and discrete data and distinguish between the purposes for which they are used. Understand what is meant by positive, negative and zero correlation with references to a scatter diagram. Draw, interpret and use lines of best fit by eye.

MODULE II.3

Practicals based on 1 & 2

- (1) Examples on sets and Venn-Diagrams, Relations and mappings.
- (2) Examples on different types of functions, algebraic operations on functions, composition of functions and inverse of a function.
- (3) Examples on change of base of logarithms, properties of logarithmic and exponential functions. Solving equations of the form $a^x = b$.

- (4) Examples on Division algorithm of polynomials, finding greatest common factor of two polynomials, remainder and factor theorem, solving quadratic and cubic polynomials.
- (5) Examples on finding equation of a line in different forms, checking if two planes are perpendicular or parallel or neither, finding equation of a plane, finding angle between a line and a plane.
- (6) Finding mean, mode and median of a discrete data.

Task

One Assignment /Class test - 10 marks

Practical and Journal Submission (Six Practical) 30 marks

Total 40 marks

B.Ed. SYLLABUS

SEMESTER I
B.Ed. Course I
PERSPECTIVE IN EDUCATION: CHILDHOOD AND GROWING UP

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain basic concepts and Principles of Educational Psychology
2. describe of the nature, process and factors influencing development
3. analyse the role of cultural context in shaping human development
4. relate the theories of Erikson and Piaget to the stage of development
5. explain self and personality

Module I: Human Development

2 Credits

Unit I: Role of Educational Psychology

- a) Educational Psychology: Meaning, Concept and Scope
- b) Stages of Growth and Development (Later Childhood and Adolescence)
- c) Role of Educational Psychology to a Teacher

Unit II: Process of Development

- a) Meaning and Principles of Growth and Development and its difference
- b) Determinants of Growth and Development: Heredity, Environment, Learning, Maturation
- c) Erikson's theory of Psychosocial Development and Piaget's theory of Cognitive Development

Unit III: Context of Child Development

- a) Child Development as a multidimensional concept within a pluralistic society with reference to Ecological System by Urie Bronfenbrenner
- b) Impact of different parenting styles on child development (Authoritarian, Authoritative, Permissive and Uninvolved)
- c) Cultural Psychology: Meaning, Scope: Culture and Motivation - Self Enhancement v/s Self Improvement, Culture and Empathy-Collectives v/s Individualistic, Prejudice and Stereotypes

Module II: Perspectives of Human Development

2 Credits

Unit IV: Methods and Approaches of Studying Human Development

- a) Methods: Observation (Participatory and Non-Participatory), Experimental and Clinical
- b) Approaches: Cross Sectional, Cross Cultural
- c) Longitudinal Approach with reference to Piaget's Theory of Cognitive Development

Unit V: Self and Personality

- a) Concept of Self and Personality
- b) Major Approaches to understand Personality: Types and Traits, Big Five Theory of Personality
- c) Defense Mechanisms- (Denial, Escape and Substitution); Kohlberg's Theory of Moral Development

Unit VI: Meeting Life Challenges

- a) Stress: Type and Source
- b) Effect and Coping Strategies of Stress
- c) Life Skills: Meaning, Importance and Strategies to develop self-reflection and inter-personal skills

Module III: Internal Assessment

2 Credits

Sr. No.	Assessment	Marks
1	Class Test	15
2	Overall Assessment-Article Review, Group Discussion, Quiz, Survey Report. Poster Presentation, Guest Lecture, Interview, Game, PPT, Narrating, Project Making, Street Play, Short Film, Film Shows	05
3	Assignments (2 x 10 Marks)	20
Total		40

Tasks - Any one from the following: (1x10=10m)

- a) Prepare a reflective journal on the basis of observations of any two students keeping the variables as determinantsof Growth and Development
- b) Conduct a case study on secondary school students based on Urie Bronfenbrenner theory
- c) Fill in a self-awareness questionnaire, interpret the results, analyse your behaviour patterns and write your reflections on it.
- d) Review any one movie of the following: 1. Smile Pinky (2008), 2. Born into Brothels (2014), 3. Salaam Bombay(1988), 4. Slumdog Millionaire (2009), 5. Gippie (2013) and 6. Mehek (2007). Discuss their content, Characters and Messages in the context of issue and concerns of childhood/adolescence.

II. Psychological Test- Any One

- a) Big five Personality Test
- b) Self-Concept

References:

1. Bhatia, H. R. (1973). Elements of Educational Psychology, 5th edition. Orient Longman.
2. Bigge, M. L. (1982). Learning Theories for Teachers, (4th edition). New York, Harper and Row Publishers, P.P. 89-90.
3. Bolles, R. C. (1975): Learning Theory. New York: Holt, Rinehart and Winston, Pp. 18-19.
4. Chauhan, S.S. (1978): Advanced Educational Psychology. New Delhi: Vikas Publishing House Pvt. Ltd.
5. Dandapani, S. (2001), A textbook of Advanced Educational Psychology. New Delhi: Anmol Publications.
6. Dunn, R. (1983). Can students identify their own Learning Styles? Educational Leadership, 40, Pp. 60-62.
7. Dash, M. (1988). Educational Psychology. Delhi: Deep and Deep Publication.
8. Duric, L. (1975). Performance of Pupils in the Process of Instruction. Bratislava, SPN, Pp. 54-90.
9. Duric, L. (1990). Educational Sciences: Essentials of Educational Psychology. International Bureau of Education, UNESCO. New Delhi: Sterling Publishers, Pvt. Ltd.
10. Fontana, D. (1995). Psychology for Teachers (3rd edition). The British Psychological Society, London: McMillanin association with BPS Books.
11. Kundu C.L. and Tutoo D.N. (1993): Educational Psychology. Sterling Publishers Pvt. Ltd.
12. Lindgren, H. C. (1967). Educational Psychology in Classroom (3rd edition). New York: John Wiley and

- sons.
13. The Psychological Foundation of Culture, Eds. Mark Schaller and Christian S. Crandall, Pub. Taylor and Francis Inc.
 14. Culture and Psychology, 4th Ed., D. Matsumoto and L. Juang, Pub. Cengage Learning Inc.
 15. Understanding Social Psychology Across Cultures, 2nd Edition, Peter Smith et al, Sage Publications
 16. The Handbook of Culture and Psychology, 2nd Edition, Eds. D. Matsumoto and Hyisung C. Hwang, Oxford University Press
 17. Mangal, S. K. (1984). Psychological Foundations of Education. Ludhiana: Prakash Publishers
 18. Mohan J. and Vasudeva P. N. (1993). Learning Theories and Teaching, In Mohan Jitendra (ed.) Educational Psychology, New Delhi, Wiley Eastern Limited, P. 146.
 19. Oza, D. J. and Ronak, R. P. (2011). Management of behavioral problems of children with mental retardation. Germany: VDM publication.
 20. Papalia D. E., and Sally, W. O. (1978). Human Development. McGraw Hill Publishing Company

SEMESTER I
B.Ed.Course II
PERSPECTIVE IN EDUCATION: CREATING AN INCLUSIVE SCHOOL

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain diversity, disability and inclusion
2. explain the concept of Inclusive Education
3. relate curriculum and assessment adaptations for inclusive classroom
4. describe the different models of disability
5. discuss the contributions of International and National Policies and Acts on Inclusive Education
6. analyse the contribution of NGO in Inclusion

Module 1: Introduction and Towards Nurturing Inclusion

2 Credits

Unit I: Understanding Inclusion

- a) Difference between: Diversity, Disability and Inclusion
- b) Meaning, Needs of Inclusion Education
- c) Models of Inclusion: Charity Model, Functional Model and Human Right Model

Unit II: Nurturing Inclusion

- a) Concept of Children with special needs and their types
- b) Characteristics of disabilities-sensory, neuro-development, loco motor and multiple disabilities
- c) Catering to the needs of children with sensory, neuro-developmental and multiple disabilities

Unit III: Policies And Acts Promoting Inclusive Education

- a) International Policies: Significance of (and Acts: Salamanca 1994), UNCRPD, EFA (MDG)
- b) National Policies and Acts: Rehabilitation Council Act 1992, National Policy for person with disability 2006, Rights to Education Act 2009, National Education Policy 2019
- c) Educational Concessions, Facilities for CWSN

Module II: Understanding And Addressing Learner's Diversity

2 Credits

Unit IV: Planning Instruction and Designing Learning Experiences for an Inclusive Classroom

- a) Curriculum Adaption/ Modification-Disability wise Curriculum Adaption/ Modification in Instruction
- b) Use of ICT in Inclusive Classroom
- c) Strategies for differentiating content in an inclusive classroom

Unit V: Inclusion in Classroom

- a) Facilitating inclusion in classroom: Attitudinal, Social and Infrastructural
- b) Individualized Educational Plans: Concepts, Steps
- c) Alternate means of assessment and evaluation in an inclusive classroom

Unit VI: Functionaries in Inclusive Settings

- a) Profile and Role of Teacher: General Teacher and Resource Teacher
- b) Role of NGO in supporting inclusive school
- c) Pre-Support and Pre-Vocational Training Program for children with special needs

Module 3: Internal Assessment 40 Marks

2 Credits

Sr. No.	Assessment	Marks
1	Class Test	15
2	Assignments (2 x 10 Marks)	20
3	Overall Participation	05
Total		40

Any two activities for assignment from the following (2 x 10 = 20 Marks)

- a) Prepare a presentation on any one model of disability (excluding models of disability given in the syllabus)
- b) Case Study of any one NGO supporting inclusive education
- c) Prepare a scrapbook showing different ICT technologies used in Inclusive Education (Picture and Information)
- d) Interview a teacher working in a mainstream school promoting inclusion
- e) Making a report of visit to a school for children with special needs

References:

1. Algozzine, Robert & Ysseldyke, James (2006). Teaching students with learning disabilities. California: Corwin press.
2. Deshpandhu, Suchitra (2014) Inclusive education in India. New Delhi: Kaniksha Publishers
3. Friend, M., & Bursuck, W. (2005). Including Students with Special Needs: A Practical Guide for Classroom Teachers (4th Ed.). Boston, MA: Allyn & Bacon
4. India Moves Towards Equal Rights For Disabled People. BMJ: British Medical Journal Vol. 310, No. 6994 (Jun. 17, 1995), p. 1556
5. Jha, M. M. (2002). School without Walls: Inclusive Education for All, Oxford: Heinemann Education.
6. K. C. (1997). Education of Exceptional Children. New Delhi: Vikas Publications
7. Karant, P. & Rozario, J. ((2003). Learning Disabilities in India. Sage Publications.
8. Karten, T. J. (2007). More Inclusion Strategies that Work. Corwin Press, Sage Publications.
9. King-Sears, M. (1994) Curriculum-Based Assessment in Special Education. California, Singular Publications.
10. Lewis, R. B. & Doorlag, D. (1995) Teaching Special Students in the Mainstream. 4th Ed. New Jersey, Pearson
11. Mangal, S. K. (2007). Educating Exceptional Children An Introduction to Special Education New Delhi: Prentice-Hall of India Pvt Limited
12. Mani, M. N. G. (1997). Techniques of Teaching Blind Children. New Delhi: Sterling Publishers.
13. Manivannan, M. (2013) Perspectives on special education. Hyderabad: Neelkamal Publishers
14. Mathew, S. (2004) Education of Children with Hearing Impairment. RCI, New Delhi: Kanishka Publications.
15. McCormick, Sandra. (1999) Instructing Students who Have Literacy Problems. 3rd Ed. New Jersey, Pearson Panda,
16. Mohapatra, Damodar. (2006) Impact of family environment on early childhood education. Hyderabad: Neelkamal Pub.
17. Naomi, G Victoria, 2014 Optical devices for low vision reading , , Hyderabad, Neelkamal Publishers.

18. Rana, Nishta. (2013) Children with special needs. Hyderabad: Neelkamal Publishers.
19. Ranganathan, Snehlata. (2014) Guidelines for children with special educational needs. New Delhi: Kaniksha Publishers
20. Rangasayee, R. & Gathoo, V. (2007). Towards Inclusive Education of Children with Hearing Impairment, A HandBook For Regular School Teachers. AYJNIHH Publishers.
21. Rao, Alla Appa, (2010) Learning Disabilities. Neelkamal Publishers. Hyderabad
22. Rao, V. K. (2001). Special Education. New Delhi: A.P.H. Publishers.
23. Rayner, S. (2007). Managing Special and Inclusive Education, Sage Publications.
24. RCI (2013) Status of disability in India 2012. New Delhi: RCI Publishers
25. Renuka, P. (2014) Children with Disabilities Hyderabad. Neelkamal Publishers
26. Sharma, Yogendra K. (2014) Inclusive education. New Delhi: Kaniksha Publishers
27. Smith, Corrine & Strick, Lisa (1999). Learning disabilities A to Z. New York: Fireside books.
28. Umadevi, M R. (2010) Special education. Hyderabad: Neelkamal Publishers
29. RCI (2013) Status of disability in India 2012. New Delhi: RCI Publishers
30. Renuka, P. (2014) Children with Disabilities Hyderabad. Neelkamal Publishers
31. Sharma, Yogendra K. (2014) Inclusive education. New Delhi: Kaniksha Publishers
32. Umadevi, M R. (2010) Special education. Hyderabad: Neelkamal Web-links:
33. RTE and disadvantaged children
<http://www.ncert.nic.in/departments/nie/dee/publication/pdf/StatusreportRTE2013.pdf>
34. THE REHABILITATION COUNCIL OF INDIA ACT, 1992
http://www.svayam.com/pdf/the_rci_act-1992&amendment_act_2000.pdf
35. Teachers in inclusion
<http://www.inclusiveeducationinaction.org/iea/index.php?menuid=25&downloaded=87&reoreid=247>
36. Universal Design for learning <http://inclusive.tki.org.nz/guides/universal-design-for-learning/>
<http://www.uvm.edu/~cdci/universaldesign/?Page=about-udl/guidelinesprinciples.php&SM=about-udl/submenu.html>

SEMESTER I
B.Ed.Course III
ABILITY COURSE: YOGA AND HEALTH EDUCATION

Total Credits: 03
Total Marks: 50
Internal Assessment: 50

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the meaning, importance, aims and objectives of Health Education.
2. explain Balance Diet, Communicable Diseases and First Aid.
3. discuss the importance health education and Yoga.
4. describe about recreation, health and safety education
5. discuss the significance of Philosophy of Yoga.
6. relate Yogic Exercise and Diet in life.

Module 1: Health Education

1 Credit

Unit I: Introduction of Health Education

- a) Concept of Health Education: Meaning, Definition and Importance of Health Education
- b) Forms of Health Education: Health Instructions, Health Service and Health Supervision
- c) Healthy Practice for Healthy Living

Unit II: Nutrition and Balanced Diet

- a) Nutrition and Balanced Diet Components and Malnutrition
- b) Foods and Nutrition, Food habits, Timing of Food, Nutrients and their functions, Seasonal foods and festivals,
Preservation of food value during cooking, food and water borne and deficiency diseases and prevention
- c) Communicable and Non-Communicable Diseases; Reproductive and Sexual Health, hygiene, HIV/AIDS, responsible sexual behaviour, measures to prevent diseases transmission

Module II: Yoga Education

1 Credit

Unit III: Essential of Yoga and Practices

- a) Meaning, Aim, Scope and function of yoga education
- b) Yoga Asanas, Pranayama and Shudhikriya (Technique, Do's and Don'ts and Benefit)
- c) Yoga Practices for Healthy Living

Unit IV: Yoga and Fitness

- a) Difference Between Physical Exercise and Yoga
- b) Yoga Practices for Memory Development
- c) Yoga Practices for Stress Development

Module 3: Suggested Tasks/Assessment (Any Five)

1 Credit

- a) Conduct workshop on various Asanas, Pranayama and Meditation
- b) Conduct five sessions on physical Exercise (PT)
- c) Demonstration of asanas and pranayama and their effect on Human body.
- d) Organising school health check-ups, referral, and practical classes of first aid and write report.
- e) Organising and discuss with students how they will contribute to health communities and environments as adults.
- f) Prepare a food chart with their nutritional values for a week
- g) Present a seminar on techniques of yoga for stress management

References:

1. Atwal & Kansal. (2003). A Textbook of Health, Physical Education and Sports, Jalandhar, A. P. Publisher,
2. Anantharaman, T.R. (1996). Ancient Yoga and Modern Science. New Delhi: Munshiram Manoharlal Publishers Pvt Ltd.
3. Bhavanani, A.D. (2008). A Primer of Yoga Theory. Pondicherry: Dhivyananda Creations, Iyyangar Nagar.
4. Nath, S.P. (2005). Speaking of Yoga. New Delhi: Sterling Publishers.
5. Kamlesh, M.L. & Sangral, M.S. (1986). Methods in Physical Education, Ludhiana: Prakash Brothers.

6. Kangane, Sopan & Sonawane, Sanjeev. (2007). Physical Education. Pune: Nirali publication.
7. Kaur, Manjeet. (2003). Health and Physical Education, Ludhiana: Tendon Publications.
8. Sharma, Anil P. (2011). Mind, Body and Divine Yoga. New Delhi: Personal Graphics & Advertiser Pvt. Ltd.
9. Samiti. Goel, A. (2007). Yoga Education, Philosophy and Practice. New Delhi: Deep and Deep Publications. <http://www.wikipedia.com>
10. S. & Vinekar, S.L. (1963). Yogic Therapy: Its Basic Principles and Methods. New Delhi: Ministry of Health and Family Welfare.
11. Swami Satyānanda (1999). Four Chapters on Freedom. Commentary on Yoga Sūtras of Patañjali Saraswathi. Munger: Bihar School of Yoga.
12. Yadav, Y.P. & Yadav, R. (1998). Art of Yoga. Friends Publications, India.

