KURUKSHETRA UNIVERSITY KURUKSHETRA

Five Years Integrated
M. Sc. Engineering Physics (3 Years BSc+2Years M.Sc.)
Under CBCS-LOCF

(Effective from the Academic Session 2020-21 in phase manner)

Department of Physics
INSTITUTE OF INTEGRATED & HONORS STUDIES
Kurukshetra University
Kurukshetra - 136 119
Haryana (INDIA)

Learning Outcomes-based Curriculum Framework
For
Five Year Integrated
M.Sc. Engineering Physics (3 Year BSc+2 Year M.Sc.)
(Effective from the Academic Session 2020-21 in phase manner in IIHS)

Table of Content

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Introduction:

M. Sc. Engineering Physics (5 years Integrated) was started way back in 2009 in the Physics Department, Institute of Integrated and Honors Studies (IIHS) of Kurukshetra University on the advice of Higher Education Department Haryana. This course is of 5 Years (10 Semesters). ***After completion of 3 years (6 Semesters), students will be awarded B. Sc. Engineering Physics which is equivalent to B. Sc. (Non-Medical).*** Next 2 years (4 semesters) course is equivalent to M.Sc. Physics. The programme was prepared by the faculty of Physical Sciences of Kurukshetra University following the guidelines of the model curriculum developed by UGC, New Delhi and looking the need of the students to complete with recent trends in higher education at national and international level. The same has been finalized by inviting comments, suggestions from experts in individual from universities, institutes, industries and alumni of the institute.

Following the guidelines of UGC, New Delhi and looking at the better employability, entrepreneurship possibilities and also to enhance the latent skills of the students Kurukshetra University has adopted the ***Choice Based Credit System*** **(CBCS)** system for assessing performance of the students from the academic year 2019-2020. The CBCS system offers flexibility to the students in choosing courses of their own choice from the exhaustive list comprising core, elective, skill based, specializations and minor components that are evaluated following the grading system. The university shall be implementing the revised syllabus of M. Sc. Engineering Physics (5 years Integrated) First Year from the coming academic year i.e., 2020-2021. This document provides detailed information on methodology of choosing different components of M. Sc. Engineering Physics (5 years Integrated) First to Fifth Year (Semester I through X) theory and practical courses.

Master of Science (M. Sc.) Engineering Physics (5 years Integrated) is a post-graduation course of Kurukshetra University. The Credit Based Grading System (CBCS) adopted under this course enables the students to develop a strong foundation of the fundamental Physics and also elevates their knowledge base to apply these foundations to the applied and advanced electives, specializations of their own choices. **The students pursuing this course will develop foundation aspects of Physics, Chemistry and Mathematics during the first 3 years. In the next 2 years, the students pursuing the course will develop in-depth understanding of various aspects of the core subjects of Physics by developing the deeper understanding level of different analogies, laws of the Nature through the subjects like classical mechanics, quantum mechanics, electrodynamics, statistical mechanics, condensed matter physics, atomic and molecular physics, nuclear physics, etc.** The course also helps the students in enhancing their analytical skill through the embedded component of the problem solving skills, seminar activities and hands-on and minds-in activities of the course. The courses offered by the University are of student-centric nature and help them to understand the basic laws of nature and develop necessary skills to apply them to the advanced areas of studies in science and engineering.

There are **core or mandatory courses (theory and laboratory courses)** meant to provide adequate knowledge on various aspects of physics discipline and to prepare the students for applying them for advanced courses. In addition, there will be skill based elective (specialization) as well as few open elective courses enabling cross-discipline movement to the students. The skill based elective courses are of more advanced nature and help the students to develop their skills in specific fields through more of the hands-on activities. The details of the courses and activities are given with detailed syllabus.

Objectives of the M. Sc. Engineering Physics program:

1. To develop skills of critical thinking, hypothesis building and applying the scientific method of physics concepts, theoretical models and laboratory experiments

2. To develop problem solving skill for identifying and formulating problems independently and creatively employing the theoretical and/or experimental methods that he has acquired during the course

3. To train the students with a working knowledge of experimental/computational techniques and instrumentation required to work independently in research and industrial environments

4. To acquire advanced knowledge in specialized areas in physics that is in tune with the front-line research in physics

5. To prepare the students to successfully compete for current employment opportunities.

Scheme and Syllabi of five years integrated
M. Sc. ENGINEERING PHYSICS Programme
(From 1st to 6th semester)
Under CBCS-LOCF
(w. e. f. from the Academic Session 2020-21 in phase manner)
(After 3 Years / 6 Semesters, students may be awarded B. Sc. -Engineering Physics Degree)

1st Year (1st and 2nd semesters)

1st Semester

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks			Duration of Examination (Hrs.)
					Internal Assessment*	End-semester Examination	Total	
AECC Course-I Communication Skills	EVS- 101	Environmental Science	2+0+0	2	10	40	50	3
Core Course-I (Physics)	EP-101	Mechanics-I	3+0+0	3	15	60	75	3
Core Course-II (Physics)	EP-102	Mechanics-II	3+0+0	3	15	60	75	3
Core Course-III (Physics)	EP-103	Physics Practical-I	0+0+2	4	----------	50	50	3
Core Course-I (Mathematics)	MT-101	Calculus	3+0+0	3	15	60	75	3
Core Course-II (Mathematics)	MT-102	Algebra and Number Theory	3+0+0	3	15	60	75	3
Core Course-III (Mathematics)	MT-103	Mathematics Practical-I	0+0+2	4	------------	50	50	3
Core Course-I (Chemistry)	CH-101	Inorganic chemistry-I	2+0+0	2	10	40	50	3
Core Course-II (Chemistry)	CH-102	Physical chemistry-I	2+0+0	2	10	40	50	3
Core Course-III (Chemistry)	CH-103	Organic chemistry-I	2+0+0	2	10	40	50	3
Core Course-IV (Chemistry)	CH-104	Chemistry practical-I	0+0+2	4	-------------	50	50	6
Total Credits/Marks in semester-I			**26**				**650**	

*Internal Assessment marks

20% marks in each theory paper shall be reserved for Internal Assessment. The following parameters (with weightage of each) forming the basis of award of Internal Assessment:-

(i) One test/Seminar for each paper (one period duration)	: 50%
(ii) One Assignment for each paper	: 25%
(iii) Attendance	: 25%

2nd Semester

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks			Duration of Examination (Hrs.)
					Internal Assessment*	End-semester Examination	Total	
AECC Course-II Communication Skills	ENG-201	English Communication	2+0+0	2#	10	40	50	3
Core Course-IV (Physics)	EP-201	Electricity, Magnetism & E.M. Theory	3+0+0	3	15	60	75	3
Core Course-V (Physics)	EP-202	Electronics	3+0+0	3	15	60	75	3
Core Course-VI (Physics)	EP-203	Physics Practical-II	0+0+2	4	---------	50	50	3
Core Course-IV (Mathematics)	MT-201	Advanced Calculus	3+0+0	3	15	60	75	3
Core Course-V (Mathematics)	MT-202	Differential Equations	3+0+0	3	15	60	75	3
Core Course-VI (Mathematics)	MT-203	Mathematics Practical-II	0+0+2	4	-----------	50	50	3
Core Course-V (Chemistry)	CH-201	Inorganic chemistry-II	2+0+0	2	10	40	50	3
Core Course-VI (Chemistry)	CH-202	Physical chemistry-II	2+0+0	2	10	40	50	3
Core Course-VII (Chemistry)	CH-203	Organic chemistry-II	2+0+0	2	10	40	50	3
Core Course-VIII (Chemistry)	CH-204	Chemistry practical-II	0+0+2	4	-------	50	50	6
Total Credits/Marks in semester-II			**26**				**650**	

#Workload for English: 1 hour for teaching theory/text and 1 hour for composition/ grammar for group of 20 (Twenty) students.

M. Sc. Engineering Physics
Semester-I
Subject: Environmental Studies
(Course Type- Ability Enhancement Compulsory Course, Course Code: EVS-101)
Nomenclature: Environmental Science
No. of credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hours

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 5 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Syllabus will be the same as for other UG courses as approved by the Board of Studies of the Department of Environmental Science, KUK

M. Sc. Engineering Physics
Semester-I
Subject: Physics
(Course Type- Core Course, Course Code: EP-101)
Nomenclature: Mechanics-I
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

ROTATIONAL MOTION

Rotation of rigid body, Moment of inertia, Torque, Angular momentum, Kinetic Energy of rotation. Theorem of perpendicular and Parallel axis (with proof), Moment of inertia of Ring, Disc, Rectangular lamina, Solid bar of rectangular cross section, Solid sphere, Hollow sphere, Spherical shell, Solid Cylinder and Hollow cylinder. Fly wheel, Moment of inertia of an irregular body, Acceleration of a body rolling down on an inclined plane.

(15 Lectures)

UNIT-II

ELASTICITY

Elasticity, Stress and Strain, Hooks law, Elastic constant and their relations, Poisson's ratio, Torsion of cylinder and twisting couple, determination of coefficient of modulus of rigidity for the material of wire by Maxwell's Needle, bending of beam (Bending moment and its magnitude), Cantilever and Centrally loaded beam, Determination of Young's modulus for the material of the beam and Elastic constants for the material of the wire by Searle's method.

(15 Lectures)

UNIT-III

OSCILLATIONS

Review of SHM, Simple Harmonic Oscillations, Differential Equation of SHM and its solution. Kinetic Energy, Potential Energy and their space average, time average, total energy. Damped oscillations, forced oscillations, transient and steady state, sharpness of resonance, power dissipation and quality factor. **(15 Lectures)**

UNIT-IV

SURFACE TENSION

Surface Tension: Synclastic and anticlastic surface, excess pressure application to spherical drop and bubbles. Variation of Surface tension with temperature.

VISCOSITY

Kinematics of moving fluids: idea of compressible and incompressible fluids, equation of continuity, steamline and turbulent flow, Reynolds's number, Euler's equation, The special case of fluid statics F = Δp, Simple applications e.g. Pascal's law and Archimedes principle. Poiseuille's equation for flow of a viscous liquid through a capillary tube.