Websites:

1. Importance of Health Education : <http://www.schoolchalao.com/basic-education/show-results/introduction-of-health-education/effect-of-health-education>
2. Healthy practices for healthy life: <https://www.eufic.org/en/healthy-living/article/10-healthy-lifestyle-tips-for-adults>
3. Streams of Yoga: https://yoga.manavata.org/?page_id=120
4. Yoga Asana and Pranayam: <https://www.timesnownews.com/health/article/yoga-asanas-pranayama-and-meditation-a-complete-yoga-guide-for-beginners/586246>
5. Shudhkriya Yoga: <https://www.rishikeshyogisyogshala.org/6-types-kriyas-ultimate-purification/>
6. Yoga Practices for Healthy Life: <https://www.yogajournal.com/lifestyle/count-yoga-38-ways-yoga-keeps-fit>
7. Postures : <https://www.edokita.com/common-postural-defects-types-causes-and-remedies/>
8. Exercises to Strengthen Physical Fitness: <https://www.nia.nih.gov/health/four-types-exercise-can-improve-your-health-and-physical-ability>
9. Components of Physical Fitness : <https://www.kenoshachc.org/2018/06/11/know-5-components-physical-fitness/>
10. Meditation Techniques: <https://www.yogajournal.com/meditation/let-s-meditate>
11. Stress Management Techniques : <http://www.boostconference.org/PDF/2015-presenters/Yoga%20for%20Stress%20Management%20and%20Relaxation.pdf>
12. Yoga for improving Short Term Memory <https://www.wellbeing.com.au/body/yoga/discover-yoga-improve-memory.html>
13. Yoga for improving Long Term Memory <https://www.stylecraze.com/articles/yoga-poses-to-improve-your-memory/>
14. NCERT Book on Yoga: <https://ncert.nic.in/dess/pdf/tiyhwlss1.pdf>
15. Yoga Education Bachelors of Education Programme :
16. <http://doe.du.ac.in/academics/bed/syllabus/Yoga%20Education%20-%20B.Ed%20-%20English.pdf>
17. Yoga Education Diploma in of Elementary Education <https://www.scribd.com/document/376181349/Yoga-Education-D-El-Ed-English-p>

SEMESTER II
B.Ed. Course IV
PERSPECTIVE IN EDUCATION: LEARNING AND TEACHING

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the concepts of Learning & Teaching.
2. analyse the factors affecting Learning.
3. explain the processes of Learning through various theoretical perspectives.
4. design the strategies of active engagement in learning.
5. explain concept of teaching and as a profession
6. apply the knowledge of teaching for better learning

Module 1: Understanding Learning

2 Credits

Unit I: Concept of Learning

- a) Learning and Teaching: Meaning and Characteristics
- b) Factors Affecting Learning: Attention (Meaning, Types and Educational Implications), Motivation (Meaning, Types and Educational Implications), Maslow's Theory of Hierarchy of Needs
- c) Multiple Intelligences (Gardener's Classification): Concept and Educational Implications

Unit II: Theories of Learning: (Principles & Educational Implications)

- a) Behaviourist Theories: Pavlov & Skinner.
- b) Cognitive Theory: Jerome Bruner
- c) Social Learning Theory: Bandura

Unit III: Active Engagement in Learning

- a) Cognitive constructivism and social constructivism (Concept and Features)
- b) Concept mapping and Mind Mapping
- c) Brain based learning: Principles and Educational Implications

Module II: Understanding Teaching

2 Credits

Unit IV: Teaching for All (Educational Needs Of Differently Abled Learners)

- a) Characteristics & role of education (strategies) in case of: Learners with Learning Disabilities
- b) Characteristics & role of education (strategies) in case of: Learners with Hyperactivity & Attention Disorders, Gifted Learner and Slow Learner
- c) Differentiated Instruction: Concept, Characteristics / Key Features & Strategies

Unit V: Teaching for Effective Learning

- a) Promoting reflection and critical thinking
- b) Creativity (Meaning and ways of promoting)
- c) Metacognition (Meaning and components)

Unit VI: Teaching as a Profession

- Professionalism in Teaching: Concept and Principles
- Evolving Roles of Teacher: Instructional Expert, Manager, Counsellor and Researcher
- Competencies for classroom management

Module 3: Internal Assessment 40 Marks

2 Credits

Sr. No.	Assessment	Marks
1	Task/Assignment for each module held in semester (2 x 10 Marks)	20
2	One Periodical Class Test held in the given semester	15
3	Overall Participation	05
Total		40

Any two tasks from the following

(2 x 10 = 20 Marks)

- Experimental Psychology (any one from the following)
 - Division of Attention
 - Group Judgement
 - Suggestion
 - Perception
 - Transfer of Learning – (Mirror Drawing / Cup & Ball)
- Psychological Test (any one from the following)
 - Sociometry test
 - Multiple Intelligence Test- Gardener
 - Thinking Style
- Construct and Develop a concept of map or mind map on any unit or topic from the course

References:

- Adams & Hamm – New Designs for Teaching & Learning, Jossey-Bass Publishers, San Francisco
- Agarwal. J.C- Essentials of Educational Psychology, Vikas Publishing House Pvt Ltd, 1995
- Bhatnagar Suresh & Saxena Anamika - Advanced Educational Psychology, R Lall Book Depot Meerut
- Brubacher, Modern Philosophies of Education, 4th Ed., McGraw Hill Book Company
- Cascio, Wayne F. & Aguinis Herman - Applied Psychology in Human Resource Management - Prentice-Hall of India, New Delhi.
- Charles Skinner - Educational Psychology.
- Chatteijee S. K. - Advanced Educational Psychology.
- Chauhan, S.S- Advanced Educational Psychology, Vikas Publication House, N.D. 1990
- Crow L.D and Crow A “Educational Psychology”
- Dandapani, S - Educational Psychology o Dandekar & Makhija - Educational Psychology
- Dandekar W. N. - Fundamentals of Experimental Psychology.
- Dash, RN & Dash, N- A Textbook of Educational Psychology.
- David W. Martin- Doing Psychology Experiments.
- Donna Walker Tileston – Ten Best Teaching Practices, 3rd Ed., Corwin
- E.G. Parameswaran & K. Ravichandra- Experimental Psychology. G
- Gage & Berliner – Educational Psychology (6th Ed.), Houghton Mifflin Co.
- Gardener, Frames of Mind
- Henson & Eller – Educational Psychology for Effective Teaching – Wadsworth Publishing Company.
- Hergenhahn, B. R. & Olson, Matthew H. - An Introduction to Theories of Learning - Prentice-Hall of India
- Jonassen & Land (Editors), Theoretical Foundations of Learning Environments, Routledge o Kakkar
- S. B. - Educational Psychology.
- Kenneth T. Henson, Ben F. Ella - Educational Psychology for Effective Teaching.
- Lahey, Benjamin- Psychology- An Introduction (Sixth Edition), Tarn McGraw Hill Publ.
- Lawson et al, A History of Psychology – Globalization, Ideas, and Applications, PrenticeHall of India
- Lefrancois Guy - Psychology for Teaching.
- Lefrancois Guy R.: Theories of Human Learning

25. Leo Postman, James Egan- Experimental Psychology.
26. Mangal S. K. — Essentials of Educational Psychology, Prentice-Hall of India. New Delhi.
27. Mangal S.K - Educational Psychology
28. Mathur, S.S- Educational Psychology 50
29. Micheal Pressley, Christine B. McCormick - Child & Adolescent Development for Educators.
30. Paulo Freire – Pedagogy of the Oppressed(2011)
31. Rajamanickam, Experimental Psychology with Advanced Experiments-Vol.1,II. Concept Publishing Company
32. Richard D. Parsons, Stephanie Lewis Hinson, Deborah Sardo-Brown- Educational Psychology.
33. Richardson, Constructivist Teacher Education: Building a World of New Understandings, Routledge Falmer
34. Tileston, Donna Walker- 10 Best Teaching Practices (3rd Ed.), Corwin - A SAGE Co.
35. Tiwari, Roma Pal- Experimental Psychology A Dynamic Approach, VinodPustakMandir
36. Walial. S. - Foundations of Educational Psychology.
37. WOOLFOLK, Anita- Educational Psychology (1 Ith Ed.), Merrill -Pearson

SEMESTER II
B.Ed.Course V
PERSPECTIVE IN EDUCATION: KNOWLEDGE AND CURRICULUM

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the epistemological basis of Education
2. justify the significance the modern child centered Education.
3. discuss the National Integration and International Understanding
4. explain the curriculum and its types
5. categorizes the Dimensions of Curriculum.
6. discuss the importance of autonomy of teacher and learner.

Module 1: Knowledge and its Relation to Education

2 Credits

Unit I: Perspective of Knowledge and Education

- a) Meaning and Characteristic of Knowledge
- b) Meaning, Definition and Characteristic of Education
- c) Forms of Education: Meaning and Characteristics of Formal, Non-formal, Informal

Unit II: Modern Child Centered Education (Concept, Characteristic, Educational Implications)

- a) Learning through Activity – M.K. Gandhi
- b) Learning through Discovery – John Dewey
- c) Learning through Dialogue – Paulo Freire

Unit III: Social and Cultural context of Education

- a) Concept and Characteristics of Democracy, Modernization.
- b) Concept and Need of Nationalism, Universalism and inter relationship with Education
- c) Concept of Values, Equity and Equality, Social Justice and Dignity with reference to Dr. Ambedkar

Module II: Curriculum and Its Relation to Education

2 Credits

Unit IV: Curriculum

- a) Curriculum –Concept and Need
- b) Determinants of Curriculum (Philosophical, Psychological, Sociological)
- c) Types of Curriculum – Concept and characteristics (Subject centered, Child centered, Hidden curriculum)

Unit V: Dimensions of Curriculum

- a) Principles of Curriculum development
- b) Process of Curriculum Development
- c) Relationship of curriculum with Syllabus and textbook

Unit VI: Curriculum Implementation and Evaluation

- Role of Teacher in Implementing the Curriculum
- Curriculum Evaluation: Meaning and Need of Curriculum evaluation
- Role of MHRD, NCERT in curriculum reform

Module 3: Internal Assessment 40 Marks

2 Credits

Sr. No.	Assessment	Marks
1	Class Test	15
2	Overall Assessment-Article Review, Group Discussion, Quiz, Survey Report. Poster Presentation, Guest Lecture, Interview, Game, PPT, Narrating, Project Making, Street Play, Short Film, Film Shows	05
3	Assignments (2 x 10 Marks)	20
Total		40

Any two tasks from the following (2 x 10 = 20 Marks)

- Preparing a report on difficulties faced in chapter wise teaching of the school subject
- Comparative study of the curriculum of different boards (SSC, ICSC, CBSE, IB)
- Report writing: Critically examine any secondary school text book of any two standards from 5th to 10th with reference to values of equity, equality and social justice.
- Seminar Presentation: Critical appraisal of philosophy and practice of Education advocated by Gandhi, Dewey and Freire.
- Critical writing: Critically examine the role of hidden curriculum with reference to school rules, rituals, celebrations and discipline.

References:

- Aggarwal, J.C., & Gupta, S. (2005). Curriculum Development. New Delhi: Shipra Publisher.
- Alexander, W.M., & Saylor, J.G. (1966). Curriculum Planning for modern schools, New York: Holt, Rinhart and Winston Inc.
- Balrara, M. (1999). Principal of Curriculum Renewal. New Delhi: Kanishka Publishers.
- Chandra, 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.
- D'Costa, Agnes R. (2016) Knowledge and Curriculum, Mumbai Himalaya Publishing House
- Khan M.I. and Nigam, B. K. (2007) Curriculum reform change and continuity. New Delhi; Kanishka Publication.
- Nigam, B.K.& Khan, I. M. (1993) evaluation and Research in Curriculum construction. New Delhi: Kanishka Publishers.
- Sharma, R. (2002). Modern methods of curriculum Organization, Jaipur: Book Enclave.

SEMESTER II
B.Ed.Course VI
ABILITY COURSE: CRITICAL UNDERSTANDING OF ICT

Total Credits: 03
Total Marks: 50
Internal Assessment: 50

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the concept of ICT
2. practice safe and ethical ways of using ICT.
3. apply the use of ICT in Teaching-Learning, Administration, Evaluation and Research.
4. design, develop and use ICT based learning resources.
5. explain the concept of Open Education Resources and Creative Commons in education.
6. demonstrate mobile learning, open learning and social learning in the classroom.

Module 1: ICT In Education And Its Implications

1 Credit

Unit I: Understanding of ICT in Education

- a) Information and Communication Technology in Education: Concept, Principles & Importance
- b) Approaches for using ICT in Education:
 - E-learning
 - Synchronous versus Asynchronous/ Online versus Offline
 - Individual versus Group
 - Computer based versus Other Digital Devices
 - Self-paced versus Instructor lead
- c) Ethical, Legal & Social safety in the use of ICT: Copyright, Netiquettes, Net safety, Plagiarism, Gaming addiction

Unit II: Designing Technology Integrated Learning Experiences

- a) Information Processing: Meaning, Gagne's Information Processing Model
- b) Pedagogy and Models for integrating technology in education: TPACK Model, Web-based learning (including Social Learning: Use of Web 2.0 tools for learning), Mobile Learning, Flipped Learning, Blended Learning: Concept and Applications
- c) Instructional Design: Meaning, Using ADDIE Model for Instructional Designing. Using E-tools for developing e- content material/resource including SLM (Self-Learning Materials) Script writing and Story Boarding, Recording, Presenting and Evaluation Criteria for evaluating them

Module II: Teacher And ICT Enabled Administration And Evaluation

1 Credit

Unit III: Use of ICT in Administration, Evaluation and Research

- a) LMS: Concepts, Features and Applications
- b) Technology Integration in Evaluation: Online and Offline Assessment tools - Computer Assisted Assessments, E- portfolios, Online Survey Tools, Quizzes, Podcasts, Storytelling, Graphics, Computer based games: Meaning and Application
- c) Administration with Technology: Role of ICT in school administration, School Management Software: Meaning and Applications

Unit IV: Emerging Trends in E-Learning

- a) Open Educational Resources: Creative Common Licensing, Massive Open Online Courses (MOOCs)
- b) Research with technology: ICT for Research-Online repositories/databases for research and digital library. E-portals: E-Pathshala, NROER, Diksha and Swayam Prabha: Concept and Applications
- c) Artificial Intelligence, Virtual Reality and Augmented Reality: Concept and Application in education

Module 3: Suggested Tasks/Assignments Activities

1 Credit

Any Five from the following:

- a) Select a case study/report related to legal and ethical issues in use of ICT. Discuss your case using any mode of line discussion forum. Submit the screenshots of your group discussion.
- b) Design a teaching lesson plan for any topic of your choice using the TPACK Model.
- c) Develop and critically evaluate an E-content material (Script writing and StoryBoard) using ADDIE Model of Instructional design for any topic of your choice.
- d) Develop and Manage a Social Networking site/Blog/ Chat forum for college based ICT course. Submit the report for the same with empirical evidence.
- e) Review an educational Mobile App and write a report on it.
- f) Using any LMS carry out the following activities for facilitating learning in any of the unit of your choice:
- g) Identify resources for a topic of your choice and upload it.
- h) Generate a test
- i) Use any discussion forum available for the discussion on the uploaded learning material.
- j) Select an educational problem and conduct a seminar on online surveys. Submit a report on the procedure and analysis of the survey result along with the screen shot.
- k) Conduct an assessment for any topic using any one of each Online and Offline assessment tools.
- l) Review a School Management Software and write a report on it.
- m) Select a topic relevant to education, collect Open Educational Resources (Text, Multimedia, Website references) and analyse the type of license used in the Open Educational Resources. Submit the report for the same with evidence.

References:

1. Goel, D. R., and Joshi, P. (1999). A Manual for INTERNET Awareness. CASE: The M. S. University of Baroda Press.
2. Mahapatra, B.C. (2006). Education in Cybernetic Age. New Delhi: Sarup Sons.
3. Mansfield, R. (1993). The Compact Guide to Windows. World and Excel. New Delhi: BPB Publishing.
4. Saxena, S. (1999). A first course in computers. New Delhi: Vikas Publishing House.
5. Tanenbaum, A. S. (1996). Computer Networks. New Delhi: Prentice Hall of India.
6. Walkenbach, J. (1997). Excel 97 Bible. New Delhi: Comdex Computer Publishing.
7. Khirwadkar, A. (2005). Information & Communication Technology in Education. New Delhi: Sarup & Sons.
8. Khirwadkar, A. (2010). e-learning Methodology: Perspectives on the Instructional Design for Virtual Classrooms. New Delhi: Sarup Book Publication Ltd.
9. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for integrating technology in teachers' knowledge. Teachers College Record, 108 (6), 1017–1054
10. Chatterjee, A., & Kothari, P. (2014, October). Bridging achievement gaps amongst school students through a technology-based blended learning model. In Frontiers in Education Conference (FIE), 2014 IEEE (pp. 1-8). IEEE.
11. Bergmann J., and Sams A., Flip your classroom: Reach every student in every class every day, Eugene, International Society for Technology in Education, 2012.
12. Göksel, Nil & Bozkurt, Aras. (2019). Artificial Intelligence in Education: Current Insights and Future Perspectives.
13. Helsel, S. (1992). Virtual Reality and Education. Educational Technology, 32(5), 38-42. Retrieved September 18, 2020, from <http://www.jstor.org/stable/44425644>

SEMESTER III
B.Ed.Course VII
ASSESSMENT FOR LEARNING

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the concept of Measurement, Assessment and Evaluation
2. describe the taxonomy of educational Objectives
3. discuss the current trends in Assessment
4. apply statistical calculation for interpretation.
5. design Unit test and achievement test
6. explain the process of assessment for learning

Module 1: Fundamentals of Assessment

2 Credits

Unit I: Concept of Assessment

- a) Meaning ,Nature and functions of Measurement, Assessment and Evaluation
- b) Perspectives of Assessment - Assessment for Learning, Assessment of Learning, Assessment as Learning
- c) Types of Assessment(Formative and summative)

Unit II: Educational objectives

- a) Relationship between Aims and Objectives
- b) Criteria of writing statements of objectives and specifications
- c) Taxonomy of Revised Bloom's Educational objectives - Cognitive, Affective, Psychomotor

Unit III: Learning Experiences

- a) Value Based Learning Experiences
- b) Sources of learning experience
- c) Records used in Assessment- Cumulative record, Reflective journal

Module II: Instrument of Assessment and Results

2 Credits

Unit IV: Tools of Assessment

- a) Characteristics of measuring tools: Validity, Reliability, Objectivity, Usability, Adequacy and Discrimination Power (Concepts and Factors Affecting them)
- b) Evaluation Tools and Techniques: Meaning, features, merits and demerits
 - (i) Observation Technique: Rating Scale and Check List
 - (ii) Self Reporting Technique: Interview and Questionnaire
 - (iii) Projective Technique: Thematic Apperception Test (TAT) and Sentence Completion Test
- c) Achievement Test: Meaning, features, merits and demerits

- i) Performance test (Oral and practical)
- ii) Written: Essay and Objective
- iii) Open book and online

Unit V: Examination Reforms

- Continuous and Comprehensive Evaluation (CCE)
- Choice Based Credit System (CBCS)
- Feedback in Assessment - Importance of Feedback in learning, Types of Feedback: Constructive feedback, Oral and Written, Individual & Group

Unit VI: Interpreting Test Scores

- Measures of Central Tendency: Mean, Median, Mode
- Percentile and Percentile Rank
- Graphical representation of data : Histogram, Frequency polygon

Module 3: Internal Assessment

2 Credits

S.No	Task	Marks
1	Assignments (2*10)	20 marks
2	Case study/ Projects/ Posters and exhibits/ Seminar/Workshop/ Co-operative Learning/ Blended Learning/ Constructivist Learning/ Nai Talim – Experiential Learning/ Open Book assignment	05 marks
3	Class Test	15 marks
	Total	40 marks

Any two tasks from the following (2 x 10 = 20 Marks)

- Developing an achievement test with its Blue Print, Answer Key and Marks Distribution.
- Developing a Portfolio / Profile / Evaluation Rubric
- Evaluation of available Unit test and reformation of the same.
- Designing Questionnaire / Interview Schedule on a given topic
- Preparing any four evaluation tools for Formative Assessment.