(15 Lectures)

CO No.	**Course code (EP-101): Mechanics-I** **After successfully completing the course, student will be able to:**
CO-1	Understand the application of both translational and rotational dynamics motions simultaneously in analyzing rolling with slipping. Write the expression for the moment of inertia about the given axis of symmetry for different uniform mass distributions.
CO-2	Understand the principles and basic terms related to elasticity through the study of Young Modulus and modulus of rigidity.
CO-3	Explain the phenomena of simple harmonic motion and the properties of systems executing such motions.
CO-4	Appreciate the concepts and Applications of surface tension and also be able to understand simple principles of fluid flow and different equations governing fluid dynamics.

REFERENCES

1. Mechanics "Berkeley Physics Course Vol. I", Charles Kittel, Tata McGraw-Hill
2. Elements of Properties of Matter, D.S. Mathur, S .Chand & Com. Pt. Ltd., New Delhi
3. Heat and Thermodynamics (5^{th} Edition), Mark W. Zermansky

4. Physics, Resnick, Halliday & Walker, Wiley
5. Properties of Matter, R. Murgeshan, S. Chand & Com. Pt. Ltd., New Delhi

M. Sc. Engineering Physics
Semester-I
Subject: Physics
(Course Type- Core Course, Course Code: EP-102)
Nomenclature: Mechanics-II
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

BASIC CONCEPTS OF CLASSICAL MECHANICS

Mechanics of single and system of particles, Conversion law of linear momentum, Angular momentum and mechanical energy for a particle and a system of particles, Centre of Mass and equation of motion.

(15 Lectures)

UNIT-II

GENERALIZED NOTATIONS

Degrees of freedom and Generalized coordinates, Transformation equations, Generalized Displacement, Velocity, Acceleration, Momentum, Force and Potential, Hamilton’s variational principle, Lagrange’s equation of motion from Hamilton’s principle, Linear Harmonic oscillator, Simple pendulum, Atwood’s machine.

(15 Lectures)

UNIT-III

THEORY OF RELATIVITY-I

Frame of reference, limitation of Newton's law of motion, Inertial frame of reference, Galilean transformation, Frame of reference with linear acceleration, Classical relativity, Galilean invariance, Transformation equation for a frame of reference- inclined to an inertial frame and Rotating frame of reference, Non-inertial frames; The accelerated frame of reference and rotating frame of reference, Fundamental frame of reference, Michelson Morley's experiment.

(15 Lectures)

UNIT-IV

THEORY OF RELATIVITY-II

Special theory of relativity, Lorentz co-ordinate and physical significance of Lorentz invariance, Length Contraction, Time Dilation, Twin Paradox, Velocity addition theorem, Variation of mass with velocity, Mass energy equivalence, Transformation of relativistic momentum and energy, relation between relativistic momentum and energy, Mass, velocity, momentum and energy of zero rest mass.

(15 Lectures)

CO No.	**Course code (EP-102): Mechanics-II**
	After successfully completing the course, student will be able to:
CO-1	Learn the concept of conservation of energy, momentum, angular momentum and apply them to understand the basic problems in physics.
CO-2	Understand and explain the Hamilton's variational principle, derive Lagrange's equation of motion from Hamilton's principle and be able to apply these principles to derive the Lagrangian and Hamiltonian for various simple mechanical systems such as Linear Harmonic oscillator, Simple pendulum, Atwood's machine.
CO-3	Differentiate between inertial and Non-inertial frame of references and Describe how fictitious forces arise in a non-inertial frame. Understand the importance of Michelson Morley's experiment in reference to special theory of relativity.
CO-4	Describe special relativistic effects and their effects on the mass and energy of a moving object and appreciate the nuances and important outcomes of Special Theory of Relativity.

REFERENCES

1. Classical Mechanics by H. Goldstein (2nd Edition)
2. Berkeley Physics Course. Vol. 1. Mechanics, E.M. Purcell
3. Concepts of Modern Physics, Arthur Beiser
4. Mechanics, D.S. Mathur, S.Chand & Com. Pt. Ltd., New Delhi

5. Berkeley Physics Course. Vol. 1. Mechanics, Charles kittel, Walter D Knight, Malvin A Ruderman, Carel A Helmholz and Burton J Moyer, McGraw-Hill, New York

M. Sc. Engineering Physics
Semester-I
Subject: Physics
(Course Type- Core Course, Course Code: EP-103)
Nomenclature: Physics Practical-I
Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -
1.Do any eight experiments from the given list of experiments.
2.The students are required to calculate the error involved in a particular experiment.
3.The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

List of Experiments:
1. Measurement of Length (or diameter) using Vernier calliper, Screw Gauge & Travelling Microscope.
2. Moment of Inertia of a Fly Wheel
3. Moment of Inertia of irregular body using a Torsion Pendulum.
4. Surface Tension by Jaeger's Method.
5. Young Modulus by Bending of Beam.
6. Modulus of rigidity of material of wire by Maxwell's Needle.
7. Elastic constant by Searle's method.
8. Viscosity of water by its flow through a uniform capillary tube.
9. Acceleration due to Gravity 'g' by Bar pendulum.
10. To study the Motion of spring and calculate Spring constant & value of Acceleration due to Gravity.
11. To compare Moment of Inertia of a solid Sphere, Hollow Sphere and solid Disc of same mass with the help of Torsion Pendulum.

CO No.	Course code (EP-103) : Physics Practical-I
	After successfully completing the course, student will be able to:
CO-1	Hands on experience with different instruments and appreciate the beauty of different concepts and related experiments in Physics.
CO-2	Verify some fundamental principles, effects and concepts of physics through Experiments.
CO-3	perform experiments related to mechanics (compound pendulum), rotational dynamics (Flywheel), elastic properties (Young Modulus and Modulus of Rigidity) and fluid dynamics (verification of Stokes law, Searle method) etc.
CO-4	Learn to present observations, results and analysis in suitable and presentable form.

REFERENCES

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House.

M. Sc. Engineering Physics
Semester – I
Subject: Mathematics
(Course Type-Core Course, Course Code: MT-101)
Nomenclature: (Calculus)
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

ε-δ definition of limit and continuity of a real valued function, basic properties of limits, types of discontinuities. Differentiability of functions. Successive differentiation. Leibnitz theorem. Maclaurin and Taylor series expansions

Unit-II:

Tangents and normals (Cartesian and parametric equations). Asymptotes in Cartesian and polar coordinates, intersection of a curve and its asymptotes. Curvature and radius of curvature of curves in Cartesian, polar and parametric forms. Newton's method. Radius of curvature for pedal curves. Centre of curvature. Circle of curvature. Evolutes and involutes.

Unit-III:

Tests for concavity and convexity. Points of inflexion. Multiple points. Cusps, nodes & conjugate points.

Reduction formulae. Rectification.

Unit-IV:

Quardrature, Sectorial area. Area bounded by closed curves. Volumes and surfaces of solids of revolution. Theorems of Pappu's and Guilden.

Course Outcomes: This course will enable the students to:

1. Calculate the limit of functions, examine the continuity of functions, understand differentiability of different type of functions, successive differentiation of functions and series expansions.
2. Understand concepts of tangents, normals, asymptotes, curvature, evolutes and involutes of a curve; the geometrical meanings of these terms and to solve related problems
3. Determine singular points of a curve and their types. To understand rectification of curves and to apply the reduction formulae.
4. Determine area bounded by curves and volumes and surface area of solids formed by revolution of curves

Recommended Text Books:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*' *Calculus* (14th edition). Pearson Education.
6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

M. Sc. Engineering Physics
Semester – I
Subject: Mathematics
(Course Type-Core Course, Course Code: MT-102)
Nomenclature: Algebra and Number Theory
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit–I:

Rank of a matrix. Row rank and column rank of a matrix. Eigen values, eigen vectors and the characteristic equation of a matrix. Minimal polynomial of a matrix. Cayley-Hamilton theorem and its use in finding the inverse of a matrix. Unitary and Orthogonal Matrices.

Unit–II:

Applications of matrices to a system of linear (both homogeneous and non–homogeneous) equations. Theorems on consistency of a system of linear equations.

Relations between the roots and coefficients of general polynomial equation in one variable. Solutions of polynomial equations having conditions on roots.

Unit–III:

Common roots and multiple roots. Nature of the roots of an equation Descarte's rule of signs. Solutions of cubic equations (Cardon's method). Biquadratic equations and their solutions.

Unit–IV:

Divisibility, Greatest Common Divisor (GCD), Least Common Multiple (LCM). Prime numbers, Fundamental Theorem of Arithemetic. Linear Congruences, Fermat's theorem. Wilson's theorem and its converse. Linear Diophanatine equations in two variables. Greatest integer function [x]. The number of divisors and the sum of divisors of a natural number n (The functions d(n) and σ(n)).

Course Outcomes: This course will enable the students to:

1. Determine rank of a matrix, eigen values, eigen vectors, characteristic equation and characteristic polynomial of square matrices. Understand unitary and orthogonal matrices and to solve related problems.
2. Find solution of homogeneous and non-homogeneous system of linear equations using matrices. Determine relation between roots and coefficients of a general polynomial equation.
3. Identify multiple roots. Application of Descarte's rule of sign. Solve cubic and biquadratic equations.
4. Understand the basic concepts of number theory and their applications in problem solving. Prove Fermat and Wilson's theorems and their applications.

Recommended Text Books:

1. A.I. Kostrikin (1984). *Introduction to Algebra*. Springer Verlag.
2. Bernard Kolman & David R. Hill (2003). *Introductory Linear Algebra with Applications* (7th edition). Pearson Education Pvt. Ltd. India.
3. S. H. Friedberg, A. L. Insel and L.E. Spence (2004). *Linear Algebra*, Prentice Hall of India Pvt. Ltd.
4. David C. Lay, Steven R. Lay & Judi J. McDonald (2016). *Linear Algebra and its Applications* (5th edition). Pearson Education Pvt. Ltd. India.
5. Gareth A. Jones & J. Mary Jones (2005). *Elementary Number Theo*ry. Springer.
6. Neville Robbins (2007). *Beginning Number Theory* (2nd edition). Narosa.
7. I. Niven (2012). *An Introduction to the Theory of Numbers* (5th edition). John Wiley & Sons.
8. H.S. Hall and S.R. Knight (2016). *Higher Algebra*, Arihant Publications.
9. Leonard Eugene Dickson (2009). *First Course in the Theory of Equations*. The project Gutenberg EBook (http://www.gutenberg.org/ebooks/29785)

M. Sc. Engineering Physics
Semester-I
Subject: Mathematics
(Course Type-Core Course, Course Code: MT-103)
Nomenclature: Mathematics practical-I
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. This course has two components, Problem Solving and Practical using MAXIMA software.
2. The examiner will set 4 questions at the time of practical examination asking two questions from the part (a) and two questions from the part (b) by taking course outcomes (COs) into consideration.
3. The examinee will be required to solve one problem from the part (a) and to execute one program successfully from the part (b).
4. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.
5. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

a) **Problem Solving**- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

1. Problems of curve tracing when equation is given in Cartesian coordinates.
2. Problems of curve tracing when equation is given in parametric form.
3. Problems of curve tracing when equation is given in polar coordinates.
4. Problem solving of determination of length of a curve expressed in Cartesian coordinates.
5. Problem solving of determination of length of a curve expressed in polar coordinates.
6. Problems of determination of volume of solids generated by revolution of curves expressed in Cartesian coordinates.
7. Problems of determination of volume of solids generated by revolution of curves expressed in polar coordinates.
8. Problems of determination of volume of solids generated by revolution of curves expressed in parametric form.

9. Problems of solving cubic equations by Cardon's method.
10. Problems of solving biquadratic equations by Ferrari' method.

b) **Practicals with Free and Open Source Software (FOSS) Tools-** The following practicals will be done using MAXIMA Software and record of those will be maintained in the practical Note Book:

1. To simplify expression, factor expression, expand expression and to do trigonometric simplification and complex simplification by making use of MAXIMA.
2. To find derivatives of functions using MAXIMA.
3. To find indefinite and definite integrals of different functions using MAXIMA.
4. To find roots of algebraic equations using MAXIMA.
5. To find the value of a determinant using MAXIMA.
6. To compute inverse of a square matrix using MAXIMA.
7. To find Eigen values and Eigen vectors of a square matrix using MAXIMA.
8. To solve system of linear equations using MAXIMA.

Course Outcomes: This course will enable the students to:

1. Handle practical problems of tracing of curves when equations are given in Cartesian, polar coordinates or in parametric form.
2. Solve practical problems of finding length of given curves, calculating volume of solids generated by revolution of curves and solving cubic and biquadratic equations.
3. Have hand on experience to find derivative and integral of different functions and to solve algebraic equations by using built in functions of MAXIMA software.
4. Attain skills to find inverse, eigen values of matrices and to solve system of linear equations by using built in functions of MAXIMA software.

M. Sc. Engineering Physics
Semester – I
Subject: Chemistry
(Course Type-Core, Course Code: CH-101)
Nomenclature: Inorganic Chemistry-I
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section – A (15 hrs)

Atomic Structure

Idea of de Broglie matter waves, Heinsenberg's uncertainty principle, atomic orbitals, quantum numbers, radial and angular wave functions, normal and orthogonal wave functions, significance of Ψ and Ψ2, probability distribution curves, shapes of s, p, d, f orbitals, Aufbau and Pauli exclusion principles, Hund's multiplicity rules, Electronic configuration of elements, effective nuclear charge, Slater's rules.

Periodic table and atomic properties

Classification of periodic table into s, p, d, f blocks, atomic and ionic radii, ionisation energy, electron affinity and electronegativity definition, methods of determination or evaluation, trend in periodic table (in s and p-block elements), Pauling , Mulliken, Allred Rachow and Mulliken Jaffe's electronegativity scale, Sanderson's electron density ratio.

Section – B (15 hrs)

Covalent Bond

Valence bond theory (Heitler-London and Pauling approach) and its limitation, directional characteristics of covalent bond, various type of hybridisation and shapes of simple inorganic molecules and ions (BeF2, BF3, CH4, PF5, SF6, IF7,SO4-2, ClO4-1, NO3-1) valence shell electron pair repulsion (VSEPR) theory to NH3, H3O+, SF4, ClF3, H2O, SnCl2, ClO3-1 and ICl2-1. Molecular orbital theory of homonuclear (N2, O2) heteronuclear (CO and NO) diatomic molecules and ions, bond energy, bond angle, bond length and dipole moments, percentage ionic character from dipole moment and electronegativity difference.

Ionic Solids

Ionic structures (NaCl, CsCl, ZnS (Zinc blende), CaF_2) size effects, radius ratio rule and its limitations, Madelung constant, Stoichiometric and Non stoichiometric defects in crystals, Lattice energy (mathematical derivation excluded) and Born- Haber cycle, Solvation energy and its relation with solubility of Ionic solids, Polarizing power and Polarisability of ions, Fajan's rule.

Course Outcomes:

CO1: States the postulates of quantum mechanics and Schrodinger equation to explain the structure of hydrogen atom

CO2: To study and explain the Radial and angular nodes and their significance in describing shapes of s,p and d orbitals

CO3: Know about Spin quantum numbers and magnetic quantum numbers and their significance.

CO4: Have knowledge about Electronic configuration, Effective nuclear charge and slater's rule

CO5: To learn about Ionic bonding and energy consideration in ionic bonding to Explain Lattice energy and solvation energy

CO6: To study Born-Lande equation and Born-Haber cycle, polarizing power and polarizability

CO7: To apply VSEPR theory in explaining shapes of some inorganic molecules and ions

CO8: Know about Rules of LCAO method, Bonding and antibonding molecular orbitals.

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:Principles of Structure and Reactivity*, Pearson Education India, 2006.
- Pradeep's inorganic chemistry, Volume I
- R Chand, inorganic chemistry, Volume I
- Modern publications,inorganic chemistry, Volume I

M. Sc. Engineering Physics
Semester – I
Subject: Chemistry
(Course Type-Core, Course Code: CH-102)
Nomenclature: Physical Chemistry-I
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section–A (15 Hours)

Kinetic Theory of Gases

Postulates of Kinetic Theory of Gases and derivation of the kinetic gas equation,Deviation of real gases from ideal behaviour, compressibility factor, causes of deviation,Van derWaals equation of state for real gases. Boyle temperature(derivation not required). Critical phenomena, critical constants and their calculation from Van der Waals equation. Andrews isotherms of CO_2.Maxwell Boltzmann distribution laws of molecular velocities and molecular energies(graphic representation – derivation not required) and their importance.
Temperature dependence of these distributions. Most probable, average and root mean square velocities (no derivation). Collision number,collision frequency, collision diameter and mean free path of molecules.

Liquids

Structure of liquids, Surface tension and its determination using a stalagmometer. Viscosity of a liquid and determination of coefficient of viscosity using Ostwald viscometer. Effect of temperature on surface tension and coefficient of viscosity of a liquid (qualitative treatment only).

Section-B (15 Hours)

Solids

Forms of solids. Unit cells, crystal systems, Bravais lattice types and identification of lattice planes. Laws of Crystallography - Law of constancy of interfacial angles, Law of rational indices. Miller indices. Elementary idea of symmetry and symmetry elements, X–Ray diffraction by crystals, Bragg’s law. Structures of NaCl, KCl and CsCl (qualitative treatment only). Defects in crystals. Glasses and liquid crystals.

Solutions and Colligative Properties

Methods of expressing concentrations of solutions, Ideal and non-ideal solutions, Recapitulation of Raoult's law and colligative properties, Thermodynamic derivation of relation between amount of solute and elevation in boiling point and depression in freezing point.Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Course Outcomes :

CO1: To learn about Role of temperature and pressure to establish the state of gases and describe the Concept of critical temperature, pressure and volume of real gases

CO2: To understand the Maxwell distribution law and various parameters associated with collisions ideal gas molecules

CO3: To study the Physical properties of liquids like surface tension, viscosity and their measurements

CO4: To understand the morphology of crystalline solids and have knowledge about various types of symmetries present in different solids

CO5: To be able to describe X-rays diffraction and Bragg's law

CO6: To have knowledge about solutions and colligative properties and their application in determining molar mass of solute.

Reference Books:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- B. R. Puri, Madan S. Pathania , L. R. Sharma *Principles of Physical Chemistry*, *48th Ed.,* Vishal Publications
- Peter Atkins , Julio de Paula , James Keeler *Atkins' Physical Chemistry*, Oxford University Press

M. Sc. Engineering Physics
Semester – I
Subject: Chemistry
(Course Type-Core, Course Code: CH-103)
Nomenclature: Organic Chemistry-I
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section-A (15 hrs)

Fundamentals of Organic Chemistry

Structure and Bonding: Localized and delocalized chemical bond, Van der Waals interactions, resonance: conditions, resonance effect and its applications, hyperconjugation, inductive effect, Electromeric effect & their comparison.

Mechanism of Organic Reactions:Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents–electrophiles and nucleophiles.Types of organic reactions (Substitution, Addition, Elimination, Rearrangement etc.). Reactive intermediates: Carbocations, carbanions, free radicals, carbenes (structure & stability).

Strength of organic acids and bases: Comparative study with emphasis on factors affecting pK values.

Stereochemistry of Organic Compounds

Concept of isomerism: Types of isomerism, Optical isomerism, elements of symmetry, molecular chirality, enantiomers, stereogeniccentre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeniccentres, diastereomers and meso compounds (tartaric acid and 2,3-dichlorobutane), threo- and erythro-diastereomers (Erythrose, Threose, 2,3-dichlorobutane), resolution of enantiomers, Relative and absolute configuration, CIP rules, R & S nomenclature. Geometric isomerism: Configuration of geometric isomers. Cis-Trans and E & Z nomenclature, Conformational isomerism: conformational analysis of ethane and n-butane; chair, boat, half chair and twist boat conformations of cyclohexane (interconversions and energy level diagram). Interconversions of Newman projection and Sawhorse formulae, Wedge Formula and Fischer representations (Erythrose, Threose and Tartaric acid), Difference between configuration and conformation.

Section-B (15 hrs)

Alkanes and Cycloalkanes

IUPAC nomenclature of branched and unbranched alkanes, classification of carbon atoms in alkanes. Isomerism in alkanes, sources, methods of formation: Wurtz reaction, Kolbe reaction, Corey-House reaction and decarboxylation of carboxylic acids, physical properties. Mechanism of free radical halogenation of alkanes: reactivity and selectivity.

Nomenclature, Baeyer's strain theory and its limitations, theory of strainless rings.

Alkenes and Dienes:

Nomenclature of alkenes, mechanisms of dehydration of alcohols and dehydrohalogenation of alkyl halide.The Saytzeff rule, Hofmann elimination, physical properties and relative stabilities of alkenes. Chemical reactions of alkenes, mechanisms involved in halogenations and halohydrogenation, electrophilic and free radical additions, Markownikoff's rule, hydroboration–oxidation, oxymercuration, reduction, ozonolysis, hydration, hydroxylation and oxidation with KMnO4.