References:

- Dandekar, W.N. (2007). Evaluation in Schools. Pune: Shree Vidya Prakashan.
- Ebel, R.L. & Fresbie, D.A. (2009). Essentials of Educational Measurement. New Delhi: PHI Learning PVT. LTD.
- Gupta, S. K. (1994). Applied Statistics for Education. Mittal Publications.
- Garrett, H.E. (2008). Statistics in Psychology and Education. Delhi: Surjeet Publication.
- Mrunalini, T. (2013). Educational Evaluation. Hyderabad: Neelkamal Publications Pvt. Ltd. Patel, R.N. (2011).
- Educational Evaluation Theory and Practice. Mumbai: Himalaya Publishing House Pvt. Ltd.
- Rani, P. (2004). Educational Measurement and Evaluation. New Delhi: Discovery Publishers. Rawat, D. S. (1970).
- Measurement, Evaluation and Statistics in Education. , New Delhi: New Raj Book Depot.
- Reynolds, C.R., Livingston, R.B., and Willson, V. (2011). Measurement and Assessment in Education. New Delhi: PHI Learning PVT. LTD.
- Siddiqui, M.H. (2010). Educational Evaluation. New Delhi: A.P.H. Publishing Corporation. Sidhu, K.S. (2009).
- New Approaches to Measurement and Evaluation. New Delhi: Sterling Publishers Pvt. Ltd.
- Ten Brink, T. D. (1974). Evaluation - A Practical Guide for Teachers. New York: McGraw Hill Book Co.
- Thorndike, R.M. (2010). Measurement and Evaluation in Psychology and Education. New Delhi: PHI Learning PVT. LTD.

SEMESTER III
B.Ed.Course VIII
PEDAGOGY OF SUBJECT – SCIENCE 1

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. Explain the concept of Science as an academic discipline
2. describe Science as a body of Knowledge
3. explain the concept of Curricular aspects of Science
4. explain the Learner and Learning Dynamics
5. explain the concept of Learning experiences and maximizing students' engagement in the learning of Science

Module 1: Fundamentals of Science

2 Credits

UNIT I: Science as an academic discipline

- a) Meaning and characteristics of academic disciplines
- b) Becher-Biglan Typology in the classification of academic disciplines
- c) Science as an academic discipline and its various branches

UNIT II: Understanding Science as a body of Knowledge

- a) Meaning and nature of Science (Science as a product and process)
- b) Values of Science in the socio-cultural context
- c) Scientific Attitude- Meaning and its characteristics

UNIT III: Curricular aspects in Science

- a) Interdisciplinary and Multidisciplinary approach
- b) Scientific Language and Communication
- c) Mathematics in Science

Module II : Transacting Science Curriculum

2 Credits

UNIT IV : Psychological Approach to Science Teaching-Learning

- a) Diversity and Inclusiveness in Science classrooms
- b) Maxims of teaching Science: Known to Unknown, Simple to Complex, Whole to Part, Particular to General, Concrete to Abstract, Empirical to Rational
- c) Internal & External correlation in Science teaching

UNIT V: Learning Experiences in Science

- a) Direct and Indirect Learning Experiences and its importance in Science (with respect to Edgar Dale's Cone of Experience)
- b) Teaching Learning Materials (TLM) in Science Education: Use of print material, charts, models, specimens, science kits, audio-visual and digital learning materials
- c) Preparation, Selection and Creation of TLM in Science

UNIT VI: Maximizing Student Engagement

- a) Science Club - Importance, Organization and Activities
- b) Science hobbies, movies and Science literature - Significance
- c) Science Museums and Planetarium - Significance

Sr. No.	Particulars	Marks
1	Task/Assignment/ Activity for each module held in the semester (2X10)	20
2	One periodical class test held in the given Semester	15
3	One Essay test held in the given Semester	05
	TOTAL	40

Suggested (Any Two) Of The Following Tasks:

1. Conduct a survey on school science teachers, college science teachers, students, professionals, farmers etc. regarding the nature and significance (value) of science.
2. Plan any 3 differentiated content strategies for a science topic in an inclusive classroom.
3. 'Mathematics is at the heart of science'. Prepare a paper establishing this relationship by analyzing the influence of mathematics in developing science concepts.
4. Prepare an attitude scale consisting of 10 items measuring the scientific temper of school students.
5. Conduct any one science club activity and write a report on it.
6. Prepare a science resource kit for teaching learning of a particular topic along with a write up ((name of unit, name of the theme/topic, materials used, procedure, learning outcomes).
7. Write a critical film review on the theme environment with respect to the values of science
8. Visit a museum / planetarium and write a reflective narrative on the significance of museum / planetarium in augmenting knowledge of Science.

References:

1. Areekkuzhiyil, Santhosh. (2017). Understanding Discipline and Subjects. Hyderabad: Neelkamel Publishers.
2. Becher, T. & Trowler, P.R. (2001). Academic tribes and territories: Intellectual inquiry and the culture of disciplines (2nd ed.). Buckingham, England: Open University Press.
3. Bhandula, Chadha and Sharma: Teaching of Science, Parkash Brothers Educational Publishers, 1985.
4. Bhatia & Bhatk the Principles and Methods of Teaching, Doaha house Booksellers and Publishers, 1994.
5. Biglan, A. (1973). Relationships between subject matter characteristics and the structure and output of university departments. Journal of Applied Psychology 57(3), 204-213.
6. Biglan, A. (1973). The characteristics of subject matter in different academic areas. Journal of Applied Psychology 57 (3), 195-203.
7. Gupta, S. K. (1983). Teaching of physical science in secondary schools. New Delhi: Sterling Publications (Pvt.) Limited.
8. <https://understandingdisciplines.webs.com/>
9. J.C.Aggarwal: Principles, Methods and Techniques of Teaching, Vikas Publishing house Pvt. Ltd., 2000.
10. Jahagirdar, R. A. (n.d.). Collected works of Justice R. A. Jahagirdar: Scientific temper. Rationalist Foundation. Retrieved from https://archive.org/details/Scientific_Temper-English-R.A.Jahagirdar
11. Janie Gross Stein, Richard Stein (Ed.)(2001)Network of knowledge: Collaborative innovation in international learning: Toronto Canada, University of Toronto Press incorporated.
12. John Loughran (1996). Developing reflective Practice: Learning about teaching and Learning through Modelling. London: Falmer Press
13. Korde and Sawant; Science and Scientific Method, Himalaya publishing house, 1980.
14. Krishnan, A. (2009). What are Academic Disciplines? Some observations on the Disciplinarity vs. Interdisciplinarity debate. Retrieved from: [eprints.ncrm.ac.uk/783/1/ what_are_academic_disciplines.pdf](http://eprints.ncrm.ac.uk/783/1/what_are_academic_disciplines.pdf)
15. Mahanti, S. (2013). A perspective on scientific temper in India. Journal of Scientific Temper, 1, 46-62. Retrieved from <http://op.niscair.res.in/index.php/JST/article/view/1099>

16. Mary, L.S.(1985). State of the art : Transforming ideas for teaching and learning science. A guide for elementary education, Washington, DC: United States,Dept. of education.
17. Mathew, T.K., & Mollykutty, T. M. (2011). Science education : Theoretical bases of teaching and pedagogic analysis. Chenganoor: Rainbow Book Publishers.
18. Narendra Vaidya: Science teaching in schools for the 21st century. Deep and deep publications Pvt Ltd.,
19. New Trends in Integrated Science Teaching, Vol.1, UNESCO.1969-70.
20. Prasad Janardhan, (1999.) Practical aspects in Teaching of Science, Kanishka Publication, N. Delhi
21. R.C Sharma (2003) Modern Science teaching, Dhanpat Rai Publishing Company
22. Ralph Martin, Colleen Sexton, Teresa Franklin, Jack Gerlovich, & Dennis McElroy (2008). Teaching Science for All Children: An Inquiry Approach. (5th ed.). Pearson, U.S.
23. Rena M.Palloff & Keith Pratt (2009): Assessing online learner: San Fransisco, Jossey – Bass.
24. Sharma, R. C. (1985). Modern science teaching. New Delhi: Dhanpat Rai & Sons. Smith and Anderson (1984). Cited in apples 4 the teacher.com articles, Science Misconceptions Research and Some Implications for the Teaching of Science to Elementary School Students.
25. Suresh K.P. and Joseph, Celene (2012). Teaching and Testing Science Process skills.New Delhi: Shipra Publications .
26. Thurber, W. A., & Collette, A. T. (1964). Teaching science in today's secondary school. New Delhi; Prentice Hall Of India Limited.
27. Tony Ghaye (2011). Teaching n and learning through Reflective Practice (2nd Edn.) Newyork: Routledge
28. Trowbridge, L. W. & Bybee, R. W. (1996). Teaching secondary school science.(6thed.). Eng

SEMESTER- III

B.Ed.Course IX

PEDAGOGY OF SCHOOL SUBJECT MATHEMATICS 1

Total Credits: 06

Total Marks: 100

External Assessment: 60

Internal Assessment: 40

Course Learning Outcomes

1. explain the basic concepts associated with Academic Disciplines
2. explain the place of Mathematics as a Discipline in the school curriculum.
3. discuss the role of Mathematics education in NEP 2020
4. explain the nature, scope & importance of Mathematics at Middle Stage and Secondary stage as outlined in NEP 2020.
5. explain the aims of teaching Mathematics and objectives in teaching Mathematics across a) Middle and Secondary Stage (as outlined in NEP) in the school education and b) the three domains (Cognitive, affective and psychomotor).
6. apply different Psychological Perspectives in Mathematics education.
7. apply different approaches to teaching mathematics in classroom situations.
8. analyze the importance of mathematics laboratory in creating interest in Mathematics.
9. apply essentials of teaching Mathematics in curriculum transaction.
10. appreciate the role of mathematics in day-to-day life.
11. analyze the characteristics of Mathematics textbook.
12. explain the need and importance of learning resources in Mathematics education.

Module 1: Fundamentals of Mathematics Education

2 Credits

Unit I: Basics of Academic Disciplines

- a) Meaning of Academic Disciplines, Relationship between Academic Discipline and Mathematics as school subject.
- b) Classification of academic disciplines: Becher -Biglan typology (pure-hard, pure soft, applied-hard, applied-soft types) with emphasis on nature of knowledge in each type.
- c) Multidisciplinary approach in teaching of Mathematics.

Unit II: Introduction to Teaching of Mathematics

- a) Meaning, Nature & Scope of Mathematics
- b) NEP 2020 and Mathematics Education
- c) Aims and Objectives of teaching Mathematics at Middle and Secondary stage (as outlined in NEP) and at different domains (Cognitive, affective and psychomotor)

Unit III: Psychological Perspectives in Mathematics Education

- a) Application of Piaget's theory in Mathematics
- b) Application of Vygotsky theory in Mathematics
- c) Application of Gardner's theory in Mathematics

Module II: Transacting Mathematics Curriculum**2 Credits****Unit IV: Essentials of Teaching Mathematics in Curriculum Transaction**

1. Values of teaching Mathematics
2. Maxims of Teaching
 - From Known to Unknown
 - From Simple to Complex
 - From Particular to General
 - From Concrete to Abstract
 - From Whole to Part
3. Approaches of curriculum construction-Concentric and Topical

Unit V: Mathematics Textbook

- a) Textbook –Need and Importance
- b) Textbook – Characteristics of good Mathematics textbook
- c) Critical analysis of Mathematics textbook

Unit VI: Learning Resources in Mathematics

- a) Need and importance of learning resources
- b) Mathematics Laboratory: Objectives, Significance and Organization
- c) 3D Objects, Models and Comic Books

Module III: Internal Assessment**2 Credits**

Sr. No.	Particulars	Marks
1	Two Task/Assignment/ Activity (2 X 10)	20
2	One periodical class test held in the given Semester	15
3	One Essay test held in the given Semester	5
	Total	40

Suggested Tasks and Assignments: (Any Two)

1. Trace the evolution of Mathematics.
2. Comparative study of place of Mathematics education as recommended by different education commissions post-independence.
3. Conduct the Seminar presentation on Piaget/Gardner/Vygotsky theory in teaching of Mathematics.
4. Critically examine the curriculum construction approach (concentric/topical) used by any education boards (CBSE/SSC/ICSE/IB/IGCSE).
5. Critically analysis any one textbook of Mathematics
6. Select a learning resource from the Mathematics lab and demonstrate a mathematics concept.

References

1. Boyer, Carl B., (1969): A History of Mathematics; Wiley, New York.
2. Content cum Methodology of Teaching Mathematics for B.Ed; NCERT New Delhi.
3. Davis David R., (1960); Teaching of Mathematics Addison Wesley Publications.
4. Ediger Mariow (2004); Teaching Math Successfully, Discovery Publication.
5. Gupta H.N. and Shankaran V (Ed.), 1984; Content cum Methodology of Teaching Mathematics, NCERT New Delhi.
6. James Anice (2005); Teaching of Mathematics, Neelkamal Publication.

7. Johan R.E. et.al, (1961): Modern Algebra; First Course, Addison-Wesley Publishing Company INC. USA.
8. Kulshreshtha; Teaching of Mathematics, R. Lal and Sons.
9. Kumar Sudhir; Teaching of Mathematics, Anmol Publications, New Delhi, India.
10. Mangal, A text book on Teaching of Mathematics, Prakash Bros., Ludhiana, India.
11. NCERT (2006) Position Paper-National Focus Group on Teaching of Mathematics, New Delhi
12. Novak, J.D. & Gowin, D.B., (1984), Learning How to Learn, New York, NY, Cambridge University Press
13. Hollands (1990), Development of mathematical skills, Blackwell Publishers, Oxford, London
14. Schonnel F.J. (1965), Diagnostic and Remedial Teaching in Arithmetic, Lever and Boyd, London
15. Pamela Cowan (2006), Teaching Mathematics, A Handbook for Primary and Secondary School Teachers, Routledge, London and New York
16. Tanner H. And Jones S. (2000), Becoming a successful teacher of mathematics, Routledge Falmer, London
17. Thompson D.R and Rubenstein, R. N (2010), Teaching and Learning High School Mathematics, John Wiley and Sons Inc., New Jersey,
18. Weinberg A.S. (1999), Connecting Mathematics and Science to Workplace Contexts: A Guide to Curriculum materials, Corwin Press Inc., California

SEMESTER III
B.Ed.Course X
ABILITY COURSE: DRAMA AND ART IN EDUCATION

Total Credits: 03
Total Marks: 50
Internal Assessment: 50

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the importance of drama & art, scope, and purpose of art education,
2. relate reality through fantasy, and to predict everyday situations to cope with unpredictable unsettling experiences,
3. discuss the self and as a form of self-expression for enhancing creativity,
4. appreciate the aesthetic the use of art in teaching learning to understand global and local culture,
5. analyze the role of the teacher as creative guide in enhancing drama and art education.

Module I: Understanding Drama and Art in Education

2 Credits

Unit I: Introduction to the concept of Drama and Art

- a) Forms of Drama and Art (Visual Art, Performing Art)
- b) Functions of Drama and Art
- c) Integration of Drama and Art in the school curriculum

Unit II: Context of Art

- a) Functions of Art : Personal, Social, Spiritual, Educational, Political
- b) Types of Contrast : Visional, Form, Negative
- c) Social and cultural importance of Art

Module II: Application of Drama and Art in Education

2 Credits

Unit III: Application of Drama and Art in Education

- a) Developing aesthetic sensibility through Drama and Art
- b) Drama and Art for creative expression
- c) Drama and Art for self-realization

Unit IV: Drama and Art for Teaching

- a) Drama and Art: Understanding social and environmental issues, Understanding global and local culture
- b) Drama and Art for children with special needs and marginalized
- c) Drama and Art for children in multilingual society

Activities:

Following activities can be organized under the course:

1. Script writing
2. Street play
3. Visit to an Art gallery
4. Visiting/Organizing exhibitions
5. Visiting/Organizing cultural festivals
6. Report on the folk life
7. Interview with experts from the field like artists, actors, singers, writers, poets, painters, musicians, dancer, etc
8. Appreciation of a film/drama/novel/folk drama, etc.