Nomenclature and classification of dienes: isolated, conjugated and cumulated dienes. Structure of butadiene. Chemical reactions: 1,2 and 1,4 additions (Electrophilic & free radical mechanism), Diels-Alder reaction (effects of substituent excluded)

Alkynes:

Nomenclature, structure and bonding in alkynes. Methods of formation.Chemical reactions of alkynes, acidity of alkynes.Mechanism of electrophilic and nucleophilic addition reactions, hydroboration-oxidation of alkynes.

Course Outcomes:

CO1: Have sound knowledge of the basic organic chemistry like electron displacement effects with suitable examples

CO2: Get information about the types of structural and stereoisomers, optical isomerism, and different nomenclature like D/L, RScis/trans, E/Z etc. of various organic compounds

CO3: Learn nomenclature of various type of alkanes and cycloalkanes, preparation and their chemical reactions

CO4: Sound knowledge of alkenes, alkynes, dienes and their chemical reactions

Reference Books:

- Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry*, John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.
- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
- Eliel, E.L. *Stereochemistry of Carbon Compounds*, Tata McGraw Hill education, 2000.
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry*, S. Chand, 2010.
- Pradeep's organic chemistry, Volume I, II
- R Chand, organic chemistry, Volume I,II
- Modern publications, organic chemistry, Volume I,II
- New Age International (P) Ltd, Publishers, Volume I,II

M. Sc. Engineering Physics
Semester-I
Subject: Chemistry
(Course Type-Core, Course Code: CH-104)
Nomenclature: Chemistry practical-I
Credits: 2

Max. Marks: 50
Time: 6 hrs.

Special Note: -

The Practical examination will be held in two sessions of 3 hours each & the students are required to perform two experiments during the examination.

Distribution of Marks:

Experiment	15+15 marks
Viva- voce	5+5 marks
Lab Record	10 marks
Total	50 marks

List of Experiments

1. Preparation of reference solutions.
2. Redox titrations: Determination of Fe^{2+}, $C_2O_4^{2-}$ (using $KMnO_4$, $K_2Cr_2O_7$)
3. Iodometric titrations: Determination of Cu^{2+} (using standard hypo solution).
4. Complexometric titrations: Determination of Mg^{2+}, Zn^{2+} by EDTA.
5. To determine the surface tension of at least two liquids using a stalagmometer by drop no. and drop weight methods (Use of organic solvents excluded).
6. To study the effect of surfactant on surface tension of water.
7. To determine the viscosity of at least two liquids by using Ostwald's viscometer (Use of organic solvents excluded).
8. To determine the specific refractivity of at least two liquids.

Course Outcomes:

CO1: To gain knowledge about Preparation of standard solutions used in the lab

CO2: Know about Redox , iodometric titrations and complexometric titrations.

CO3: To study the concept of surface tension and its determination by various methods

CO4: To know about viscosity and its measurements by using Ostwald's viscometer

M. Sc. Engineering Physics
Semester-II
Subject: English
(Course Type-Ability Enhancement Compulsory Course, Course Code: ENG-201)
Nomenclature: English Communication
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note: All questions are compulsory.

Q. 1. The paper setter will set two questions from Unit II. The student shall attempt one out of the given two. (Marks-10)

Q. 2. This question shall be based on unit III. The student shall attempt one question out of two. (Marks-10)

Q. 3 There will be 25 grammatical items based on unit IV. The student shall attempt any 20 items. (Marks-20)

Note: Internal Assessment: The student shall be required to make a presentation/PPT based on unit I.

UNIT – I

Listening and Speaking Skills

1. Listening Skills (Active-Passive, Accent)
2. Speaking Skills (Stress, Intonation, Assertion, Rhetorical questions)
3. Oral Presentation, Debates, Elocution and Extempore

UNIT – II

Writing Skills

1. Report writing
2. Paragraph writing
3. Letter writing

UNIT – III

Technical and Modern Communication

1. Resume writing
2. Email
3. Blogs and Comments on Social Media

UNIT- IV

Grammar

1. Common errors in the use of English
   (Noun, Pronoun, Adjective, Adverb, Conjunction)
2. Correct use of verbs and Articles
3. Vocabulary: Homonyms, Homophones, Pair of words

Course Outcomes:

1. The students will learn the rhetorics of presentation.
2. They will learn to comment and respond to correspondence.
3. They will learn the basics of grammar and composition.
4. They will be acquainted with verbal and non-verbal communication.

M. Sc. Engineering Physics
Semester-II
Subject: Physics
(Course Type-Core, Course Code: EP-201)
Nomenclature: Electricity, Magnetism & Electromagnetic Theory
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hours

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

VECTOR BACKGROUND AND ELECTRIC FIELD

Gradient of a scalar and its physical significance, Line, Surface and Volume integrals of a vector and their physical significance, Flux of a vector field, Divergence and curl of a vector and their physical significance, Gauss's divergence theorem, Stoke's theorem. Derivation of electric field $\vec{E}$ from potential as gradient. Derivation of Laplace and Poisson equations, Electric flux, Gauss's Law, Mechanical force of charged surface, Energy per unit volume.

(15 Lectures)

UNIT-II

MAGNETISM

Magnetic induction, Magnetic flux, Solenoidal nature of vector field of induction, properties of $\vec{B}$ (i) $\nabla.\vec{B} = 0$ (ii) $\nabla\times\vec{B} = \mu_o J$, Electronic theory of dia and paramagnetism, Domain theory of ferromagnetism (Langevin's theory), Cycle of Magnetization- Hysteresis loop (Energy dissipation, Hysteresis loss and importance of Hysteresis Curve).

(15 Lectures)

UNIT-III

ELECTROMAGNETISM

Maxwell equations and their derivations, Displacement current, Vector and Scalar potentials, Boundary conditions at interface between two different media, Propagation of electromagnetic wave (Basic idea, no derivation), Poynting vector and Poynting theorem.

(15 Lectures)

UNIT-IV

A.C. ANALYSIS

A.C. circuit analysis using complex variable with (a) Capacitance and Resistance (CR) (b) Resistance and Inductance (LR) (c) Capacitance and Inductance (LC) and (d) Capacitance, Inductance and Resistance (LCR), Series and parallel resonance circuit, Quality factor (sharpness of resonance).

(15 Lectures)

CO No.	Course code (EP-201): Electricity, Magnetism & Electromagnetic Theory After successfully completing the course, student will be able to:
CO-1	Explain and differentiate the vector and scalar formalisms of electrostatics. Also be able to Apply Gauss's law of electrostatics to solve a variety of problems.
CO-2	Describe the important properties of magnetic field. Understand the properties and theories of dia-, para- & ferromagnetic materials.
CO-3	Derive Maxwell equations and understand the role of displacement current, scalar and vector potentials and boundary conditions at the interface between different media. The students will also be able to have basic idea about the propagation of electromagnetic waves.
CO-4	Analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.

REFERENCES

1. Electricity and Magnetism, Reitz and Milford (Prentice Hall of India)
2. Electricity and Magnetism, A.S. Mahajan and A.A. Rangwala (Tata McGraw Hill)
3. Electricity and Magnetism, Edward M Purcell, 1986, McGraw-Hill Education
4. Electricity and Magnetism, J.H. Fewkes & J. Yarwood, Vol. I, 1991, Oxford University Press.
5. Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn 1998 Benjamin Cummings.
6. Electricity and Magnetism, R. Murugeshan, S.Chand & Com. Pt. Ltd., New Delhi
7. Electromagnetic Fields and waves, K.D. Prasad, Satya Prakashan, New Delhi

M. Sc. Engineering Physics
Semester-II
Subject: Physics
(Course Type, Course Code: EP-202)
Nomenclature: ELECTRONICS
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hours

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

BASIC ELECTRONICS

Ideal current source, Ideal voltage source, Current and voltage divider law, Millman's theorem, Thevenin's theorem, Norton's theorem and numericals based on these theorems. Maximum power transfer theorem (with both DC and AC sources), Delta-Star theorem, Nodal Analysis, Maxwell Loop method.

(15 Lectures)

UNIT-II

SEMICONDUCTORS

Energy bands in solids, Intrinsic and extrinsic semiconductors, carrier mobility and electrical resistivity of semiconductors, Hall effect, p-n junction diode and their characteristics, Zener and Avalanche breakdown, Zener diode, Zener diode as a voltage regulator. Light emitting diodes (LED), Photoconduction in semiconductors, Photodiode, Solar Cell, *p-n* junction as a rectifier, half wave and full wave rectifiers (with derivation), filters (series inductor, shunt capacitance, L-section or choke, π and R.C. filter circuits).

(15 Lectures)

UNIT-III

TRANSISTORS

Junction transistors, Working of NPN and PNP transistors, Three configurations of transistor (C-B, C-E, C-C modes), Common base, common emitter and common collector characteristics of transistor, Constants of a transistor and their relation, Advantages and disadvantages of C-E configuration. D.C. load line. Transistor biasing; various methods of transistor biasing and stabilization.

(15 Lectures)

UNIT-IV

TRANSISTOR AMPLIFIERS

Amplifiers, Classification of amplifiers, common base and common emitter amplifiers, coupling of amplifiers, various methods of coupling, Resistance- Capacitance (RC) coupled amplifier (two stage, concept of band width, no derivation), Feedback in amplifiers, advantages of negative feedback, emitter follower, distortion in amplifiers.

(15 Lectures)

CO No.	**Course code (EP-202) : Electronics**
	After successfully completing the course, student will be able to:
CO-1	Understand the complex electrical networks analysis using different network theorems.
CO-2	Understand the basic concepts and different applications of PN junction diode in different type of rectifiers, voltage regulators, solar cell, LED's etc.
CO-3	Describe the basic structure, working principle and characteristics of Bipolar Junction transistors.
CO-4	Understand and explain the classification of Amplifiers and the various coupling & feedback methods in BJT amplifiers.

REFERENCES

1. Basic Electronics and Linear Circuits, N. N. Bhargava, D.C. Kulshreshtha and S.C. Gupta (TITI CHD)
2. Solid State Electronics, J.P. Agarwal, Amit Agarwal , Pragati Prakashan Meerut
3. Electronics Fundamentals and Applications, J.D. Ryder (Prentice Hall India)
4. Solid State Electronics, B.L.Theraja, S. Chand & Company, Delhi/Chandigarh
5. Electronic Devices and Circuits, Jacob Millman and Christos Halkias, McGraw Hill Publisher, New Delhi

M. Sc. Engineering Physics
Semester-II
Subject: Physics
(Course Type-Core, Course Code: EP-203)
Nomenclature: Physics Practical-II
Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. Do any eight experiments from the given list of experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

List of Experiments:

1. To use Multimeter for measuring Resistance, A.C. and D.C. Voltage and Current, checking of electrical fuses.
2. Low resistance by Carey Foster's bridge with calibration.
3. Determination of Impedance of an A.C. circuit and its verification.
4. Frequency of A.C. mains using an electromagnet.
5. Frequency of A.C. mains Electrical vibrator.
6. High resistance by substitution method.
7. To draw forward and reverse characteristics of semiconductor diode.
8. Zener diode voltage regulation characteristics.
9. Verification of inverse square law by photo- cell.
10. To study the characteristics of Solar cell.
11. To study the characteristics of a transistor in C.B configuration.
12. To study the characteristics of a transistor in C.E. configuration.

CO No.	**Course code (EP-203) : Physics Practical-II** **After successfully completing the course, student will be able to:**
CO-1	Hands on experience with the uses of multimeter.
CO-2	Characterize various devices namely PN junction diodes, LEDs, Zener diode, solar cells, PNP and NPN transistors.
CO-3	Perform the experiments to determine the values of frequency of A.C. mains, values of low and high resistances using different methods and be able to appreciate the concepts of physics involved in these experiments.
CO-4	Learn to present observations, results and analysis in suitable and presentable form.

REFERENCES

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

M. Sc. Engineering Physics
Semester – II
Subject: Mathematics
(Course Type-Core, Course Code: MT-201)
Nomenclature: Advanced Calculus
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Mean value theorems: Rolle's Theorem and Lagrange's mean value theorem and their geometrical interpretations, Cauchy mean value theorem. Taylor's Theorem with various forms of remainders, Darboux intermediate value theorem for derivatives. Indeterminate forms.

Unit-II:

Functions of several variables, Level curves and surfaces, Limits and continuity. Partial differentiation. Total Differentials; Composite functions & implicit functions. Chain rule. Change of variables. Homogenous functions & Euler's theorem on homogeneous functions. Taylor's theorem for functions of two or more variables.

Unit-III:

Differentiability of real valued functions of two variables. Schwarz and Young's theorem. Implicit function theorem. Extrema of functions of two and more variables; Maxima, Minima critical points, Method of Lagrange multipliers. Constrained optimization problems

Unit-IV:

Double integration over rectangular and nonrectangular regions, Double integrals in polar co-ordinates. Jacobian. Change of order of integration. Triple integral over a parallelepiped and solid regions, Volume by triple integrals, Triple integration in cylindrical and spherical coordinates. Dirichlet integrals. Beta and Gama functions.

Course Outcomes: This course will enable the students to:

1. Understand and to prove Rolle's Theorem, mean value theorems and their geometrical interpretations. To determine indeterminate forms.
2. Learn conceptual variations while advancing from one variable to several variables in calculus, limit and continuity, partial differentiation of such functions. To understand composite functions, homogeneous functions and to solve related problems.
3. Understand differentiability of real valued functions of two variables and to prove associated results. To determine maximum and minimum of functions of two variables and to apply multivariable calculus in optimization problems.
4. Evaluate double and triple integrals. To learn about Dirichlet integrals, Beta and Gamma functions and to solve related problems.

Recommended Text Books:

1. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
2. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
3. Wieslaw Krawcewicz & Bindhyachal Rai (2003). *Calculus with Maple Labs*. Narosa.
4. Gorakh Prasad (2016). *Differential Calculus* (19th edition). Pothishala Pvt. Ltd.
5. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*' *Calculus* (14th edition). Pearson Education.
6. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.
7. Jerrold Marsden, Anthony J. Tromba & Alan Weinstein (2009). *Basic Multivariable Calculus*, Springer India Pvt. Limited.
8. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.

M. Sc. Engineering Physics
Semester – II
Subject: Mathematics
(Course Type-Core, Course Code: MT-202)
Nomenclature: Differential Equations
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Basic concepts and genesis of ordinary differential equations, Order and degree of a differential equation, Differential equations of first order and first degree, Equations in which variables are separable, Homogeneous equations, equations reducible to homogeneous, Linear differential equations and equations reducible to linear form. Exact differential equations, Integrating factor. First order higher degree equations solvable for x, y and p. Clairaut's form and singular solutions. Orthogonal trajectories of one-parameter families of curves in a plane.

Unit-II:

Solutions of homogeneous linear ordinary differential equations of second order with constant coefficients, linear non-homogeneous differential equations. Linear differential equation of second order with variable coefficients. Method of reduction of order, method of undetermined coefficients, method of variation of parameters. Cauchy-Euler equation.

Unit-III:

Solution of simultaneous differential equations, total differential equations.

Genesis of Partial differential equations (PDE), Concept of linear and non-linear PDEs. Complete solution, general solution and singular solution of a PDE. Linear PDE of first order. Lagrange's method for PDEs of the form: $P(x,y,z)\, p + Q(x,y,z)\, q = R(x,y,z)$, where $p=\partial z/\partial x$ and $q=\partial z/\partial y$.

Unit-IV: Second Order Partial Differential Equations with Constant Coefficients

Integral surfaces passing through a given curve. Surfaces orthogonal to a given system of surfaces. Compatible systems of first order equations. Charpit's method, Special types of first order PDEs, Jacobi's method. Solutions of second order linear partial differential equations (homogeneous and non-homogeneous) with constant coefficients. Solution of PDEs with variable coefficients reducible to equations with constant coefficients.

Course Outcomes: The course will enable the students to:

1. Understand the basic concepts of ordinary differential equations and to learn various techniques of finding exact solutions of certain solvable first order differential equations. and.
2. Develop the skills of solving homogeneous and non-homogeneous second order linear ordinary differential equations with constant coefficients and with variable coefficients.
3. Understand total differential equations and basic concepts of partial differential equations. To learn methods and techniques for solving linear PDEs of first order.
4. Apply theory of PDEs to determine integral surfaces through a given curve and to find orthogonal surfaces. To understand compatible systems and Charpit method, Jacobi method methods for solving PDEs. To learn techniques of solving second order PDEs.

Recommended Text Book:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10th edition). J. Wiley & Sons
2. B. Rai & D. P. Choudhury (2006). *Ordinary Differential Equations - An Introduction*. Narosa Publishing House Pvt. Ltd. New Delhi.
3. Shepley L. Ross (2007). *Differential Equations* (3rd edition). Wiley.
4. George F. Simmons (2017). *Differential Equations with Applications and Historical Notes* (3rd edition). CRC Press. Taylor & Francis.
5. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.

M. Sc. Engineering Physics
Semester-II
Subject: Mathematics
(Course Type-Core, Course Code: MT-203)
Nomenclature: Mathematics practical-II
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. This course has two components, Problem Solving and Practical using MAXIMA software.
2. The examiner will set 4 questions at the time of practical examination asking two questions from the part (a) and two questions from the part (b) by taking course outcomes (COs) into consideration.
3. The examinee will be required to solve one problem from the part (a) and to execute one program successfully from the part (b).
4. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.
5. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

a) Problem Solving- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

1. Problems of finding continuity of functions of several variables.
2. Problems of finding differentiability of functions of several variables.
3. Problems of finding maxima and minima of functions of two variables.
4. Solving optimization problems.
5. Problem solving of determination surface area through application of double integrals in Cartesian and polar coordinates.
6. Problems of determination of volume using triple integrals.
7. Problems of solving differential equations which are reducible to homogeneous.
8. Problems of solving differential equations which are reducible to linear.
9. Problems of solving differential equations by method of undetermined coefficients.
10. Problems of solving different PDEs using Lagrange's method.
11. Problems of solving PDEs with Charpit's method.
12. Problems of solving second order PDEs with variable coefficients which can be reduced to those with constant coefficients.

b) Practicals with Free and Open Source Software(FOSS) Tools- The following practicals will be done using MAXIMA Software and record of those will be maintained in the practical Note Book:

1. To find partial derivatives of a function using MAXIMA.
2. To find total differential of a function of several variables using MAXIMA.
3. To find partial derivatives by chain rule and implicit differentiation.
4. To plot a curve in two dimensions, three dimensional plots and level surfaces using MAXIMA.
5. To find exact solutions of first and second order ODEs using ode2 and ic1/ic2 built in functions of MAXIMA.
6. To find exact solutions of first and second order ODEs using desolve and at value built in functions of MAXIMA.
7. To evaluate double and triple integrals using MAXIMA.
8. To find numerical solution of a first order ODE using plotdf built in function of MAXIMA.

Course Outcomes: This course will enable the students to:

1. Practical problems of checking continuity and differentiability and of finding maxima and minima of functions of several variables.
2. Practical problems of evaluating double and triple integrals in reference of their applications.
3. Develop skills of solving ODEs which are reducible to homogeneous, linear.
4. Practical problems of solving partial differential equations.
5. Hands-on experience to find partial derivatives, total derivative, plot graphs of functions, evaluate double and triple integrals, solve ordinary differential equations by using built in functions of MAXIMA software.

M. Sc. Engineering Physics
Semester – II
Subject: Chemistry
(Course Type-Core, Course Code: CH-201)
Nomenclature: Inorganic Chemistry-II
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section – A (15 hrs)

Hydrogen Bonding and Van der Waals forces

Hydrogen Bonding – Definition, types, effects of hydrogen bonding on properties of substances, application Brief discussion of various types of Van der Waals forces.

Metallic Bond and semiconductors

Metallic bond – Qualitative idea of valence bond and Band theories of metallic bond (conductors, semiconductors, insulators). Semiconductors – Introduction, types and applications.

s-Block elements

Comparative study of the elements including diagonal relationship, Anomalous behaviour of Lithium and Beryllium compared to other elements in the same group, salient features of hydrides, oxides, halides, hydroxides (methods of preparation excluded), behaviour of solution in liquid NH3.

Chemistry of Noble Gases

General physical properties, low chemical reactivity, chemistry of xenon, structure and bonding in fluorides, oxides and oxyfluorides of xenon.