9. Workshop on developing short plays/ street play for educational, entertainment or social / environmental relevance
10. Workshop on preparing a script for a radio programme to propagate a social behaviour or awareness of social issues
11. Organizing art, craft and music exercises with small groups followed by discussions and presentation.
12. Workshop –Developing theatre skills, pottery, folk dance, animations depicting culture and art.
13. Review the position paper National Focus Group on Arts, Music, Drama and Theatre by NCTE on Drama for children with special needs.
14. Visit a centre for children with special needs and observe the use of drama and art in the activities conducted.

Assignments: Any two of the following (5x10 = 50m)

1. Role Playing’ activity for historical / contemporary personalities wherein students play the role of that personality to advocate his/her opinions/decisions/thought processes (for example, Akbar, Hitler, Galileo, Bhagat Singh etc.) and write a reflective essay highlighting the elements of stagecraft.
2. Develop and present a lesson using any one technique of Drama and Art Or using any Art form
3. Developing masks and puppets to teach any topic in their methods, present a lesson using it. Submission of a lesson plan is required.
4. Write an appreciation essay on the historical monuments (sculpture and architecture) or any piece of art (music, dance drama, painting)
5. Write a self-reflective essay on how this course on Dram and Art will make you a better teacher.
6. Review studies on effectiveness of drama and art on education and present the same.
7. Observe an Art period in a school and briefly write your reflections on it.

References

1. Akademi South Asian Dance, UK – <http://www.southasiandance.org.uk/>
2. Andrewes, E.: A Manual for Drawing and Painting, Hazall Watson and Viney Ltd., 1978
3. Carini, P.F. (2001). Valuing the immeasurable. In Starting strong: A different look at children, schools, and standards (pp. 165–181). New York: Teachers College Press, CCRT official website
5. Chawla, S.S. (1986). Teaching of Art. Patiala: Publication Bureau, Punjabi University.
6. Dodd, N. and Winifred, H. (1971/1980). Drama and Theatre in Education, London: Heinmann.
7. Doshi, Saryu (Ed.), “Marg–A Magazine of the Arts – Trends and Transitions in Mumbai: Indian Marg Publications, Art” Vol. XXXVI No. 2, 1984.
8. Efland, A. D. (1990). A history of Art Education: Intellectual and social currents in teaching the visual arts. New York, NY: Teachers College Press.
9. Harriet, G. (1964). Art in Everyday Life. Calcutta: Oxford and IBH Publishing Company.
10. John, B., Yogin, C., & Chawla, R. (2007). Playing for real: Using drama in the classroom. Macmillan.
11. Khokar, Mohan, Traditions of Indian Classical Dance, Delhi: Clarion Books, First ed., 1979., London, 1973
12. Khanna, S. and NBT (1992). Joy of Making Indian Toys, Popular Science. New Delhi: NBT.
13. McCaslin, N. (1987). Creative Drama in the Primary Grades. Vol. I and In the Intermediate Grades, Vol. II, New York/London: Longman.
14. Mishra, A. (2004). Aaj bhi Kharein hai Talaab, Gandhi Peace Foundation, 5th Edition.
15. Prasad, D. (1998). Art as the Basis of Education, NBT, New Delhi.
16. Sahi, J. and Sahi, R. (2009). Learning Through Art, Eklavya.
17. Shirley, G. (2000). Art, an A to Z guide. Franklin Watts: USA.
18. Vaze, P. (1999). How to Draw and Paint Nature. Jyosna Prakashan: Mumbai.
19. Ward, A. (1993). Sound and Music. Franklin Watts: New York.

Websites:

1. Athiemoalam, L. Drama-In-Education and its effectiveness in English Second/Foreign classes, www.uni-oldenburg.de/zsn
2. Arts Education Matters: We know, We Measured it, <http://www.edweek.org/ew/articles/2014/12/03/13greene.h34.html>
3. Bhattacharya, K.K. & Gupta, D.D. : Interpreting theatre as a communication medium, <http://www.caluniv.ac.in/global-mdia-journal/ARTICLEDEC2013/>
4. Boudreault, C.: The benefits of using drama in the ESL/EFL classroom,
5. <http://iteslj.org/Articles/Boudreault-Drama.html>
6. Dewey, J.: Art as an experience, <http://plato.stanford.edu/entries/dewey-aesthetics/>
7. Drama in education, <https://www.questia.com/library/education/curriculum-andinstruction/>
8. drama-in-education
9. Drama Games, http://en.wikipedia.org/wiki/Drama_Teaching_Techniques
10. Drama Strategies, <http://dramaresource.com/strategies/69-drama-techniques>
11. Importance of Arts education, <http://www.educationfund.org/programs/artoffoundobjects/importance ofArts Education>

SEMESTER IV
B.Ed.Course XI
CONTEMPORARY INDIA AND EDUCATION

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the concepts, characteristics, causes of various Diversities in Contemporary Indiansociety.
2. describe the challenges faced due to various diversities and the role of education in addressingthem.
3. critically analyze the constitutional values related to the Diversity, Stratification and Marginalization.
4. apply the Policies, Curricular Framework and Role of Education in Indian context.
5. explain the provisions and recommendations of various government initiatives for the ParadigmShift in Education.
6. discuss the emerging trends in education.

Module 1: Contemporary Indian Society

2 Credits

Unit I. Understanding and Addressing Diversities in Contemporary Indian Society

- a) Concepts of Diversity, Linguistic Diversity, Regional Diversity and Religious Diversity.
- b) Characteristics and Causes of Linguistic Diversity, Regional Diversity and Religious Diversity.
- c) The role of education in addressing the challenges of diversity - linguistic, regional and religious in modern India.

Unit II. Understanding and Addressing Inequality in Indian society

- a) Concept and Causes of Stratification with respect to Caste, Class & Gender.
- b) Concept and characteristics of Marginalized groups in Indian society: SC/ST/NT (Nomadic Tribes)/PWD (person with disability).
- c) Role of education in addressing Inequalities with respect to Stratification and Marginalization in Indian society.

Unit 3: Values enshrined in Indian Constitution addressing Diversity, Stratification andMarginalization

- a) Constitutional Values like democracy, socialism and equality for reducing stratification and marginalization
- b) Education and Fundamental Rights and Duties: Articles 14, 15, 16, 21A, 29 and 30.
- c) Directive Principles of state policy with regards to stratification and marginalization (Article 41, 45,46,350A)

Module II: Government Initiatives in Education

2 Credits

Unit IV – Policies, Curricular Framework and Role of Education

- a) National Policy of Education-1986,
- b) National Curricular Framework-2005
- c) National Education Policy 2020

Unit V- Paradigm Shift in Education

- a) Yash Pal Committee Report-‘Learning without Burden’ (1992-93),and its provisions
- b) RTE Act 2009 and its Provisions
- c) RMSA and Recommendations for Secondary Education

Unit VI- Emerging Trends in Education

- a) Open & Distance Education: Concept & Characteristics
- b) Globalization, Liberalization & Privatization: Concept, Characteristics and Implications
- c) Digitalisation in Education: Concept, Characteristics and Challenges

Module 3: Internal Assessment

2 Credits

Sr. No.	Particular	Marks
1	Task/Assignment for each module held in the semester (2X10)	20
2	One periodical class test held in the given semester	15
3	Overall participation (tasks/ assignments/ Group discussion/poster competition/ elocution/	05
	Total	40

Any two of the following tasks/assignments:

- a) Organizing and conducting street plays on various diversities (Linguistic, Regional and Religious) and addressing its related issues.
- b) Critical analysis of a documentary based on Stratification and Marginalisation in Indian society.
- c) Critical analysis of the provisions and recommendations of School Education-NEP 2020.
- d) Seminar presentation on the impact of emerging trends/policies in Education

References:

1. Agarwal J.C. (1991). Theory and practices of education. New Delhi: Vikas publishing house Pvt Ltd.
2. Agarwal. J.C (2008). Education in the emerging Indian Society. Shipra Publications
3. Aggarwal J. C. (1994). Learning without burden: An Analysis. Shipra Publications.
4. Aggarwal J.C.(2016).Right to Education and Revitalizing Education, Shipra Publications.
5. Anand, C.L. et.al. (1983). Teacher Education in Emerging in Indian Society, NCERT, New Delhi.
6. Arora G.L & Pranati Panda.Fifty Years of Teacher Education in India (Post Independence Developments). New Delhi:NCERT
7. Bhatia K K.(2015). Contemporary India and education, Tandon Publications, Ludhiana.
8. Chaube,S.P.(1997).Landmarks in modern Indian education.Mumbai:Himalaya Publishing House.
9. Chaube, S. P. (1999). Philosophical and Sociological Foundations of Education.Agra: Shri Vinod Pustak Mandir.
- 10.Chaube. S.P. (2013). Problems of Indian Education. Shri Vinod Pustak Mandir : Agra
- 11.Chinara B.(1997). Education and Democracy. New Delhi : APH.
- 12.Dash,BN(2002).Teacher and education in the emerging Indian Society.Vol.2. Hyderabad: Neelkamal publication.
- 13.Final National Education Policy 2020 (PDF) (Report). Ministry of Human Resource Development.
- 14.Jain, M K.(2014). Committees and commissions, ShriVinodPustakMandir : Agra
- 15.John, Zeepa Sara. (2012) Philosophical and Sociological Foundations of Education. Chennai: Almighty Book Company,
- 16.Khanna, J.(2016). Education as a field of study,Tandon Publications, Ludhiana.
- 17.MansuriL(2019).Contemporary India and Education.HimalayanPublusing House.
- 18.Mukherji, S. M.(1966). History of education in India, charya book depot, baroda.
- 19.National Advisory Committee Contributor India (2004). Department of Education (1971), Government of India, Ministry of Human Resource Development, Department of Education, Learning Without Burden: Report of the National Advisory Committee Appointed by the Ministry of Human Resource Development
- 20.NCERT (2005). National curriculum framework, New Delhi.
- 21.Public report on basic Education in India: The Probe team in association with centre for development

economics, October 1998

22. Qureshi, Muniruddin. (2005). Social aspects of Education. Anmol Publications Pvt. Ltd.: New Delhi
23. Ravikumar, S.K. (2001). Educational Sociology, Mangal Deep Publications, Jaipur.
24. Sampat, Urmi. (2007). Education in changing Indian society, Himalaya Publishing House, Mumbai.
25. Sharma R.A. (1993). Teacher Education: Theory, Practice and Research. Meerut : International Publishing House
26. Sharma, D. (2015). Contemporary India and Education, Tandon Publications, Ludhiana.
27. Sngaravelu.G. (2012). Education in the Emerging Indian Society. Neelkamal Publications Pvt. Ltd.: New Delhi
28. Swaroop Sarena, N.R. & Shikha Chaturvedi. (2012). Teacher in Emerging Indian Society. Lall Book Depot
- 29.: Meerut
30. Zhijian, L. The multirole of Teacher: Retrieved July 10, 2012, from Wuhan university of science and engineering: <http://www.seiofbluemountain.com>
31. Vision of Teacher Education in India Quality and Regulatory Perspective. Volume 1 August, 2012. Retrieved from
32. http://mhrd.gov.in/sites/upload_files/mhrd/files/documentreports/JVC%20Vol%201.pdf
33. https://www.mhrd.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
34. <https://www.mhrd.gov.in/rte>

SEMESTER IV
B.Ed.Course XII
PEDAGOGY OF SUBJECT – SCIENCE I

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the objectives of teaching Science as given by NCF 2005
2. justify the role of place of Science curriculum with reference to NEP, 2020 and curriculum organization
3. explain the use effectively the different methods, approaches and techniques for teaching- learning of science
4. explain the innovations in Science teaching -learning process
5. design the planning and lesson planning
6. explain the different areas, tests and criteria for measuring learning outcomes of learners
7. explain the significance of science process skills and its evaluation.

Module 1: Contemporary Trends in Science Teaching

2 Credits

Unit I: Policy and Perspectives in Science teaching

- a) Aims and Objectives of teaching Science with respect to NCF, 2005 (Upper Primary, Secondary and Higher Secondary)
- b) Place of Science with reference to NEP 2020
- c) Curriculum Organization- Concentric and Topical approach

Unit II: Science Teaching: Methods, Approaches and Techniques

- a) Methods of Teaching: Lecture cum demonstration method, Project Method (Meaning, Steps and Illustration)
- b) Approaches- Inductive - deductive Approach (Meaning, Steps and Significance)
- c) Techniques: Concept Mapping (Meaning, Steps and Significance)

Unit III: Innovations In Science Teaching - Learning

- a) Scenario Based Learning - Meaning and Strategies
- b) Experiential Learning - Application of Kolb's cycle in Science learning
- c) Blended learning with ICT - Meaning and Significance

Module II: Planning and Evaluation In Science

2 Credits

Unit IV: Planning for Science Instruction

- a) Unit Planning: Meaning, Steps and Importance in Science teaching
- b) Understanding the context of teaching - learning (factors related to the learning situation)
- c) Lesson Planning: Meaning, Steps and Importance in Science teaching

Unit V: Measuring Learning outcomes in Science

- a) Areas of Continuous Comprehensive Evaluation in Science
- b) Achievement test and Diagnostic test: Meaning, Construction and Administration
- c) Criteria for assessment of Practical work: Laboratory and Project Work

Unit VI: Evaluating Science Process skills

- a) Science Process Skills: Basic and Integrated (Types and Significance)
- b) Rubrics - Meaning, Use (as a tool for recording process skills)
- c) Approaches to the Assessment of Science Process Skills: Alternatives, Authentic and Performance Assessments

Module 3 : Internal Assessment**2 Credits**

Sr. No.	Particulars	Marks
1	Task/Assignment/ Activity for each module held in the semester (2X10)	20
2	One periodical class test held in the given Semester	15
3	One Essay test held in the given Semester	05
	TOTAL	40

Suggested (Any Two) of the Following Tasks:

1. Prepare an innovative lesson plan based on any topic of your choice and conduct the lesson.
2. Conduct any one experiment in science laboratory for secondary students and prepare the report including the journal writing instructions
3. Prepare a rubric for assessment of a science project work of secondary students.
4. Analyze the NCF-2005/ 2021 position paper with respect to the recommendations for the development of school science curriculum at different levels.
5. Design one activity each for developing any 4 basic and 4 integrated science process skills among school students.
6. Prepare a unit test for assessing achievement in Science (Blue print, Marking scheme, Soring key and Final question paper)
7. Identify any one common learning difficulty in science and prepare a diagnostic test for it or suggest remedial measures for the same.
8. Prepare a Concept Map/Mind Map on any selected unit in Science.

References:

1. "The Science Process Skills" <https://narst.org/research-matters/science-process-skills>
2. Aggarwal, J.C.: Principles, Methods and Techniques of Teaching, Vikas Publishing house Pvt. Ltd., 2000
3. Bhatia & Bhatk the Principles and Methods of Teaching, Doaha house Booksellers and Publishers, 1994. J.C.Agarwal: Prin
4. CCE in science https://ncert.nic.in/dee/pdf/CCE_Science.pdf
5. Deborah, and Kimberly (2017) "Rubrics: Tools for Making Learning Goals and Evaluation Criteria Explicit for Both Teachers and Learners" CBE—Life Sciences Education, <https://www.lifescied.org/doi/full/10.1187/cbe.06-06-0168>
6. <https://ttcinovations.com/five-ways-to-engage-students-with-scenario-based-learning/>
7. Kochhar , S.K. Kochhar: Methods and Techniques of Teaching, Sterling Publishers Pvt Ltd., 2003.: Methods and Techniques of Teaching, Sterling Publishers Pvt Ltd., 2003.
8. Lalima and Kiran, (2017)"Blended Learning: An Innovative Approach:Universal Journal of Educational Research, <https://files.eric.ed.gov/fulltext/EJ1124666.pdf>
9. National Education Policy 2020- MHRD https://www.education.gov.in/sites/upload_files/mhrd/files/NEP_Final_English_0.pdf
10. NCERT. (2005)National Curriculum Frame Work New Delhi: NCERT
11. Oloruntegbe, K.O (2010) "Approaches to the Assessment of Science Process Skills" , Journal of College Teaching & Learning. <https://www.clutejournals.com/index.php/TLC/article/download/125/122>
12. Pedagogy of Science, https://ncert.nic.in/desm/pdf/phy_sci_partI.pdf
13. Pedagogy of Science, https://ncert.nic.in/desm/pdf/phy_sci_PartII.pdf
14. Sharma, R.C. Modern science teaching, Dhanpat Rai Publishing company (P) ltd, New Delhi, 2006
15. Suresh K.P. and Joseph, Celene (2012). Teaching and Testing Science Process skills.New Delhi: Shipra Publications .
16. Teaching of Science, <https://ncert.nic.in/pdf/focus-group/science.pdf>

SEMESTER-IV
B.Ed.Course XIII
PEDAGOGY OF SCHOOL SUBJECT MATHEMATICS II

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. analyze pedagogically the Mathematics content.
2. design the unit plan, year plan and Lesson plan.
3. explain the hierarchical arrangement of the Mathematics curriculum.
4. explain the different strategies and techniques of teaching Mathematics.
5. illustrate the different strategies & techniques in teaching Mathematics.
6. explain different approaches in teaching Mathematics.
7. explain the appropriate methods to teach different content of Mathematics.
8. apply ICT in Mathematics Education for : a) Teaching - learning b) Assessment

Module 1: Instructional Planning in Mathematics

2 Credits

Unit I: Pedagogical Analysis

- a) Content Analysis
- b) Instructional Objectives
- c) Strategies for Instruction and Assessment

Unit II: Planning in Mathematics

- a) Curriculum Hierarchy and Annual plan
- b) Unit plan & Concept Mapping of a unit
- c) Lesson Planning

Unit III Strategies & Techniques of Teaching Mathematics

- a) Individualised learning, Guided learning (Need and importance)
- b) Drill, Review & Assignment in teaching of Mathematics. (Concept, Advantages and Disadvantages)
- c) Brainstorming, Seminar (Concept, Advantages and Disadvantages)

Module II: Methods of Teaching

2 Credits

Unit IV: Teaching of Mathematics I

- a) Teaching Concepts (Concept Development Design)
- b) Teaching Generalizations (Inductive Deductive)
- c) Teaching Problem Solving (Problem Solving)

UNIT V: Teaching of Mathematics II

- a) Teaching Constructions (Lecture cum Demonstration)
- b) Teaching Proofs (Analytical Synthetic)
- c) Experiential learning

Unit VI: ICT in Teaching -Learning of Mathematics - I

- a) GeoGebra, Virtual Manipulatives, Robocompass (Applications, Advantages and Limitations)
- b) Symbolab, nzmaths, Coggle (Applications, Advantages and Limitations)
- c) ICT for Assessment - Edpuzzle, Socrative

Module III: Internal Assessment

2 Credits

Sr. No.	Particulars	Marks
1	Two Task/Assignment/ Activity (2 X 10)	20
2	One periodical class test held in the given Semester	15
3	One Essay test held in the given Semester	5
	Total	40

Suggested Tasks and Assignments: (Any Two)

- 1. Prepare Pedagogical Analysis Plan for any selected topic in Mathematics.
- 2. Organise a seminar on any mathematical topic.
- 3. Prepare a math lesson using any of the ICT tools.
- 4. Prepare a lesson plan in mathematics using appropriate method/ approach to teach Concepts /Generalizations /Problem Solving/ Constructions/ Proofs
- 5. Prepare a Concept map & Unit Plan of any unit from Mathematics.
- 6. Create an online test using an appropriate app.

References

- 1. Content cum Methodology of Teaching Mathematics for B.Ed; NCERT New Delhi.
- 2. Ediger Mariow (2004); Teaching Math Successfully, Discovery Publication.
- 3. Gupta H.N. and Shankaran V (Ed.), 1984; Content cum Methodology of Teaching Mathematics, NCERT New Delhi.
- 4. Hudgins, Bryce B. (1966); Problem Solving in the classroom, MacMillan, New York.
- 5. James Anice (2005); Teaching of Mathematics, Neelkamal Publication.
- 6. Johan R.E. et.al, (1961); Modern Algebra; First Course, Addison-Wesley Publishing Company INC. USA.
- 7. Kulshreshtha; Teaching of Mathematics, R. Lal and Sons.
- 8. Kumar Sudhir; Teaching of Mathematics, Anmol Publications, New Delhi, India.
- 9. Pamela Cowan (2006), Teaching Mathematics, A Handbook for Primary and Secondary School Teachers, Routledge, London and New York
- 10. Tanner H. And Jones S. (2000), Becoming a successful teacher of mathematics, Routledge Falmer, London
- 11. Agarwal S.M. The Teaching of Mathematics
- 12. Mangal S.K. Teaching of Mathematics
- 13. Sidhu Kulbir Singh The Teaching of Mathematics
- 14. Kumar Sudhie Ratnalikar D.N; Teaching of Mathematics
- 15. Sahu Binod K; Teaching of Mathematics.
- 16. James Anice Teaching of Mathematics
- 17. Kulkshetra Arun Kumar; Teaching of Mathematics,
- 18. Wadhava Shalini; Modern methods of Teaching of Mathematics

19. Amit Goel; Learn and Teach Mathematics.
20. Davis David R., (1960); Teaching of Mathematics Addison Wesley Publications.
21. <https://www.robocompass.com/>
22. <https://www.freotech4teachers.com/2019/10/robocompass-robotic-geometry-box.html>
23. https://robocompass.s3.amazonaws.com/docs/RoboCompass_Handout_Edited.pdf
24. <https://www.symbolab.com/>
25. <https://www.common sense.org/education/website/symbolab>
26. <https://symbolab.en.uptodown.com/android>
27. <https://nzmaths.co.nz/>
28. <http://www.mathscentre.co.nz/>
29. <https://coggle.it/about>
30. <https://en.wikipedia.org/wiki/Coggle>
31. <https://archive.is/20130704011721/http://www.edutechmag.org/2013/04/03/just-coggle-it>
32. <https://www.freotech4teachers.com/2013/03/coggle-simple-mind-mapping-tool.html>
33. <https://chrome.google.com/webstore/detail/coggle-collaborative-mind/hbcapocoafbfcjgdgammadkndakcfoi?hl=en-GB>
34. Edpuzzle for Math Teachers - <https://www.youtube.com/watch?v=Il-OKb-iSRU>
35. <https://www.plu.edu/itech/wp-content/uploads/sites/19/2017/03/edpuzzlegettingstarted.pdf>
36. <https://support.edpuzzle.com/hc/en-us/sections/360001671011-Getting-Started>
37. <https://www.techlearning.com/how-to/what-is-edpuzzle-and-how-does-it-work>
38. <https://blogs.umass.edu/onlinetools/assessment-centered-tools/edpuzzle/>
39. <https://www.socrative.com/>
40. <https://www.jct.ie/perch/resources/maths/socrative-tutorial-maths-pdf.pdf>
41. <https://highschoolmathteachers.com/5-ways-engage-students-math-class-using-socrative/>
42. <https://blogs.umass.edu/onlinetools/assessment-centered-tools/socrative/>

SEMESTER IV
B.Ed.Course XIV
ABILITY BASED COURSE: READING AND REFLECTING OF TEXTS

Total Credits: 03
Total Marks: 50
Internal Assessment: 50

Course Learning Outcomes

By the end of the course, student will be able to:

1. Justify the importance of reading and reflecting among students
2. explain the reflective reading skills
3. explain the appreciation of texts from diverse fields
4. discuss the importance of comprehension skills in learning
5. examine the social media impact on texts

Module I: Basics of Reading & Reflecting

Unit I: Understanding Reading

2 Credits

- a. Reading – Concept, Need & Importance
- b. The process of reading – (Saccade, eye movements, etc)
- c. Reading Evaluation (Understanding and evaluating student's pronunciation, intonation, voice modulation & word and sentence stress)

Unit II: Understanding Reflection

- a. Reflection - Concept, Need & Importance
- b. Theories of Reflective Learning – Kolb's Experiential Learning Theory and Schon's Theory of Reflective Practice
- c. Incorporating Reflective Practice in the classroom – Pedagogical practices (pre-reading, while reading and postreading)

Module II – Reading in the Classroom

2 Credits

Unit III: Reading for Comprehension

- a. Types of Texts (Expository, Narrative, Persuasive, Transactional, Argumentative)
- b. Strategies to enhance reading comprehension (Identifying main ideas, understanding context cues, paraphrasing, skimming, scanning)
- c. Davis' Nine Skills of Comprehension

Unit IV: Exposure to Global and Local Literature

- a. Genres of Text Material (Pamphlets, Newspapers, Documents, Advertisements, Books & Novels, Graphic novels, Comics etc.)

- b. Reading & Social Media – Understanding the form and purpose of Facebook, Instagram and Twitter posts, blogs etc
- c. The Vernacular medium – Exposure to texts from Indian writers writing in an Indian language (letters, plays, short stories, books etc.)

Any five tasks from the following

(5 x 10 = 50 Marks)

(Assignments to be completed and assessed in the form of a project report. These assignments can be done as group-work or individually but will be assessed individually for each student)

1. Conduct a speed of reading test for a group of students and suggest measures for improvement of comprehension.
2. Create a rubric and evaluate self or peer's level of pronunciation, word and sentence stress, intonation and voice modulation
3. Determine a set of pre-reading, while reading and post reading questions. Thereafter conduct a reading session and incorporate these reflective learning strategies.
4. Present a Book Review on a book of educational significance
5. Conduct a reading session while incorporating any two strategies to enhance reading comprehension
6. Choose a passage from any text and create questions encompassing all of Davis's nine skills
7. Select a text on a topic of current interest/ controversy and express the writer's opinion and your own opinion about the subject
8. Analyse the social media posts of any hashtag of educational interest
9. Collect different genres of text material and discuss its advantages and disadvantages.
10. Read any vernacular text by an Indian author and discuss the difference between texts in English and texts in the vernacular language.

References:

1. Reading Comprehension Strategies Book series by Becky Jildano
2. <https://thisreadingmama.com/comprehension/comprehension-strategies/>
3. The Reflective Practitioner by Donald A Schon, New York Publishers, ISBN 0—465—06874—X (hbk); ISBN 0—465—06878—2 (pbk)
4. Learning by Thinking: How Reflection Improves Performance by Gia Di Stefano, Francesca Gino, Gary Pisano and Bradley Staats retrieved on 8th September from <https://hbswk.hbs.edu/item/learning-by-thinking-how-reflection-improves-performance>
5. Fundamental Factors of Reading Comprehension by Frederick B Davis retrieved on 8th September, 2020 from <http://www.iapsych.com/wmfhcaarchive/LinkedDocuments/DAVI11.pdf>

SEMESTER V
B.Ed.Course XV
EDUCATIONAL MANAGEMENT

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the concepts and their application to educational management
2. apply Henry Fayol to Educational management
3. explain the Systems Approach to Educational management
4. describe the essential components of Organizational climate.
5. explain Time management and classroom management
6. justify the role of time table, staff meeting, attendance system and absenteeism

Module I: Fundamentals of Educational Management

2 Credits

Unit I. Concept of Educational Management

- a) Concept and Objectives of Educational Management.
- b) Principles of Management by Henry Fayol and its application to Educational Management
- c) Functions of Management - Planning, Organising, Staffing, Directing and Controlling

Unit II. Process and Organizational of Educational Management

- a) Systems Approach to Educational management.
- b) Meaning and Importance of Organizational climate, Factors affecting organizational climate
- c) Types of Management: Time Management (Meaning and Importance) and Classroom Management (Meaning and Elements)

Unit III: Organizational Management

- a) Quality Management: Concept, Process
- b) Event Management: Meaning and process.
- c) Institutional Planning: Meaning, Areas and Steps

Module II: Fundamentals of Educational Administration

2 Credits

Unit IV- Leadership and Human Resource Management

- a) Concept and Process of Human Resource Management
- b) Leadership Styles: Transformational Leadership, Team Leadership, (Meaning, Characteristics, Merits and Demerits)
- c) Leadership Skills: Grievance, Crisis Management (Meaning and Need), Conflict Management (Meaning, Need and Process)

Unit V – Educational Administration

- a) Timetable: Importance, Types and Principles of Time Table Construction
- b) Staff Meeting: Need, Types and Process
- c) Absenteeism in schools (Student)-Causes and Measures, Biometric Attendance System (Concept and Importance)

Unit VI- Educational Administration in India

- a) School Records- Types, ICT - Maintenance of Record in Educational Institution
- b) Characteristics of State, National and International Systems Of Education – SSC, CBSE - Boards of Education
- c) Functions of NCTE, NCERT, Secondary School Code – Importance and Characteristics not for the examination

Module III: Internal Assessment

2 Credits

S.No	Task	Marks
1	Assignments (2*10)	20 marks
2	Case study/ Projects/ Posters and exhibits/ Seminar/Workshop/ Co-operative Learning/ Blended Learning/ Constructivist Learning/ Nai Talim – Experiential Learning/ Open Book assignment	05 marks
3	Class Test	15 marks
	Total	40 marks

Any two tasks from the following

(2 x 10 = 20 Marks)

- a. Prepare a report on any school activity, keeping in mind five functions of Management
- b. Critically analyze the time table of your internship institution based on the principles of time table framing
- c. Critically analyze and compare any two Educational Boards in India
- d. Prepare an Action plan in taking decision using Decision making skill to solve a problem
- e. Visit any one of school office and report about school records
- f. Case study of any educational institution for analysing quality management / Human resource management

References:

1. Organizational Behaviour, O. Jeff Harris, Ph. D. Sandraj. Hartman, Ph. D. Jaico - Publisher
2. Principles and Practice of Management, L.M. Prasad. Sultan Chand & Sons - Publisher
3. Essentials of Organization Behavior, Stephen P. Robbins. Prentice Hall of India Pvt. Ltd - Publisher
4. Educational Management, Ms. Ashima V. Deshmukh, Dr. Anju P. Naik. Himalaya – Publisher
5. Industrial & Organizational Psychology, P.A. Bhagwatwar. Sheth – Publisher
6. Leadership. Better Yourself, Anthony D' Souza. Books - Publisher
7. Management, V.S.P. Rao, P.S. Naryana..Permier Books Company - Publisher
8. Human Resource Management, David A. DeCenzo, Stephen P.Robbins, Susan L. Verhulst.. Eleventh Edition.International Student Version. Wiley – Publisher,
9. Leaders for Today Hope for Tomorrow Empowering and Empowered Leadership Anthony J. D'Souza PaulinePublication, 2001
10. Managing for Innovation Neville I. Smith and Murray Ainsworth 1989Mercury Business Books
11. Empowering Team Learning Enabling Ordinary People to do Extraordinary things Michael Pearn, Jaico Publishing House 2002
12. Train Your Team Yourself Lisa Hadfield-Law Jaico Publishing House 2002
13. Train Smart Rich Allen Second Edition Corwin Press 2008
14. Essentials of Management Fourth Edition Joseph L. Massie Prentice Hall of India Fourth edition 1990
15. Organizational Behaviour Text and Cases Uma Sekaeen Tata McGraw-Hill Publishing Company Limited,1989
16. Management Principles and Functions Fourth Edition Ivancevich Donnelly Gibson Richard D. Irwin, INC,1980
17. The Process of Management T S Mc Alpine, Vikas Publishing House Pvt.Ltd. 1978
18. Total Quality Bharat Wakhlu, Wheeler Publishing,1994
19. The Motivation Manual Gisela HagemannMulti-tech Publishing Co. 1994
20. Human Resource Development Editors UddeshKohliDharni P Sinha Allied Publishing Ltd.1994
21. Leadership: Theory and Practice, by Peter Northouse Eight Edition
22. Leadership for the 21st Century, by Joseph C. Rost, published in 1991, Praeger, Westport London.
23. The 7 Habits of Highly Effective People, by Stephen R. Covey
24. Servant Leader, by Ken Blanchard
25. On Becoming a Leader, by Warren Bennis
26. The Leadership Challenge, by Jim Kouzes and Barry Posner
27. Making Organizational Roles Effective, Udai Pareek, Tata Mc-Graw- Hill Publishing Company Limited,

Unit I and II

Website:

28. <https://www.toolshero.com/management/14-principles-of-management/>
29. <https://managementinnovations.wordpress.com/2008/12/04/henri-fayols-14-principles-of-management/>
30. http://www.managementstudyguide.com/management_functions.htm
31. www.managementstudyguide.com/importance-of-quality-management.htm
32. www.managementstudyguide.com/human-resource-management.htm
33. <http://www.managementstudyguide.com/crisis-management.htm>
34. www.management4all.org/2013/06/leadership-role-concept-function.html
35. www.yourarticlelibrary.com/leadership/leadership-meaning...and-functions/53325/

SEMESTER V
B.Ed.Course XVI
ABILITY COURSE: UNDERSTANDING THE SELF

Total Credits: 03
Total Marks: 50
Internal Assessment: 50

Course Learning Outcomes

By the end of the course, student will be able to:

- explain the concept of the self.
- explain better self-awareness
- evaluate emotions and expression
- develop compassion for self and others, being other centered
- explain the qualities of resilience
- describe the process of empathetic while being assertive and able to resolve conflicts amicably.

Module I – I, Me And Myself

2 Credits

Unit I: Exploring the self

- a) Knowing the self – self- concept, self -esteem
Activities - Create a work of art depicting how they see themselves (painting, collage, drawing, etc.)
- b) Knowing the strengths and weaknesses Activities – Johari Window/ SWOC analysis
- c) Knowing ways to reflect on self
Activities – Reflective journal/diary (online or offline)/blogs and other online communities

Unit II: The evolving self

- a) Self-awareness and self-motivation
Activities – complete tools and questionnaire to create awareness about self and to motivate the self
- b) Positive thinking
Activities – watching a movie / reading a book and writing a review on them.
- c) Emotions and how to handle them

Module II– Others And I

2 Credits

Unit III – The Emerging self

- a) Self-compassion, other-centeredness - Activities – tools for compassion and self-compassion, movies or videos showing compassion/ narrate instances of selfless acts committed by people in the world
- b) Resilience - Activities – meditation, making a dream board and an action plan to make it true.
Reading about success and failures of people in the world and reflecting on the same.
- c) Social identity – Henry Tajfel's theory - Activities – Videos on prejudice / creating social identity

Unit IV - The Caring Self

- a) Empathy - Activities – celebrating days showing kindness, completing empathy worksheets, practicing empathetic listening activity
- b) Assertive self-expression - Activities – small group discussion, brainstorming sessions, role play
- c) Conflict resolution - Activities – strategies and skills required for conflict resolution

Any five tasks from the following

(5 x 10 = 50 Marks)

(Assignments to be completed and assessed in the form of a project report. These assignments can be done as group-work or individually but will be assessed individually for each student)

- a) Present a narrative on “Your Journey as a person”. Include major insights, takeaways, breakthroughs achieved and action plans for the future
- b) Prepare a student portfolio containing evidences of your strengths in the form of creative art/ writing/ pictures of your achievements/ testimonials/ appreciation received. How have these achievements helped you to evolve as a person by helping you build a positive self image?
- c) Identify one personal conflict experienced and the process of resolution of the conflict.
- d) Prepare a report on Self Expression – small group discussion, brainstorming sessions, role play

- e) Prepare a report on Social identity – Henry Tajfel’s theory
- f) Report on Five activities towards Positive thinking
- g) Select a text on a topic of current interest/ controversy and express the writer’s opinion and your own opinion about the subject
- h) Analyse your SWOC and write how to enhance each aspect of the same.