Section – B (15 hrs)

p-Block elements:

Electronic configuration, atomic and ionic size, metallic character, melting point,ionization energy, electron affinity, electronegativity, inert pair effect and diagonal relationship.

Boron family (13th group):

Diborane: Preparation, properties and structure (as an example of electron deficient compound and multicenter bonding), Borazine chemical properties and structure, relative strength of Trihalide of Boron as lewis acids, structure of aluminium (III) chloride.

Carbon family and Nitrogen family (14th and 15th group):

Catenation, Carbides, fluoro carbons, silicates (structural aspects). Oxides: Structure of oxides of nitrogen and phosphorus, Oxyacids : Structure and relative acid strength of oxyacids of nitrogen and phosphorus, structure of white and Red phosphorus.

Oxygen family (16th group):

Oxy acids of sulphur – structure and acidic strength, Hydrogen Peroxide – properties and uses.

Halogen family (17th group):

Interhalogen compounds (their properties and structures), Hydra and oxy acids of chlorine – structure and comparison of acid strength, cationic nature of Iodine.

Course Outcomes :

CO1: To know the concept and able to explain types and effect of hydrogen bonding and van der waals forces on properties of substances

CO2: To learn about the various theories of metallic bonding with reference to conductors, insulators and semiconductors and their applications

CO3: To know about the diagonal relationship among S- block elements and about hydrides, oxides, hydroxides and halides of S-block elements

CO4: Learn about chemistry of noble gases with special reference to xenon

CO5 To know about the physical and chemical properties of p-block elements

CO6: Have knowledge about the boron family elements their structure, preparation and properties of diborane and borazine

CO7: To learn about the elements of carbon and nitrogen family and concept of catenation, carbides and fluorocarbons

CO8: To know about the elements of oxygen family and have knowledge about the chemical properties of oxides of Sulphur

Reference readings

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:Principles of Structure and Reactivity*, Pearson Education India, 2006.
- Pradeep's inorganic chemistry, Volume I
- R Chand, inorganic chemistry, Volume I
- Modern publications,inorganic chemistry, Volume I

M. Sc. Engineering Physics
Semester – II
Subject-Chemistry
(Course Type-Core, Course Code: CH-202)
Nomenclature: Physical Chemistry-II
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section–A (15 Hours)

Chemical Kinetics

The concept of reaction rates. Effect of temperature, pressure, catalyst and other factors on reaction rates. Order and molecularity of a reaction. Derivation of integrated rate equations for zero, first and second order reactions (both for equal and unequal concentrations of reactants). Half–life of a reaction. General methods for determination of order of a reaction. Concept of activation energy and its calculation from Arrhenius equation. Theories of Reaction Rates: Collision theory and Activated Complex theory of bimolecular reactions. Comparison of the two theories (qualitative treatment only).

Introduction to Statistical Mechanics

Need for statistical thermodynamics, thermodynamic probability, Maxwell-Boltzmann distribution statistics, Born oppenheimer approximation, partition function and its physical significance. Factorization of partition function.

Section-B (15 Hours)

Conductance

Conductance, equivalent and molar conductance and their variation with dilution for weak and strong electrolytes. Kohlrausch law of independent migration of ions.Transference number and its experimental determination using Hittorf and Moving boundary methods. Ionic mobility. Applications of conductance measurements:determination of degree of ionization of weak electrolyte, solubility and solubility products of sparingly soluble salts, ionic product of water, hydrolysis constant of a salt. Concepts of pH and pKa , Buffer solution, Buffer action, Henderson – Hasselbalch equation, Buffer mechanism of buffer action, Conductometric titrations (only acid-base).

Electrochemistry-I

Reversible and irreversible cells. Concept of EMF of a cell. Measurement of EMF of a cell. Nernst equation and its importance. Types of electrodes. Standard electrode potential. Electrochemical series. Thermodynamics of a reversible cell, calculation of thermodynamic properties: ΔG, ΔH and ΔS from EMF data.Calculation of equilibrium constant from EMF data.

Course Outcomes:

CO1: To have the knowledge about the concepts of rates of chemical reactions and its applications in derivation of reactions of various orders and half-life

CO2: To understand the need of statistical mechanics and Maxwell-Boltzmann distribution, partition function and its significance

CO3: To have information about conductance and its applications to deduce various parameters related to electrolytic solutions, to know about pH and conductometric titrations

CO4: Know about Concept of basics of cells their EMF determination by use of Nernst equation and thermodynamic properties

Reference Books:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- B. R. Puri, Madan S. Pathania , L. R. Sharma*Principles of Physical Chemistry* Vishal Publications
- Peter Atkins , Julio de Paula , James Keeler *Atkins' Physical Chemistry*, Oxford University Press
- K.J. Laidler, *Chemical Kinetics*, Perason

M. Sc. Engineering Physics
Semester – II
Subject – Chemistry
(Course Type-Core, Course Code: CH-203)
Nomenclature: Organic Chemistry-II
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section-A (15 hrs)

Arenes and Aromaticity

Nomenclature of benzene derivatives: Aromatic nucleus and side chain. Aromaticity: the Huckel rule, aromatic ions, annulenes up to 10 carbon atoms, aromatic, anti-aromatic and non-aromatic compounds. Aromatic electrophilic substitution, mechanism of nitration, halogenation, sulphonation, and Friedel-Crafts reaction.Activating , deactivating substituents. Orientation in monosubstituted benzenes

Alkyl and Aryl Halides

Nomenclature and classes of alkyl halides, methods of formation, chemical reactions. Mechanisms and stereochemistry (inversion and racemization) of nucleophilic substitution reactions of alkyl halides, SN2 and SN1 reactions with energy profile diagrams.

Methods of formation and reactions of aryl halides, the addition-elimination and the elimination -addition mechanisms of nucleophilic aromatic substitution reactions.

Relative reactivities of alkyl halides vsallyl, vinyl and aryl halides.

SECTION-B (15 hrs)

Alcohols and Epoxides

Monohyric alcohols: nomenclature, methods of formation by reduction of aldehydes, ketones, carboxylic acids and esters. Hydrogen bonding.Acidic nature.Reactions of alcohols. Dihydric alcohols — nomenclature, methods of formation, chemical reactions of vicinal glycols, oxidative cleavage [$Pb(OAc)_4$ and HIO_4] and pinacol-pinacolone rearrangement.

Synthesis of epoxides. Acid and base-catalyzed ring opening of epoxides, orientation of epoxide ring opening,

Ethers (aliphatic and aromatic): Cleavage of ethers with HI.

Phenols

Nomenclature, structure and bonding.Preparation of phenols, physical properties and acidic character.Comparative acidic strengths of alcohols and phenols, resonance stabilization of phenoxide ion.Reactions of phenols — electrophilic aromatic substitution, Mechanisms of Fries rearrangement, Claisen rearrangement, Reimer-Tiemann reaction, Kolbe's reaction

Carboxylic Acids & Acid Derivatives

Nomenclature of Carboxylic acids, structure and bonding, physical properties, Preparation of carboxylic acids.Reactions of carboxylic acids.Hell-Volhard-Zelinsky reaction.Mechanism of decarboxylation.Relative stability of acyl derivatives.Physical properties, interconversion of acid derivatives by nucleophilic acyl substitution.

Mechanisms of esterification and hydrolysis (acidic and basic).

Course Outcomes:

CO1: Know about Huckel's rule of aromaticity and various methods of preparation of aromatic Hydrocarbons

CO2: Get knowledge about the mechanism of S_N1 and S_N2 reactions and other various chemical reactions of aryl and aryl halides

CO3: Know about alcohols, phenols, ethers, epoxides and their chemical reactions

CO4: Knowledge about various methods for the preparation of carboxylic acid, carboxylic derivatives (ester, amide, acid chlorides, anhydrides) and their chemical reactions

Reference Books:

- Graham Solomon, T.W., Fryhle, C.B. &Dnyder, S.A. *Organic Chemistry,* John Wiley & Sons (2014).
- McMurry, J.E. *Fundamentals of Organic Chemistry*, 7th Ed. Cengage Learning India Edition, 2013.

- Sykes, P. *A Guidebook to Mechanism in Organic Chemistry*, Orient Longman, New Delhi (1988).
- Finar, I.L. *Organic Chemistry* (Vol. I & II), E.L.B.S.
- Morrison, R.T. & Boyd, R.N. *Organic Chemistry*, Pearson, 2010.
- Bahl, A. &Bahl, B.S. *Advanced Organic Chemistry,* S. Chand, 2010.
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry* Cengage Learning India Pvt. Ltd., New Delhi (2009).
- Mahan, B.H. *University Chemistry* 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry* 5th Ed. Macmillan Publishing Co.: New York (1985).
- Pradeep's organic chemistry, Volume I & II
- R Chand, organic chemistry, Volume I & II
- Modern publications, organic chemistry, Volume I & II
- New Age International (P) Ltd, Publishers, Volume I, II

M. Sc. Engineering Physics
Semester-II
Subject: Chemistry
(Course Type-Core, Course Code: CH-204)
Nomenclature: Chemistry practical-II
Credits: 2

Max. Marks: 50
Time: 6hrs.

Special Note: -

The Practical examination will be held in two sessions of 3 hours each & the students are required to perform two experiments during the examination.

Distribution of Marks:

Experiment	15+15 marks
Viva- voce	5+5 marks
Lab Record	10 marks
Total	50 marks

List of Experiments

1. Preparation and purification through crystallization or distillation and ascertaining their purity through melting point or boiling point

(i) Iodoform from ethanol (or acetone)

(ii) *m-Dinitrobenzene* from nitrobenzene (use 1:2 conc. HNO_3 - H_2SO_4 mixture if fuming HNO_3 is not available)

iii) p-Bromoacetanilide from acetanilide

iv) Dibenzalacetone from acetone and benzaldehyde

v) 2,4-DNP derivative of Benzophenone/Acetophenone.

2. To study the process of (i) sublimation (ii) Crystallization of camphor and phthalic acid

3. Qualitative Analysis of any one of the following Inorganic cations and anions by paper chromatography (Pb^{2+}, Cu^{2+}, Ca^{2+}, Ni^{2+}, Cl^-, Br^-, I^-, PO_4^{3-} and NO_3^-).