References:

<https://hbr.org/2018/01/what-self-awareness-really-is-and-how-to-cultivate-it>
<https://positivepsychology.com/self-awareness-matters-how-you-can-be-more-self-aware/>
<https://positivepsychology.com/kindness-activities-empathy-worksheets/>
<https://blog.trainerswarehouse.com/assertiveness-games-activities>
<https://www.skillsyouneed.com/ps/assertiveness>

SEMESTER VI
B.Ed.Course XVIII
PEDAGOGY OF SUBJECT – SCIENCE III

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. apply innovative strategies used in teaching of Science
2. illustrate the e-Resources used in teaching of Science
3. demonstrate the use of Support Media in teaching of Science
4. explain the management perspectives and quality indicators in Science teaching
5. explain the methods & approaches to teaching Science
6. explain the Professionalism and Professional Development in teaching of Science

Module 1 : Learning Resources For Science Teaching-Learning

2 Credits

Unit I: Innovative Strategies for Curricular Enrichment

- a) Concept and Significance of Curricular Enrichment in Science
- b) Innovative strategies for learning through experience and correlation (Lego designing, Coding, Culinary Skills, Developing Green Audits, Ted Talks, Learn Genetics)
- c) Reflective Teaching: Characteristics, Advantages and Disadvantages

Unit II: E-Resources For Science Teaching-Learning

- a) Virtual laboratories / Simulation -Meaning and Use in Science teaching - learning
- b) Mobile laboratories, Science Express - Meaning and Significance in Science
- c) Free Online Educational Resources (OER) / YouTube - Significance in Science teaching -learning

Unit III: Supportive Media In Teaching Of Science

- a) Development of Improvised Apparatus for designing simple experiments in Science
- b) Preparation and Importance of Herbarium and Terrarium in Science learning
- c) Curriculum accessories and support material- Critical analysis of text books, journals, handbooks, student's workbook.

Module II : Science Teacher And Enhancing Teaching Effectiveness.

2 Credits

Unit IV: Management In Science Teaching

- a) Global Perspectives in the teaching of Science (Global to Local)
- b) Science Laboratory- Organization, Planning & Maintenance
- c) Quality Indicators in Science teaching-learning

Unit V: Science Teaching Skills---Methods, Approach And Tools

- a) Methods-, Problem Solving, Laboratory Method
- b) Approach: Constructivist Approach (7E's)
- c) Tool: PEOR (Predict-Explain-Observe-React and Revisit) - Meaning, Steps and Significance

Unit III: Professionalism and Professional Development

- a) Professionalism and Continuous Professional Development (CPD): Meaning, Characteristics and Avenues.
- b) STEM (Science, Technology, Engineering Mathematics) Curriculum & Career Opportunities in Science
- c) Diagnostic Testing and Remedial Teaching in Science: Significance / Role of teacher

Module 3 : Internal Assessment**2 Credits**

Sr. No.	Particulars	Marks
1	Task/Assignment/ Activity for each module held in the semester (2X10)	20
2	One periodical class test held in the given Semester	15
3	One Essay test held in the given Semester	05
	Total	40

Suggested (Any Two) Of The Following Tasks:

1. Prepare an improvised aid for teaching science. Make a video on the procedure of preparing the aid and its use for science teaching learning.
2. Record a video on scientific discoveries and create your own you tube channel for science content, give an innovative name and upload your video.
3. Prepare a diagnostic test for any one topic in Science and identify the learner needs and prepare a remedial plan for the same.
4. Critically analyze any secondary standard text book with respect to the aims and objectives stipulated by NCF 2005/ NCF 2021.
5. For any one topic of science, find 3 OERs and justify its appropriateness.
6. Interview 5 school science teachers with respect to the need and avenues of CPD and write a report.
7. Conduct a green audit of your college. (Collaborate with the college environment cell if necessary).
8. Prepare a design for a science laboratory for a secondary school.

References:

1. A guide for elementary education, Washington, DC: United States, Dept. of education.
2. <https://www.ahaworldcampus.com/b/what-is-professional-development#:~:text=Professional%20development%20refers%20to%20all,additional%20skills%20in%20the%20future.https://www.nace.co.uk/blogpost/1761881/329136/10-challenging-enrichment-activities-to-engage-more-able-learners>
3. Innovation in international learning: Toronto Canada,
4. John Loughran (1996). Developing reflective Practice: Learning about teaching and Learning through Modelling. London: Falmer Press
5. Mary, L.S.(1985). State of the art: Transforming ideas for teaching and learning science.
6. Mathew, T.K., & Mollykutty, T. M. (2011). Science education: Theoretical bases of
7. Rena M.Paloff & Keith Pratt (2009): Assessing online learner: San Fransisco, Jossey – Bass.
8. Sharma, R. C. (1985). Modern science teaching. New Delhi: Dhanpat Rai & Sons.
9. Teaching and pedagogic analysis. Chenganoor: Rainbow Book Publishers.
10. Increasing Trend of STEM Education in India will open new career avenues for the youth, <http://bweducation.businessworld.in/article/Increasing-Trend-Of-STEM-Education-In-India-Will-Open-New-Career-Avenues-For-The-Youth-/12-08-2020-307832/>

SEMESTER-VI
B.Ed.Course XIX
PEDAGOGY OF SCHOOL SUBJECT MATHEMATICS III

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the strategies and techniques in Mathematics education.
2. explain the contemporary strategies and techniques to teach different topics in Mathematics.
3. discuss the need of OERs and MOOCs for Mathematics.
4. analyse the use of Web based Applications in Mathematics Education.
5. explain the Differentiated Learning Strategies in Mathematics education.
6. explain the avenues for professional development of a Mathematics teacher.
7. appreciate the contributions of Mathematicians.
8. Explain the mathematics through various recreational activities.

Module I: Contemporary Strategies, Techniques and Needs of Diverse Learners 2 Credits

Unit I: Contemporary Techniques in Mathematics Education

- a) Models of Teaching - CAM, AOM
- b) Cooperative Learning Strategies
- c) 7E Constructivist Approach

Unit II: ICT in Teaching -Learning of Mathematics - II

- a) OERs for Mathematics Education (Concept and Need)
- b) MOOCs for Mathematics Education (Concept and Need)
- c) Web based Applications for Mathematics Education - (OLABS, IXL, Activeinspire)

Unit III: Differentiated Learning Strategies in Mathematics Education

- a) Enrichment strategies for Gifted and Slow Learners
- b) Strategies for Learners with Dyscalculia
- c) Diagnostic Testing and Remedial Teaching in Mathematics.

Module II: Mathematics Teacher And Promoting Mathematics Education 2 Credits

Unit IV: The Mathematics Teacher

- a) Competencies of Mathematics Teacher, Difficulties faced by Mathematics Teachers
- b) Professional Development - Concept and Need
- c) Avenues for Professional Development of Mathematics teacher.

Unit V: Contribution of Mathematicians

- a) Western Mathematicians - Euclid, Pythagoras
- b) Indian Mathematicians - Aryabhatta, Ramanujam
- c) Vedic Mathematics - Concept and any 4 techniques

Unit VI: Recreational Activities in Mathematics Education

- a) Math Club - Objectives, Significance and Organization,
- b) Games, Puzzles, Riddles
- c) Visits, Trails, Exhibitions

Module III: Internal Assessment

2 Credits

Sr. No.	Particulars	Marks
1	Two Task/Assignment/ Activity (2 X 10)	20
2	One periodical class test held in the given Semester	15
3	One Essay test held in the given Semester	5
	Total	40

Suggested Tasks and Assignments (Any Two)

1. Plan a lesson using any one of the following techniques
 1. CAM/AOM model
 2. Any Cooperative Learning Strategy
 3. 7E Constructivist Approach
2. Interview any mathematics teacher and prepare a report of the differentiated instructional strategies used.
3. Interview a mathematics teacher and prepare a report on the difficulties faced in mathematics teaching and strategies used to overcome the difficulties.
4. Creatively present the Mathematical contribution of any one contemporary Mathematician.
5. Plan any 2 recreational activities to teach any mathematical concept that can be carried out for the math club
6. Visit a math club of a school and prepare a report of its functioning and activities carried out for the year.

References

1. Joyce Bruce R., and Marsha Weil. 1986. Models of teaching. Prentice-Hall of India, New Delhi, India
2. Sahni, Madhu. 2019. Pedagogy of Mathematics. Vikas Publishing House, Noida, India.
3. Kulshreshtha; Teaching of Mathematics, R. Lal and Sons.
4. Kumar Sudhir; Teaching of Mathematics, Anmol Publications, New Delhi, India.
5. Agarwal S.M. The Teaching of Mathematics
6. Mangal S.K. Teaching of Mathematics
7. Sidhu Kulbir Singh The Teaching of Mathematics
8. Sahu Binod K; Teaching of Mathematics.
9. James Aniee Teaching of Mathematics
10. Kulkshetra Arun Kumar; Teaching of Mathematics.
11. <https://niepid.nic.in/MODELS%20OF%20TEACHING.pdf>
12. <http://165.139.150.129/intervention/Differentiated%20Instruction%20for%20Math.pdf>
13. <https://resilienteducator.com/classroom-resources/examples-of-differentiated-instruction/>
14. <https://educationnorthwest.org/sites/default/files/2012.99.pdf>

15. https://www.brevardschools.org/site/handlers/filedownload.ashx?moduleinstanceid=6174&dataid=8255&FileName=Differentiated_Instruction_in_Secondary_Mathematics.pdf
16. <https://www.middleweb.com/42899/tiered-activities-make-math-more-inclusive/>
17. https://www.education.gov.in/en/sites/upload_files/mhrd/files/upload_document/20130808_CSFCConceptPaper_OER_MHRDConference_v0.7.pdf
18. <https://www.edweek.org/teaching-learning/open-educational-resources-oer-overview-and-definition/2017/04>
19. <http://www.hbcse.tifr.res.in/research-development/maths-ed>
20. <https://mathedu.hbcse.tifr.res.in/>
21. https://www.michigan.gov/mde/0,4615,7-140-28753_80670_80676---,00.html
22. <https://libguides.humboldt.edu/openedu/math>
23. <https://irsc.libguides.com/mathematics/OER>
24. <https://libraries.etsu.edu/research/guides/mathematics/oer>
25. <https://www.edutopia.org/open-educational-resources-guide>
26. <https://www.infoprolearning.com/blog/advantages-and-disadvantages-of-moocs-massive-open-online-courses-for-learning/>
27. <https://www.mooc.org/about-moocs>
28. <https://www.distancelearningportal.com/articles/645/why-should-i-study-a-mooc-in-2021.html#:~:text=MOOCs%20can%20bring%20knowledge%20to,can%20complement%20traditional%20university%20learning.>
29. <https://swayam.gov.in/explorer?category=Mathematics>
30. <https://www.youcubed.org/resource/online-courses-for-teachers/>
31. <http://www.olabs.edu.in/> and http://www.olabs.edu.in/?pg=topMenu&id=5#What_is_Online_Labs_
32. <https://in.ixl.com/maths/>
33. <https://in.ixl.com/#curriculum> and <https://in.ixl.com/standards/maths>
34. <https://www.prometheanworld.com/products/lesson-delivery-software/activinspire/>
35. <http://www2.hawaii.edu/~shavonn/activclassroom/activinspire.html>
36. <http://pbtraining.weebly.com/1-intro-to-activinspire.html>

SEMESTER VII
B.Ed.Course XXI
PEACE EDUCATION

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the information about historical development of peace Education.
2. describe the constitutional values and their importance for social harmony.
3. appreciate the contribution of Mahatma Gandhi, Rabindranath Tagore, and Vivekanand in Peace Building.
4. discuss the conflict resolution techniques and non-violent activism for peace building
5. explain the qualities and role of teacher for peace education and integrating peace education in the curriculum
6. analyze the role of mass media and other social agencies in Peace Education.

Module I: Fundamentals of Peace Education

2 Credits

Unit I: Peace Education: Concept and Nature of Peace Education

- a) Peace: Meaning, Definitions and Classification of peace
- b) Peace Education: Meaning, Definitions and aims of peace education
- c) Need and relevance of peace education in the present contexts.

Unit II: Basis of Peace Education

- a) Historical Development of Peace Education
- b) Constitutional Values and Peace Education
- c) Contribution of Gandhiji, Rabindranath Tagore, Vivekanand to promoting the values of peace.

Unit III: Areas of Peace Education

- a) Peace Education and Conflict Management: Meaning, Types, Role of Education
- b) Recommendations on Peace Education (NCF 2009);
- c) Violence and Non-violent activism: Addressing the challenges of direct violence (terrorism, war, assault, Riots) and indirect violence (discrimination, sexism, racism, and poverty, lack of education and health services) through peace education.

Module II: Module II: Integration of Peace Education in School Curriculum 2 Credits

Unit IV Transacting of Peace Education

- a) Integrating Peace Education in Curriculum: Subject perspectives, Subject context, Co-curricular activities, Classroom activities
- b) Educating for Culture of Peace: Developing Capabilities for Mediation, Developing Values like tolerance, Patience, Mutual respect, Introspection, Objectivity,
- c) Introspection, yoga, persuasion for peace- Cultivating the perspective and skills necessary for peace.

Unit V: Preparation and Role of agencies for Peace Education

- a) Role and qualities of teacher promoting peace.
- b) Role of agencies for Peace: Family, Community, NGOs.
- c) Role of social media in Peace Education.

Unit VI: Concerns and Challenges for Peace

- a) Life at school: Culture of competition; Corporal Punishment and its Consequences Change management
- b) Addressing challenges to Peace in Multicultural Society.
- c) Struggles for Peace (Mother Teresa, Nelson Mandela)

MODULE 3: INTERNAL ASSESSMENT 40 MARKS

2 Credits

Sr. No.	Assessment	Marks
1	Class Test	15
2	Overall Assessment-Article Review, Group Discussion, Quiz, Survey Report. Poster Presentation, Guest Lecture, Interview, Game, PPT, Narrating, Project Making, Street Play, Short Film, Film Shows	05
3	Assignments (2 x 10 Marks)	20
Total		40

Any two tasks from the following

(2 x 10 = 20 Marks)

- a) Panel discussion on values of peace and social justice in 21st century
- b) Promotion of peace in the school/community through essays, posters, poems or stories.
- c) Prepare a Case Study of major conflicts between nation and states in present times.
- d) Role plays to enact situations involving conflict, corporal punishment, discrimination, and domestic violence in day-to-day life.
- e) Films clips displaying concerns of peace, good intercultural relationships, environmental presentation and other key ideas and discussions thereon, like -Doha Debates, etc
- f) Write a comparative essay on the contribution of educational thinkers
- g) Collect the material useful for promoting peace education (Poetry, story, songs, and cartoon strips etc.
- h) Select a country and study their efforts to promote and nurture peace in their school systems, campuses, and educational ministries. Write a report.

References:

1. Adans, D. (Ed). (1997). UNESCO and a culture of peace, promoting a global movement. Paris: UNESCO Publication.
2. Chadha, S. C. (2008). Education value & value education. Meerut: R.Lall Books Depot.
3. Dalai,Lama 1980.Universal Responsibility and the Good Heart.Library of Tibetan Works & Archives, Dharmshala,Dist.Kangra.H.P.
4. Dalai,Lama 2000.Transforming the Mind ,Translated by Dr. Thupten Jinpa, edited by Dominique Side & Dr. Thupten Jinpa, horsons, London.
5. Diwahar, R. R., & Agarwal, M. (Ed). (1984). Peace education. New Delhi: Gandhi Marg.
6. Gangurde, K.D.(2001)Religion And Peace, A Gandhian Perspective, Gandhi Smriti and Darshan Samiti, New Delhi.
7. Hant,T.N.(2004). Being Peace, Nice Printing Press, Delhi.
8. Harris, I.M. 1998.Peace Education .McFarland, North Carolina, NCERT, New Delhi.
9. Johan, G.(1996). Peace by peaceful means. New Delhi: Sage Publication.
10. Kaur, B. 2006.Teaching of peace and Conflict and Pride – School Histories of the Freedom Struggle in India .Penguin Books India Pvt, Ltd., New Delhi.
11. Kumar, K. 2006. Peace Lines. Penguin Publications, New Delhi,(In Press).
12. Kumar, K. (2007). Shanti Shiksha Aur Gandhi.(in Hindi) Maharshi Valmiki College of Education. Delhi University. 196
13. Kumar, M. (Ed). (1994). Non-violence, contempory issues and challenges. New Delhi: Gandhi peace foundation.
14. Krishnamurti, J. (1992). Education and world peace. In Social responsibility. Krishnamurti Foundation.
15. Krishnamurti, J. 1997. The Flame of Attention. Krishnamurti Foundation. Trust Ltd., London.
16. Morrison, M. L. (2003). Peace education. Australia: McFarland.
17. Ministry of Human Resource Development. 1993 Learning Without Burden: A Report of the Advisory Committee, (MHRD), Department of Education, New Delhi.
18. Prasad, D (2005), Education for Living Creativity and Peacefully. Spark India Hyderabad, AP. □ Salomon, G., & Nevo, B. (2002). Peace Education: The concept, principles, and practices around the world. London: Lawrence Erlbaum Associates.
19. UNESCO (2001). Learning the Way to Peace-A Teachers Guide to Peace Education. A.S. Balasooriya , UNESCO, New Delhi.
20. UNESCO (2002). Learning to Be: A Holistic and Integrated Approach to Value Education For Human Development.Bangkok.
21. Valson, T. (2006). Living in Harmony: A Course on Peace and Value Education. Oxford, New Delhi. Journals :
22. Journal of the Krishnamurti School. Krishnamurti Foundation of India, 124-126, Green Ways Road, RA Puram,Chennai-600028
23. Education or Peace, Dr.Usha Rao (Himalya Publishing House ,First Edition ,2012) □ Striving For Peace ,Ram Punyani (Two Enterprises)
24. Non-violence and Peace Education, (Volume I), Dr. Ravindra Kumar , Mrs.Megha □ Pandey, Sanjay (2004).PeaceEducation. New Delhi: NCERT .
25. Fran Schmidt and Alice Friedman. 1988. Peacemaking Skills for Little Kids . Miami , Florida USA : Peace Education Foundation.
26. Peace and Value Education .Dr. Kiruba Charles & V. Arul Selvi . (Neelkamal Publications Pvt Ltd , New Delhi , First Edition ,2012)