Course Outcomes:

CO1: To learn about, How to Purify organic compounds by crystallization (with alcohol and water), sublimation and distillation

CO2: Able to prepare various organic compounds and also their derivatives

CO3: To study the process of sublimation and crystallization of camphor and phthalic acid

CO4: Able to analyze qualitatively inorganic cations and anions using paper chromatography

KURUKSHETRA UNIVERSITY KURUKSHETRA

Five Years Integrated
M. Sc. Engineering Physics (3 Years BSc+2Years M.Sc.)
Under CBCS-LOCF
(Effective from the Academic Session 2021-22)

Department of Physics
INSTITUTE OF INTEGRATED & HONORS STUDIES
Kurukshetra University
Kurukshetra - 136 119
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Scheme and Syllabi of five years integrated
M. Sc. ENGINEERING PHYSICS Programme
(From 1st to 6th semester)
Under CBCS-LOCF

(w. e. f. from the Academic Session 2021-22)

(After 3 Years / 6 Semesters, students may be awarded B. Sc. -Engineering Physics Degree)

2nd Year (3rd and 4th Semesters)

3rd Semester

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks			Duration of Examination (Hrs.)
					Internal Assessment*	End-semester Examination	Total	
Skill Enhancement Course-I	SEC-301	Programming skills with - C	2+0+0	2	10	40	50	3
Core Course-VII (Physics)	EP-301	Thermal Physics	3+0+0	3	15	60	75	3
Core Course-VIII (Physics)	EP-302	Statistical Mechanics	3+0+0	3	15	60	75	3
Core Course-IX (Physics)	EP-303	Physics Practical-III	0+0+2	4	----------	50	50	3
Core Course-VII (Mathematics)	MT-301	Real Analysis-I	3+0+0	3	15	60	75	3
Core Course-VIII (Mathematics)	MT-302	Mechanics – I	3+0+0	3	15	60	75	3
Core Course-IX (Mathematics)	MT-303	Mathematics Practical-III	0+0+2	4	-----------	50	50	3
Core Course-IX (Chemistry)	CH-301	Inorganic chemistry-III	2+0+0	2	10	40	50	3
Core Course-X (Chemistry)	CH-302	Physical chemistry-III	2+0+0	2	10	40	50	3
Core Course-XI (Chemistry)	CH-303	Organic chemistry-III	2+0+0	2	10	40	50	3
Core Course-XII (Chemistry)	CH-304	Chemistry practical-III	0+0+2	4	----------	50	50	6
Total Credits/Marks in semester-III			**26**				**650**	

*Internal Assessment marks

20% marks in each theory paper shall be reserved for Internal Assessment. The following parameters (with weightage of each) forming the basis of award of Internal Assessment:-

(i) One test/Seminar for each paper (one period duration) : 50%

(ii) One Assignment for each paper : 25%

(iii) Attendance : 25%

4th Semester

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks			Duration of Examination (Hrs.)
					Internal Assessment*	End-semester Examination	Total	
Skill Enhancement Course-II (Physics)	SEC- 401	(A) Applied Optics (B) Renewable Energy & Energy Harvesting	2+0+0	2	10	40	50	3
Core Course-IX (Physics)	EP-401	Wave & Optics	3+0+0	3	15	60	75	3
Core Course-X (Physics)	EP-402	Quantum Mechanics	3+0+0	3	15	60	75	3
Core Course-XI (Physics)	EP-403	Physics Practical-IV	0+0+2	4	---------	50	50	3
Core Course-IX (Mathematics)	MT-401	Abstract Algebra	3+0+0	3	15	60	75	3
Core Course-X (Mathematics)	MT-402	Numerical Analysis	3+0+0	3	15	60	75	3
Core Course-XI (Mathematics)	MT-403	Mathematics Practical-IV	0+0+2	4	-----------	50	50	3
Core Course-XIII (Chemistry)	CH-401	Inorganic chemistry-IV	2+0+0	2	10	40	50	3
Core Course-XIV (Chemistry)	CH-402	Physical chemistry-IV	2+0+0	2	10	40	50	3
Core Course-XV (Chemistry)	CH-403	Organic chemistry-IV	2+0+0	2	10	40	50	3
Core Course-XVI (Chemistry)	CH-404	Chemistry practical-IV	0+0+2	4	------------	50	50	6
Total Credits/Marks in semester-IV			**26**				**650**	

M. Sc. Engineering Physics
Semester – III
Subject: Mathematics
(Course Type- Skill Enhancement, Course Code: SEC-301)
Nomenclature: Programming Skills with C
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Overview of C: Introduction and importance of C, Basic structure of a C program, Executing a C program. Elements of C: C character set, C tokens, Identifiers and keywords, Constants and Variables, Data types, Assignment statement, Symbolic constants.

Operators & Expression: Arithmetic, relational, logical, bitwise, unary, assignment, conditional operators and special operators. Arithmetic expressions, evaluation of arithmetic expression, type casting and conversion, operator hierarchy & associativity.

Unit-II

Input/output: Unformatted & formatted I/O function, Input functions viz. scanf(), getch(), getche(), getchar(), gets(); output functions viz. printf(), putch(), putchar(), puts().

Decision making & branching: Decision making with IF statement, IF…ELSE statement, Nested IF statement, ELSE-IF ladder, SWITCH statement, GOTO statement.

Unit-III:

Decision making & looping: For, while, and do-while loop, jumps in loops, break, continue statement.

Arrays: Definition, types, initialization, processing an array.

Unit-IV:

Character Strings: Declaration and initialization, Reading and writing, Arithmetic Operations on Characters, Putting strings together, Comparison of strings, String handling Functions.

User defined functions: Need for user defined functions, form of C functions, return values and their types, calling a function, category of functions, nesting of functions, Recursion, Functions with arrays, scope of variables in functions, ANSI C functions.

Course Outcomes: This course will enable the students to:

1. Familiarize with C programming language. Learn elements of C, data types, constants and variables, operations and operators, statements and expressions. Use these tools for writing C programs.
2. Learn Input/ Output functions in C, to write reading and writing statements in C, decision making statements and structures in C. Apply this knowledge to use as tools in writing C programs.
3. Understand loops and arrays, their types, characteristics and structures. Attain the skill to write C programs which involve arrays and multiple iterations.
4. Learn strings of characters, their declaration, input/ output, operations on strings and functions which handle strings. Learn declaration, types and calling of user defined functions in C.
5. Be ready to attain the skills of programming by making use of tools and knowledge mentioned in the Cos 1 to 4.

Recommended Text Books:

1. B.W. Kernighan and D.M. Ritchie : The C Programming Language, 2nd Edition
2. V. Rajaraman : Programming in C, Prentice Hall of India, 1994
3. Byron S. Gottfried : Theory and Problems of Programming with C, Tata McGraw-Hill Publishing Co. Ltd., 1998
4. Programming in ANSI C, E. Balagurusamy, Tata McGraw-Hill Publishing Co. Ltd.

M. Sc. Engineering Physics
Semester-III
Subject: Physics
(Course Type-Core Course, Course Code: EP-301)
Nomenclature: Thermal Physics
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1.Nine questions will be set in total.
2.Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3.Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4.20% numerical problems are to be set.
5.Use of scientific (non-programmable) calculator is allowed.

UNIT-I

KINETIC THEORY OF GASES-I

Assumption of Kinetic theory of gases, pressure of an ideal gas (with derivation), Kinetic interpretation of Temperature, Ideal Gas equation, Degree of freedom, Law of equipartition of energy and its application for specific heat of gases, Real gases, Vander Wall's equation, Brownian motion (Qualitative).

(15 Lectures)

UNIT-II

KINETIC THEORY OF GASES-II

Maxwell's distribution of speed and velocities (derivation required), Experimental verification of Maxwell's law of speed distribution: most probable speed, average and r.m.s. speed, Mean free path, Transport of energy and momentum, Diffusion of gases.

(15 Lectures)

UNIT-III

THERMODYNAMICS-I

Thermodynamic system and Zeroth law of thermodynamics, First law of thermodynamics and its limitations, Reversible and irreversible process, Second law of thermodynamics and its significance, Carnot theorem, Absolute scale of temperature, Absolute Zero and magnitude of each division on work scale and perfect gas scale, Joule's free expansion, Joule Thomson effect, Joule-Thomson (Porous plug) experiment, conclusions and explanation, analytical treatment of Joule Thomson effect, Entropy, calculations of entropy of reversible and irreversible process, T-S diagram, entropy of a perfect gas, Nernst heat law (third law of thermodynamics), Liquefaction of gases, (oxygen, air, hydrogen and helium) solidification of helium below 4K, Cooling by adiabatic demagnetization.

(15 Lectures)

UNIT-IV

THERMODYNAMICS-II

Derivation of Clausius-Clapeyron and Clausius latent heat equations and their significance, specific heat of saturated vapours, phase diagram and triple point of a substance, development of Maxwell thermodynamical relations, Thermodynamical functions: Internal energy (U), Helmholtz function (F), Enthalpy (H), Gibbs function (G) and the relations between them, derivation of Maxwell thermodynamical relations from thermodynamical functions, Application of Maxwell relations: relations between two specific heats of gas, Derivation of Clausius-Clapeyron and Clausius equation, variation of intrinsic energy with volume for (i) perfect gas (ii) Vander wall gas (iii) solids and liquids, derivation of Stefan's law, adiabatic compression and expansion of gas & deduction of theory of Joule Thomson effect.

(15 Lectures)

CO No.	Course code (EP-301): Thermal Physics
	After successfully completing the course, student will be able to:
CO-1	Learn about Kinetic interpretation of Temperature, the real gas equations, Van der Waal equation of state and Brownian motion.
CO-2	Learn the basic aspects of kinetic theory of gases, Maxwell-Boltzman distribution law, equitation of energies, mean free path of molecular collisions, viscosity, thermal conductivity, diffusion.
CO-3	Understand the basic concepts of thermodynamics, the first and the second law of thermodynamics, Joule Thomson effect, Joule-Thomson (Porous plug) experiment, the concept of entropy and the associated theorems, calculations of entropy of reversible & irreversible process, T-S diagram and Nernst heat law (third law of thermodynamics).
CO-4	Derive the Clausius-Clapeyron and Clausius latent heat equations and understand their significance. The students will also be able to learn about Maxwell's thermodynamic relations their physical interpretations.