27. Gultang, J. (1996). Peace by Peaceful Means: Peace and Conflict , Development and Civilisation , PRIO: International Peace Research Institute of Oslo and Sage Publications. □ The Real World of Technology (available in Hindi) Karve, I. Yuganta. Kesavan, M. □ Education and the Significance of Life Kumar, K. Learning from Conflict. Kumar, K.
28. Ways to Peace Norberg - Hodge, H. Ancient Futures. Russell, B
29. Common Sense and Nuclear Warfare. Sheehan, V. Mahatma Gandhi Singh, N. Loktantra, Sanskriti aur Shiksha (also available in English in Kumar, K. (ed.) Democracy and Education in India).
30. Teresa, Mother. Reaching out in Love UNICEF.
31. The State of the World's Children (reports of the last five years). UNESCO.
32. Learning the Way of Peace: Teacher's Guide. Websites: Hiroshima Peace Memorial Museum Peace Education: INEE Site (endorsed by UNESCO)
33. Aims of Peace Education by UNICEF page 22-24.
<https://www.unicef.org/education/files/PeaceEducation.pdf>
34. Integrating Peace Education in Teacher Education

**SEMESTER VII
B.Ed.Course XXII
LANGUAGE ACROSS CURRICULUM**

**Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40**

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the linguistic background of students.
2. describe the provisions made for language in different policies
3. explain the nature and techniques of classroom discourse and discussion based learning
4. justify the role of language across different school subjects.
5. describe the strategies to enhance reading and writing skills
6. illustrate different study skill

Module-1: Fundamentals of Language Across Curriculum

2 Credits

Unit I: Concerns for Language in Curriculum

- a) Understanding multilingualism in the classroom: (meaning and characteristics of multilingualism)
- b) Functions of Language (Inside and Outside the classroom)
- c) Language Across Curriculum Approach (concept and importance for teachers and students)

Unit -2 Policies and provisions relating to languages

- a. Constitution of India (Article 343, 351, 350A)
- b) NPE 1986, NCF-2005,
- c) National policies of education NPE (2020)

Unit III: Language and Curriculum Transaction

- a) Classroom Discourse — Meaning, and importance of classroom discourse.
- b) Discussion as an approach for learning; (meaning and importance)
- c) The nature of questioning in the classroom — meaning and types of questions used in the classroom,

Module-2: Acquisition of Skills

2 Credits

Unit IV: Developing Communication Competencies- reading and writing

- a) Types of texts- nature of expository texts vs. narrative texts; transactional vs. reflective texts; reading strategies — such as scanning, skimming (meaning and importance)
- b) Writing — importance of writing skill, strategies to enhance writing skills. (any 3)
- c) Teaching Study Skills- Note-taking & note-making, (meaning and importance)

Unit V- Theories of language acquisition (Theory and educational implications)

- a) Chomsky's theory of language acquisition
- a) Ellor's Deficit theory
- b) Skinner's theory of language acquisition

Unit-6 – Language across Subjects

- a) Language for general and specific purpose
- b) Importance of language as a medium to teach different school subjects with reference to language registers used.
- c) Role of a subject teacher to develop linguistic competence (with reference to vocabulary, pronunciation, speed, intonation, punctuation)

Module 3: Internal Assessment 40 Marks**2 Credits**

Sr. No.	Assessment	Marks
1	Class Test	15
2	Overall Assessment-Article Review, Group Discussion, Quiz, Survey Report. Poster Presentation, Guest Lecture, Interview, Game, PPT, Narrating, Project Making, Street Play, Short Film, Film Shows	05
3	Assignments (2 x 10 Marks)	20
Total		40

Any two tasks from the following

(2 x 10 = 20 Marks)

- Prepare a lesson plan on any topic from 5th to 9th standard, incorporating the types of questions
- Read any kind of text and reflect with reference to the type of text and its implications.
- Take a story/poem and rewrite in the other form
- Read any article from newspaper/magazine/journal using skimming and scanning technique and record your observation and reflection in the journal.

References

- Anderson, R.C. (1984) Role of the Reader's Schema in Comprehension, Learning and Memory. In R.C. Anderson, J. Osborn & R.J. Tierney (ed) Learning to Read in American schools: Based Readers and content texts. Hillsdale, Lawrence Erlbaum Associates: New Jersey.
- Applying a Vygotskian Model of Learning and Development in B. Spodek (ed.) Handbook of research on the education of young children. Macmillan: New York.
- Armbruster, Bonnie B. (1984) The Problem of "Inconsiderate Text" In Duffy, G. G. (ed.) Comprehension Instruction, Perspectives and Suggestions. Longman: New York. □ Butler, A. and J. Turnbull, (1984) Towards Reading-Writing Classroom Primary English Teaching Association Cornell University: New York.
- Freedman S. W. and A. H. Dyson (2003) Writing in Flood J. et. al. Handbook of Research on Teaching English Language Arts: Lawrence Erlbaum Associates Inc: New Jersey, USA..
- Kumar Krishna (2007) The Child's Language and the Teacher. National Book Trust: New Delhi.
- Labov, W. (1972) The logic of Non- Standard English. In Language in Education. Prepared by Language and Learning course Team. Routledge: London
- Martin, Jr. B. (1987) The Making of a Reader: A Personal Narrative. In Bernice E. Cullinan, Children's Literature in the Reading Programme. International Reading Association: Michigan..
- Mason, J. M. and S. Sinha (1992) Emerging Literacy in the Early Childhood Years. □ Monson, R.
- J. (1991) Charting a New Course with Whole Language. Edn. Leadership.
- Pinnell, G.S. (1985) Ways to Look at the Functions of Children's Language. In A. Jaggar, M. Trika and Smith-Burke (ed.) Observing the language learner. International Reading Association: Newark, DE.
- Purves, Alan C. (1988). The Aesthetic Mind of Louise Rosenblatt. Reader 20.
- Rhodes, L. K. and N. L. Shanklin (1993) Windows into Literacy. Heinemann, The University of Michigan: UK.
- Rothleen, L. and A. M. Meinbach (1991) The Literature Connection: Using Children's Books in Classroom. Good Year Books: Tucson, USA.
- Sinha, S. (2000) Acquiring Literacy in Schools. Redesigning Curricula: A symposium on working a framework for School education Seminar
- Sinha, Shobha. (2009). Rosenblatt's Theory of Reading: Exploring Literature. Contemporary Education Dialogue.

17. Teals, W. and E. Sulzby (1986) Introduction: Emergent Literacy as a perspective for Examining how young Children Become Writers and Readers. In W. Teals, E. Sulzby (ed.) Emergent Literacy: Writing and Reading. Norwood: New Jersey

SEMESTER VIII
B.Ed.Course XXV
GENDER SCHOOL AND SOCIETY

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. differentiate the concept of gender, gender perspective, gender bias, gender stereotype
2. discuss the gradual paradigm shift from women studies to gender studies
3. explain the important landmarks in connection with gender and education in the historical and contemporary period
4. explain the gender issues in school, curriculum, textual materials across disciplines, pedagogical processes and its intersection with class, caste, culture, religion and region
5. discuss the role of Gender, Power and Sexuality relate to education (in terms of access, curriculum and pedagogy)
6. explain the concept empowerment, gender parity, equity and equality, patriarchy and feminism

Module 1: Introduction to Gender Issues

2 Credits

Unit I: Gender Issues: Key Concepts

- a) Gender, Gender Perspective, Sex, Sexuality, Patriarchy, Masculinity and Feminism
- b) Gender Bias, Gender Stereotyping and Empowerment
- c) Equity and Equality in relation with caste, class, culture, religion, ethnicity, disability and region.

Unit II: Gender Studies: paradigm shift

- a) Paradigm shift from Women's Studies to Gender Studies
- b) Historical Backdrop: Some land marks from 'Our Past'- Social reform movement of the 19th & 20th centuries with focus on women's experiences of education.
- c) Contemporary Period - Recommendations of Policy Initiatives Commissions and Committees. Schemes, Programmes and Plans.

Unit III: Gender, Power and Education

- a) Theories: Socialization Theory, Gender Difference, Structural Theory, Deconstructive Theory
- b) Gender Identities and Socialization practices: In Family, Schools, Other Formal and Informal Organizations
- c) Power Relations in Society in the context of gendered division of labour

Module II: Gender Issues in Education

2 Credits

Unit IV: Gender Issues in Curriculum

- a) Gender, Culture and Institution: Intersection of class, caste and religion
- b) Curriculum and the Gender Question, Gender and the hidden curriculum
- c) Construction of Gender in Curriculum Framework since independence: An Analysis

Unit V: Operation Finance and Human Resources

- Schooling of Girls: Inequalities and Resistances (Issues of access, retention and exclusion.
- Teacher as an agent of change
- Understanding the importance of addressing sexual harassment at workplace, in family,neighbourhood and other formal and informal institutions

Unit VI: Gender, Sexuality, Sexual harassment & Abuse

- Linkages and differences between Reproductive Rights and Sexual Rights
- Development of Sexuality including Primary influences in the lives of Children (such as gender, body image, role models), Perception of society towards women's body: Carrying the load of familyprestige
- Agencies perpetuating violence: family, school, work place and media (print and electronic),Institutions redressing sexual harassment and abuse.

Module 3: Internal Assessment40 Marks

2 Credits

Sr. No.	Assessment	Marks
1	Class Test	15
2	Overall Assessment-Article Review, Group Discussion, Quiz, Survey Report. Poster Presentation, Guest Lecture, Interview, Game, PPT, Narrating, Project Making, Street Play, Short Film, Film Shows	05
3	Assignments (2 x 10 Marks)	20
Total		40

Any two tasks from the following
Marks)

(2 x 10 = 20

- Project on how student perceive sexuality and their own body images. It would also focus on how gender identities are formed
- Preparing Analytical Report on portrayal of women in print and electronic media
- Preparation of tools to analyse reflection of gender in curriculum
- Analysis of textual materials from the gender perspective
- Identify gender bias and gender stereotype in textual materials.
- Felid visits to schools to observe the schooling processes from a gender perspective
- Project on Women Role Models

References:

- Report of the CAGE Committee on Girl's Education and the common School System (MHRD, New Delhi, June 2005) Available in English and Hindi.
- National Curriculum Framework NCERT 2005
- Gender Issues in Education, Position Paper, NCERT, 2006
- Bhasin, Kamla. 2000. Understanding Gender. New Delhi: Kali for Women.
- Bhasin, Kamla. 2004. Exploring Masculinity. New Delhi: Women Unlimited.
- Bringing Girls Centrestage: Strategies and Interventions for Girls' Education in DPEP, MHRD, New-Delhi, 2000
- Chakravarti, Uma Gendering Caste Through a Feminist Lens, 2003 Mandira Sen for Stree, animprint of Bhatkal and Sen, 16 Southern avenue, Calcutta 700026
- Chanana, Karuna. 1985. 'The Social Context of Women's Education in India, 1921-81,'in New Frontiers of Education, July-September. New Delhi: 15 (3):1-36.

**SEMESTER VIII
B.Ed.Course XXVI
ACTION RESEARCH**

**Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40**

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the concept of Action Research
2. illustrate the process of Action Research
3. apply the cycles of Action Research in the teaching-learning process.
4. apply the methods of Action Research to the teaching learning process.
5. explain the various data collection tools of Action Research.
6. distinguish between quantitative and qualitative data analysis in Action Research.

Module 1: Fundamentals of Action Research

2 Credits

Unit I: Basics of Action Research

- a) Meaning, Principles, Characteristics, Benefits and Limitations of Action Research
- b) Difference between Fundamental and Action Research
- c) Identification of Problem in Action Research – Locating, Delimiting Problem, Research questions

Unit II: Action Research- Types, Approaches and Methods

- a) Types of Action Research –Individual teacher action research and Collaborative action research(Meaning, Rationale, uses and limitations)
- b) Approaches of Action Research: Qualitative and Quantitative - Concept and Need
- c) Methods of Action Research –Experimental and Case Study- Meaning, Purpose, Process and limitations

Unit III: Process of Action Research

- a) Action Research Process –Stephen Kemmi’s Action Cycle, Kurt Lewin’s Force Field Analysis.
- b) Validation of Action research -Concept and types : Self, Peer and Learner
- c) Ethics in Action Research

Module II: Action Research: Tools And Techniques, Plan And Report
Credits

2

Unit IV: Evolving Concept Of Counselling

- a) Tools for Data Collection – (Characteristics, uses and limitations) 1. Questionnaire –Open and Close ended
- b) Artifacts: Documents, Records (Student’s journals, logs, audio, videos) b) Techniques of Data Collection1.
- c) Interviews –Structured and Unstructured 2. Observation- Participant and Non-Participant
Role of teacher in Action Research, Action Research for Professional development of teachers

Unit V: Planning, Conducting and Reporting Action Research

- a) Designing the Action Research Plan (research question, need, significance, aims and objectives, research team, research design, schedule and budget)
- b) Analysis of Data: Quantitative- Descriptive Analysis- Percentage, Mean, Correlation and Graphical representation (uses and limitations)

- c) Qualitative (Immersion reflecting, standing back analyzing; synthesizing; relation to other work; locating reflecting back; returning for more data Presenting disseminating and sharing).

Unit VI: Reporting Action Research

- Features of a good quality Action Research Report – Comprehensibility, Authenticity, Truthfulness and Appropriateness.
- Sharing and Reflecting - Locally, Action Research Communities, Professional Conferences and print and e-Journals.
- Reflection in Action Research

Module 3: Internal Assessment 40 Marks

2 Credits

Sr. No.	Assessment	Marks
1	Class Test	15
2	Overall Assessment-Article Review, Group Discussion, Quiz, Survey Report. Poster Presentation, Guest Lecture, Interview, Game, PPT, Narrating, Project Making, Street Play, Short Film, Film Shows	05
3	Assignments (2 x 10 Marks)	20
Total		40

Any two tasks from the following (2 x 10 = 20 Marks)

- Design an action research plan.
- Make a scrap book depicting TWO case studies related to professional growth of teachers while doing action research.
- Prepare a tool for data collection for an action research project of your relevance.
- Critically review any action research report for elements of good reporting.

References:

- Crowder, N.A. (1959). Action Research to Improve School Practices. New York: Columbia University.
- NRC, (2001) National Research Council. Mathematics learning study: Center for Education, Division of Behavioural and Social Sciences and Education, Adding it up: Helping children learn mathematics. Edited by J. Kilpatrick et al., Washington, DC: National Academy Press <http://www.edel.edu/pbl>
- Lavin, R.E. (1995). Cooperative Learning: Theory, Research and Practice. (2nd ed). Michigan: Allyn & Bacon.
- Sharma R. A. (1993). Teacher education, Theory, Practice and Research. Meerut : International Publishing house.
- Ebel, R.L. (1969). Outdoor Education. Encyclopaedia of Educational Research (4th ed.) Crow, L.D., & Crow, A. (2008). An introduction to guidance. Delhi: Surjeet Publications.
- Dave, Indu. The Basic Essentials of Counselling Sterling Publisher. New Delhi
- Gibson, Robert. Introduction to Counselling & Guidance. Prentice - Hall of India. New Delhi
- Kavyamala Publishers. Qureshi, H. (2004). Educational guidance. New Delhi: Anmol Publications Pvt. Ltd.
- Jones, A.J. (2008). Principles of guidance. (5 ed). Delhi: Surjeet Publications.
- Kaushik, V.K & Sharma, S.R. Fundamentals of Psychology Anmol Publisher. New Delhi Chandra, Ramesh. Guidance & Counselling Kalpaz Publications. Delhi.
- Kinra, A.K. Guidance and Counselling. New Delhi: Pearson Longman.
- Paul, Lengrand. An Introduction to Lifelong Education 2 Croom Hekn-London the UNESCO Press-Paris. London.
- Meenakshisundaram, A. (2005). Guidance and counseling. Dindigul: Kavyamala Publishers.
- Panda, N.P. Education & Exceptional Children. Deep & Deep Publisher. New Delhi Kalia, H.L. Counselling in Schools ICON. New Delhi.
- Rao, Narayana. Counselling Guidance Tata Mc GrawHill . New Delhi Vashist, S.R. Methods of Guidance Anmol Publication. New Delhi
- R.N. (2008). Vocational guidance & counseling. Delhi: Surjeet Publications.
- Safaya, B.N. (2002). Guidance and Counselling. Chandigarh: Abhishek Publications.

18. Sharma, R.A.(2008). Career information in career guidance. Meerut: R. Lall Books Depot.
19. Shrivastava, K.K. Principles of Guidance & Counselling Kanishka Publishers Distributors. New Delhi.
20. Sidhu, H.S. Guidance and Counselling. Patiala: Twenty First Century Publication.
21. Singh, Raj. Educational & Vocational Guidance. Commonwealth Publication. New Delhi
22. Rao, S.N . Guidance & Counselling. Discovery Publications. New Delhi

SEMESTER VIII
B.Ed.Course XXVII
ELECTIVE: GUIDANCE AND COUNSELLING

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the basic concepts in guidance and counselling.
2. design strategies, tests technique and plans of guidance.
3. explain the concept and strategies for career guidance and job satisfaction.
4. explain the basic concepts in counselling.
5. describe the process, skills and strategies of counselling.
6. discuss the psychological issues faced by adolescents and strategies to help them cope.

Module I: Fundamentals of Guidance

2 Credits

Unit I: Evolving Concept of Guidance

- a) Meaning, Characteristics, Need of Guidance
- b) Types of Guidance – Educational, Personal, Vocational,
- c) Agencies / Personnel Responsible for Guidance- Home, School, Workplace

Unit II: Strategies and Techniques for Guidance (Uses And Limitations)

- a) Strategies for Guidance - Individual and Group
- b) Standardized tests technique - Aptitude, Attitude
- c) Non- standardized tests technique- Case study, Interview

Unit III: Career Guidance

- a) Sources of Career information and Strategies of disseminating career information
- b) Ginsberg's Theory of Vocational Choice, Factors influencing Vocational Choice
- c) Job Analysis: Concept and Factors affecting Job Satisfaction

Module II: Fundamentals Of Counselling

2 Credits

Unit IV: Evolving Concept Of Counselling

- a) Meaning and Characteristics of Counselling
- b) Types of Counselling – Directive, Non-directive
- c) Process of Counselling - Initial Disclosure, In-depth exploration and Commitment to action

Unit V: Counselling Skills, Approaches And Intervention

- a) Skills required for Counselling - Listening, Questioning , Responding , Communicating

- b) Approaches of Counselling – Cognitive Behavioural Therapy (Albert Ellis), Self-Theory (Carl Rogers)
- c) Counselling for Adolescent Issues – Bullying, Relationship [Peer and Parent], Addiction (Substance abuse & technology induced social networking), Academic Stress.

Unit VI: Role of a Counsellor

- a) Role of a teacher as a counsellor
- b) Qualities & qualifications of counsellor
- c) Professional ethics of a counsellor

Module 3: Internal Assessment 40 Marks

2 Credits

Sr. No.	Assessment	Marks
1	Class Test	15
2	Overall Assessment-Article Review, Group Discussion, Quiz, Survey Report. Poster Presentation, Guest Lecture, Interview, Game, PPT, Narrating, Project Making, Street Play, Short Film, Film Shows	05
3	Assignments (2 x 10 Marks)	20
Total		40

Any two tasks from the following (2 x 10 = 20 Marks)

- a) Preparation of scrap book for career guidance.
- b) Reflective account of the take away from the course and their application in future career.
- c) Visit and report of a visit to any one place (Employment exchange, Guidance Bureau, counselling centre)
- d) Design a checklist/Questionnaire to collect information on students educational, psychological or social problem.
- e) Preparing a career guidance chart
- f) Preparation of a vocational/ educational counseling programme for class-X students
- g) Strategies for handling Academic Stress / Bullying / Relationship / Handling puberty Issues / suicide.
- h) Career Dissemination Session for school or junior college (any two careers)

References:

1. Bhatnagar, R.P., & Seema, R. (2003). Guidance and counseling in education and psychology. Meerut: R. Lal Book Depot.
2. R. Lal Book Depot.
3. Bhatnagar, Asha & Gupta, Nirmala. Guidance & Counselling -Vol. 1 Vikas Publisher House. New Delhi.
4. Chauhan, S.S. (2008). Principles and techniques of guidance. UP: Vikas Publishing House Pvt. Ltd. Sharma.
5. Crow, L.D., & Crow, A. (2008). An introduction to guidance. Delhi: Surjeet Publications.
6. Dave, Indu. The Basic Essentials of Counselling Sterling Publisher. New Delhi
7. Gibson, Robert. Introduction to Counselling & Guidance. Prentice - Hall of India. New Delhi
8. Kavyamala Publishers. Qureshi, H. (2004). Educational guidance. New Delhi: Anmol Publications Pvt. Ltd.
9. Jones, A.J. (2008). Principles of guidance. (5 ed). Delhi: Surjeet Publications.
10. Kaushik, V.K & Sharma, S.R. Fundamentals of Psychology Anmol Publisher. New Delhi Chandra, Ramesh. Guidance & Counselling Kalpaz Publications. Delhi.
11. Kinra, A.K. Guidance and Counselling. New Delhi: Pearson Longman.
12. Paul, Lengrand. An Introduction to Lifelong Education 2 Croom Hekn-London the UNESCO Press-Paris. London.
13. Meenakshisundaram, A. (2005). Guidance and counseling. Dindigul: Kavyamala Publisher
14. Rao, Narayana. Counselling Guidance Tata Mc GrawHill . New Delhi Vashist, S.R. Methods of Guidance Anmol Publication. New Delhi
15. R.N. (2008). Vocational guidance & counseling. Delhi: Surjeet Publications.
16. Safaya, B.N. (2002). Guidance and Counselling. Chandigarh: Abhishek Publications.
17. Sharma, R.A. (2008). Career information in career guidance. Meerut: R. Lal Books Depot.
18. Shrivastava, K.K. Principles of Guidance & Counselling Kanishka Publishers Distributors. New Delhi.

19. Sidhu, H.S. Guidance and Counselling. Patiala: Twenty First Century Publication.
20. Singh, Raj. Educational & Vocational Guidance. Commonwealth Publication. New Delhi.
21. Rao, S.N . Guidance & Counselling. Discovery Publications. New Delhi.

SEMESTER VIII
B.Ed.Course XXVII
ENVIRONMENT MANAGEMENT

Total Credits: 06
Total Marks: 100
External Assessment: 60
Internal Assessment: 40

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the environmental concepts, ecosystem and ecological pyramid
2. explain the environmental issues and the various approaches of teaching environmental education.
3. describe the sustainable development goals 2030 by United Nations Development Programme(UNDP)
4. explain the sustainable practices in reducing ecological footprint
5. explain the concept of Environmental Quality, Environmental Audit, Environmental Impact Assessment
6. illustrate Environmental initiatives, projects and laws

Module I: Fundamentals of Environment Management

2 Credits

Unit I: Foundation of Environment

- a) Environmental Education: Concept, Scope and Need of Environmental education
- b) Ecosystem: Concept of Ecosystem, Structure of Ecosystem, Types of Ecosystem – Aquatic and Terrestrial Ecosystem
- c) Ecological pyramid: Concept and types of Ecological pyramid - Pyramid of numbers, Pyramid of biomass, Pyramid of energy.

Unit II: Environmental Issues and Concerns

- a) Climate Change, Ozone layer depletion (causes, effect and Remedies)
- b) Loss of Biodiversity, Land mis-management (causes, effect and Remedies)
- c) Energy Crisis (causes, effect ,precautions and alternate energy sources)

Unit III: Foundation to Environmental Education

- a) Environmental Education: Concept, Principles and Significance
- b) Historical Developments: Stockholm conference (1972), Intergovernmental conference (1977), Kyoto Protocol (2005), Tbilisi + 30 (2007)
- c) Approaches to teaching environmental education: Interdisciplinary approach and Multidisciplinary approach.

Module II: Environment Management Towards Sustainable Development Practices- 2 Credits

Unit IV: Practices for sustainable Environment

- a) Sustainable Development Goals (SDG's 2030): Concept and significance, Components -17 SDG's
- b) Sustainable Environment Management: Meaning and Significance – Rainwater Harvesting, Mangrove Management, Disaster Management
- c) Paradigm shift from Environmental education to Sustainable development – Concept and Significance

Unit V: Environmental Initiatives

- a) Environmental Quality: Concept, need to protect environment quality
- b) Environmental Audit: Objectives, Elements of audit, process of environmental audit
- c) Environmental Impact Assessment (EIA) : Significance, process of EIA.

Unit VI: Environment Initiatives, Projects and Laws

- a) Concept and Significance of Movements: Raleganj Siddhi Movement, Green Peace Movement, Tarun Bharat Sangh Movement.
- b) Concept and Significance of Projects: Tiger project, Narmada Bachao Andolan
- c) Concept and Significance of Laws: Laws of conservation and Protection: Environment Protection Act, Wildlife Protection Act and Noise Pollution Act.

Module III: Internal Assessment

2 Credits

S.No	Task	Marks
1	Assignments (2*10)	20 marks
2	Case study/ Projects/ Posters and exhibits/ Seminar/Workshop/ Co-operative Learning/ Blended Learning/ Constructivist Learning/ Nai Talim – Experiential Learning/ Open Bookassignment	05 marks
3	Class Test	15 marks
	Total	40 marks

Any two tasks from the following (2 x 10 = 20 Marks)

1. Conduct activities like tree plantations, Go Green drives, various competitions based on environment
2. Awareness activity in community/school regarding various environmental issues through an exhibition/display
3. Critically analyze the implementation of action plan on Education for sustainable development at global level.
4. Calculate your ecological/carbon footprint and state ways to reduce the carbon footprint.
5. Conduct an environmental audit and report on any development/ industrial projects.
6. Study the impact of any goods purchased on the environment with reference to its manufacturing, packaging and transportation cost.

References:

1. Agarwal, K.C, (2001) Environmental Biology Bikaner, Nidi Publications Ltd.
2. Agarwal, K.M, Sikdar P.K, Deb, S.C A Textbook of Environment Kolkotta, Macmillan India Limited.
3. Bharucha, E the Biodiversity of India Ahmedabad, Mapin Publishing Pvt. Ltd.
4. Cunningham, W.P. Cooper, T.H. Gorhani, E & Hepworth, M.T. (2001) Environmental Encyclopedia, Mumbai, Jaico Publications House.
5. Deb S.C Environmental Management, Jaico Publishing House, Mumbai
6. Devi U, Reddy A, Environmental Education for Rural Population, Delhi Discovery Publication House.
7. Dhyani S.N. Wildlife Management New Delhi Rawat Publications
8. Dutt, N H, Gopal, Environmental Pollution and Control, Hyderabad, Neelkamal Publication.
9. Enger E.D, Bradley F.S Environmental Science- A Study of Interrelationship
10. G Tyler Miller Jr, Environmental Science, 11th edition, Cengage learning India Pvt ltd
11. Ghanta R & Rao D B Environmental Education Delhi, Discovery Publication House.
12. Gupta N.L and Gurjar R.K (Eds.) Sustainable Development (2 Vols) : New Delhi Rawat Publications.
13. Krishnamacharyulu V, Reddy Environmental Education Hyderabad Neelkamal Publications.
14. Marilee G, Jeri M, Chakraborty C Environmental Studies MannanPrakashan
15. Murray B (1996) the Philosophy of Social Ecology: Essays on Dialectical Naturalism New Delhi, Rawat Publications.
16. Nanda, V. K, Environmental Education New Delhi Anmol Publication.
17. Odum E.P Fundamentals of Ecology USA, W.B. Saunders Co.
18. Paneerselvam & Ramkrishnan, Environmental Science Education Delhi, Sterling Publications.

19. Rai R.K, Environmental Management: New Delhi, Rawat Publications.
20. Ranjan R. Environmental Education, New Delhi.Mohit Publication.
21. Reddy P, Reddy N Environmental Education, Hyderabad Neelkamal Publication.
22. Saxena, A. B Education for the Environmental Concern New Delhi Radha Publication.
23. Sharma R A Environmental Education Meerut R Lal Book Depot.
24. Singh M S Environmental Education Delhi Adhyayan Publishers.
25. Singh P; Sharma S Environmental and Pollution Education, New Delhi Deep and Deep Publications.
26. Singh Y.K, Teaching of Environmental Science, APH Publishing House, New Delhi
27. Suneetha G; Rao D B Environmental Awareness of School Studies, Sonali Publication.
28. Townsend C., Harper J, and Michael Begon, Essentials of Ecology Blackwell Science.
29. Trivedi R.K. Handbook of Environmental Laws, Rules Guidelines, Compliances and Standards, Vols. I and II, Enviro Media (R)
30. Wanger K.D., (1998) Environmental Management. Philadelphia, W.B. Saunders Co.
31. Wright R.T; Environmental Science- Toward a sustainable future, 9th edition, Prentice-Hall of India Pvt Ltd, new Delhi 2007
32. "Survey of the Environment" The Hindu (Magazine)
33. https://en.wikipedia.org/wiki/Carbon_credit
34. <http://unesdoc.unesco.org/images/0015/001540/154093e.pdf>

SEMESTER VIII
B.Ed.Course XXXI
ABILITY COURSE: CYBER LAWS

Total Credits: 03
Internal Assessment: 50

Course Learning Outcomes

By the end of the course, student will be able to:

1. explain the concept of cyber security.
2. discuss the importance of cyber laws.
3. explain cyber space jurisdiction
4. discuss the significance of intellectual property rights and trademark disputes

Module I: Basics of Computer and Computer Safety

2 Credits

Unit I: Computer & Cyber Security

- a) Basics of Networks and internet, Types of Network, Definition of Cyber Security - Types of Attacks, Network Security
- b) Overview of Security threats, (d) Hacking Techniques, Password cracking
- c) Insecure Network connections, Malicious code, Concept of Fire wall Security

Unit II: Cyber Laws

- a) Evolution of the IT Act, Genesis and Necessity
- b) Salient features of the IT Act, 2000, various authorities under IT Act and their powers, Penalties & Offences, amendments.
- c) Impact on other related Acts (Amendments) : i) Amendments to Indian Penal Code ii) Amendments to Indian Evidence Act iii) Amendments to Bankers Book Evidence Act. iv) Amendments to Reserve Bank of India Act.

Module II: Information Technology Law

2 Credits

Unit III: Cyber Space Jurisdiction and Laws in India

- a) Jurisdiction issues under IT Act, 2000., Traditional principals of Jurisdiction, Extra terrestrial Jurisdiction,
- b) Case Laws on Cyber Space Jurisdiction
- c) Digital / Electronic Signature in Indian Laws, E – Contracts and its validity in India, Cyber Tribunal & Appellate Tribunal, Cyber Regulations

Unit IV: Intellectual Property Rights, Domain Names and Trademark Disputes

- a) Concept of Trademarks / in Internet Era, Cyber Squatting, Reverse Hijacking
- b) Jurisdiction in Trademark Disputes, Copyright in the Digital Medium, Copyright in Computer Programmes
- c) Copyright and WIPO Treaties, Concept of Patent Right, Relevant Provisions of Patent Act 1970

Module III: Internal Assessment 40 Marks

2 Credits

Any five tasks from the following

(5 x 10 = 50 Marks)

(Assignments to be completed and assessed in the form of a project report. These assignments can be done as group-work or individually but will be assessed individually for each student)

- a) Power Point Presentation on cyber laws ,
- b) Report on any one internet application
- c) Do's and Don'ts of Cyber Security
- d) Report on Intellectual Property Rights.
- e) Report any one cyber Crime that you have heard or witnessed.

References:

1. E- Commerce - Kenneth Laudon, Carol Traver , Pearson Education
2. Frontiers of Electronic Commerce - Kalakota & Whinston
3. E- Commerce - Rajaraman
4. E- Commerce - Whitley
5. E- Commerce concepts and cases - Rao and Deshpande.
6. Programming in VB 6.0 - Julia case Bradley, Anita C. Milspaugh, TMH
7. Visual Basic 6.0 Programming - Content Development Group, TMH
8. The Complete Reference to Visual Basic 6 - Noel Jerke, TMH
9. Visual Basic 6 Programming Black Book - Steven Holzner, Dreamtech Press
10. Cyber Law & Cyber Crimes By Advocat Prashant Mali; Snow White publications, Mumbai
11. Cyber Law in India by Farooq Ahmad; Pioneer Books
12. Information Technology Law and Practice by Vakul Sharma; Universal Law Publishing Co. Pvt. Ltd.
13. The Indian Cyber Law by Suresh T. Vishwanathan; Bharat Law House New Delhi
14. Guide to Cyber and E – Commerce Laws by P.M. Bukshi and R.K. Suri; Bharat Law House, New Delhi
15. Guide to Cyber Laws by Rodney D. Ryder; Wadhwa and Company, Nagpur
16. The Information Technology Act, 2000; Bare Act – Professional Book Publishers, New Delhi
17. Computer Forensics: Principals and Practices by Linda Volonino, Reynaldo Anzaldua and Jana Godwin; Pearson Prentice – Hall 2007
18. First Responder's Guide to Computer Forensics by Richard Nolan et al; Carnegie Mellon, 2005.
19. Digital Evidence and Computer Crime, 2nd Ed. By Eoghan Casey; Academic Press, 2004.
20. The Regulation of Cyberspace by Andrew Murray, 2006; Rutledge – Cavendish.
21. Scene of the Cybercrime: Computer Forensics Handbook by Syngress.
22. Security and Incident Response by Keith J. Jones, Richard Bejtloich and Curtis W. Rose
23. List of Websites for more information is available on: [Http://www.garykessler.net.library/forensicsurl.html](http://www.garykessler.net.library/forensicsurl.html)
24. Introduction to Forensic Science in Crime Investigation by Dr. (Smt) Rukmani Krishnamurthy.
25. Bahl, J.C. and Nagamia, S.M. (1974) Modern Business Correspondence and Minute Writing
26. Balan, K.R. and Rayudu C.S. (1996) Effective Communication, Beacon New Delhi
27. Barkar, Alan (1993) Making Meetings Work, Sterling Publication Pvt. Ltd., New Delhi
28. Basu, C.R. (1998) Business Organisation and Management, T.M. H. New Delhi
29. Bhargava and Bhargava (1971) Company Notices, Meetings and Regulations
30. Black, Sam (1972) Practical Public Relations, E.L.B.S. London
31. Burton, Grand Thakur (1995), Management Today Principles and Practices T.M.H., New Delhi
32. Ecouse Barry (1999), Competitive Communication: A Rhetoric for Modern Business, OUP
33. Fisher Dalmar (1999), Communication in Organisation, Jaico Pub House, Mumbai, Delhi
34. Frailey, L.E. (1982) Handbook of Business Letters, Revised Edition, Prentice Hall, New Jersey
35. Lesikar, Raymond V and Petit, John D. (1994) Business Communication: Theory and Application
36. McQuail, Denis (1975), Communication, Longman
37. Merrihue, William (1960) Managing by Communication, McGraw Hill, New York
38. Monippalli, M.M. (1997), The Craft of Business Letter Writing, T.M.H. New Delhi
39. Murphy, Herta and Hilde Brandt, Herbert W (1984) Effective Business Communication, McGraw Hill, New York
40. Parry, John (1968) The Psychology of Human Communication
41. Parson, C.J. and Hughes (1970) Written Communication for Business Students, Great Britain
42. Stephenson, James (1988) Principles and Practice of Commercial Correspondence, Pilman and Sons Ltd. London
43. Shurter, Robert L. (1971) Written Communication in Business, McGraw Hill, Tokyo