REFERENCES

1. Thermal Physics and Statistical Mechanics, S.K. Roy, New Age International Publishers, New Delhi
2. Thermodynamics and Statistical Physics, J.K. Sharma and K.K. Sarkar, Himalaya Publishing House, Bombay
3. Introduction to Thermodynamics and its Applications, Stowe Keith, University Press (India) Pvt. Ltd, Hyderabad
4. Introductory Thermodynamics, Pierre Infelta, BrownWalker Press, Boca Ratan, Florida
5. Fundamentals of Thermodynamics, J. K. Johnson, University of Pittsburgh 2009
6. Thermodynamics and Its Applications, Jefferson Tester, Michael Modell, 3rd Edition
7. Thermodynamics, Statistical Thermodynamics & Kinetics, Thomas Engel, Philip Reid, 2nd Edition

M. Sc. Engineering Physics
Semester-III
Subject: Physics
(Course Type-Core Course, Course Code: EP-302)
Nomenclature: Statistical Mechanics
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

STATISTICAL PHYSICS-I

Microscopic and Macroscopic systems, events-mutually exclusive, dependent and independent. Probability, statistical probability, A-priori Probability and relation between them, probability theorems, some probability considerations, combinations possessing maximum probability, combination possessing minimum probability, Tossing of 2,3 and any number of Coins, Permutations and combinations, distributions of N (for N= 2,3,4) distinguishable and indistinguishable particles in two boxes of equal size, Micro and Macro states, Thermodynamical probability, Constraints and Accessible states, Statistical fluctuations, general distribution of distinguishable particles in compartments of different sizes, Condition of equilibrium between two systems in thermal contact-- β parameter, Entropy and Probability (Boltzmann's relation).

(15 Lectures)

UNIT-II

STATISTICAL PHYSICS-II

Postulates of statistical physics, Phase space, Division of Phase space into cells, three kinds of statistics, basic approach in three statistics. M. B. statistics applied to an ideal gas in equilibrium- energy distribution law (including evaluation of σ and β), speed distribution law & velocity distribution law. Expression for average speed, r.m.s. speed, average velocity, r. m. s. velocity, most probable energy & mean energy for Maxwellian distribution.

(15 Lectures)

UNIT-III

QUANTUM STATISTICS

Need for Quantum Statistics: Bose-Einstein energy distribution law, Application of B.E. statistics to Planck's radiation law B.E. gas, Degeneracy and B.E. Condensation, Fermi-Dirac energy distribution law, F.D. gas and Degeneracy, Fermi energy and Fermi temperature, Fermi Dirac energy distribution law, Fermi Dirac gas and degeneracy, Fermi energy and Fermi temperature, Fermi Dirac energy distribution law for electron gas in metals, Zero point energy, Zero point pressure and average speed (at 0 K) of electron gas, Specific heat anomaly of metals and its solution. M.B. distribution as a limiting case of B.E. and F.D. distributions, Comparison of three statistics.

(15 Lectures)

UNIT-IV

THEORY OF SPECIFIC HEAT OF SOLIDS

Dulong and Petit law. Derivation of Dulong and Petit law from classical physics, Specific heat at low temperature, Einstein theory of specific heat, Criticism of Einstein theory, Debye model of specific heat of solids, success and shortcomings of Debye theory, comparison of Einstein and Debye theories,

(15 Lectures)

CO No.	**Course code (EP-302): Statistical Mechanics**
	After successfully completing the course, student will be able to:
CO-1	Understand the concepts of microstate, macrostate, thermodynamic probability and also understand the studies of particles with their distinguishably or indistinguishably nature and conditions which lead to the three different distribution laws e.g. Maxwell-Boltzmann distribution, Bose-Einstein distribution and Fermi-Dirac distribution laws of particles.
CO-2	Learn the basic Postulates of statistical physics, Phase space, Division of Phase space into cells and be able to derive the expression for average speed, r.m.s. speed, average velocity, r. m. s. velocity, most probable energy & mean energy for Maxwellian distribution.
CO-3	Understand the need and application of Quantum Statistics: Bose-Einstein & Fermi-Dirac statistics and be able to articulate the connection as well as dichotomy between classical statistical mechanics and quantum statistical mechanics.
CO-4	Learn and understand the different law's and theory of specific heat of solids and their significance.

REFERENCES

1. Statistical Mechanics, S. Prakash and J.P. Agarwal, Kedar Nath Ram Nath & Co, Meerurt
2. Statistical Physics "Berkeley Physics Course. Vol. 5", Reif, Mc Graw Hill Book Co. Ltd., New Delhi
3. Statistical Mechanics, D.A. Mc Quarrie, Viva Books Pvt Ltd., New Delhi
4. Classical and Statistical Thermodynamics, Hanna A. Rizk, Narosa Publishing House, New Delhi

M. Sc. Engineering Physics
Semester-III
Subject: Physics
(Course Type- Core Course, Course Code: EP-303)
Nomenclature: Physics Practical-III
Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. Do any eight experiments from the given list of experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

LIST OF EXPERIMENTS

1. Measurement of Planck constant using black body radiation.
2. To determine Stefan's Constant.
3. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
4. To determine the thermal conductivity of bad conductor by Lee and Charlton's disc method.
5. To determine the temperature co-efficient of resistance by platinum resistance thermometer.
6. To study the variation of thermo e.m.f. across two junctions of a thermocouple with temperature.
7. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge.
8. To determine Mechanical Equivalent of Heat by Callender and Barne's contant flow method.
9. To draw a calibration curve for a thermocouple.

CO No.	Course code (EP-303) : Physics Practical-III
	After successfully completing the course, student will be able to:
CO-1	Hands on experience with different instruments and appreciate the beauty of different concepts and related experiments in Physics.
CO-2	Verify some fundamental principles, effects and concepts of physics through Experiments.
CO-3	Perform basic experiments in thermal Physics, viz., determinations of Stefan's constant, coefficient of thermal conductivity, temperature coefficient of resistant, variation of thermo-emf of a thermocouple with temperature difference at its two junctions and calibration of a thermocouple.

CO-4 Learn to present observations, results and analysis in suitable and presentable form.

REFERENCES

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House.

M. Sc. Engineering Physics
Semester – III
Subject: Mathematics
(Course Type-Core, Course Code: MT-301)
Nomenclature: Real Analysis-I
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Finite and infinite sets, countable and uncountable sets, bounded and unbounded sets in $\mathbb{R}$. Least upper bound (supremum), greatest lower bound (infimum) of a set and their properties. The set of real numbers ($\mathbb{R}$) as an ordered field, Least upper bound properties of $\mathbb{R}$**,** Metric property and completeness of $\mathbb{R}$. Archimedean property of $\mathbb{R}$. Neighbourhood of a point, interior points, isolated points, limit points. Open sets, closed sets, interior of a set, closure of a set in real numbers and their properties. Bolzano-Weierstrass theorem.

Unit-II:

Sequences in $\mathbb{R}$**,** Convergent sequence and its limit, Limit theorems, Bounded and monotonic sequences in $\mathbb{R}$. Cauchy's theorem on limits, Monotone convergence theorem, Limit superior and limit inferior, Cauchy sequence, Cauchy's convergence criterion. Subsequences, Subsequential limits.

Unit-III:

Infinite series: Convergence and divergence of Infinite Series, Comparison Tests of positive terms Infinite series, Cauchy's general principle of Convergence of series, Convergence and divergence of geometric series, Hyper Harmonic series or p-series. D-Alembert's ratio test, Raabe's test, Logarithmic test, Abel's test, Cauchy's nth root test, Gauss Test, Cauchy's integral test, Cauchy's condensation test.

Unit-IV:

Alternating series, Absolute and conditional convergence, Leibniz test, Rearrangements of series.

Pointwise and uniform convergence of sequence and series of functions, M_n-test, Weierstrass's M-test. Uniform continuity. Uniform convergence and continuity.

Course Outcomes: This course will enable the students to:

1. Understand basic concepts of real number system and set theory. Preliminary results on neighbourhood of a point, interior and limit points, open sets, closed sets etc.
2. Learn real sequences, their limit, boundedness and convergence. To find convergence and divergence of a sequence. To understand Cauchy sequence, subsequence and to prove related theorems.
3. Understand infinite series and its basic properties. Attain skills to determine convergence of a series of real numbers by applying various tests.
4. Understand absolute and conditional convergence of alternating series and related tests. Learn the basic concepts of pointwise convergence and uniform convergence of sequence and series of functions.

Recommended Text Books:

1. T. M. Apostol (2008). *Mathematical Analysis: A Modern Approach to Advanced Calculus*. Pearson Education.
2. Charalambos D. Aliprantis &) Owen Burkinshaw1998). *Principles of Real Analysis* (3rd edition). Academic Press.
3. Robert G. Bartle & Donald R. Sherbert (2015). *Introduction to Real Analysis* (4th edition).Wiley India.
4. Gerald G. Bilodeau, Paul R. Thie & G. E. Keough (2015). *An Introduction to Analysis* (2nd edition), Jones and Bartlett India Pvt. Ltd.
5. E. Hewitt & K. Stromberg (2013). *Real and Abstract Analysis.* Springer-Verlag.
6. K. A. Ross (2013). *Elementary Analysis*: *The Theory of Calculus* (2nd edition). Springer.
7. Walter Rudin. *Principles of Mathematical Analysis* (3rd edition), Tata McGraw Hill.

M. Sc. Engineering Physics
Semester – III
Subject: Mathematics
(Course Type-Core, Course Code: MT-302)
Nomenclature: Mechanics – I
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Composition and resolution of forces, Parallel forces, Couples, Moment of force and a couple about a point and a line, Equilibrium of a particle and of a rigid body acted on by forces in one plane.

Unit-II:

Concept of friction, Laws of friction, Problems of equilibrium under forces including friction. Concepts of centre of mass and centre of gravity, Centre of gravity of an uniform arc, plane area and solids of revolution.

Unit-III:

Velocity and acceleration of a particle along a curve: radial and transverse components, tangential and normal components, Relative velocity and acceleration, Angular velocity and acceleration. Newton's laws of motion. Simple harmonic motion and elastic strings.

Unit-IV:

Work, Power and Energy. Projectile motion. Kepler's laws of planetary motion.

Course Outcomes: This course will enable the students to:

1. Understand basic concepts of forces, their resultant and moment; couples and their moments. Conditions for the equilibrium of particles/rigid body acted upon by various planar forces. To attain the problem solving skill for scientific problems.
2. Learn the concepts of friction and laws of friction, centre of mass and centre of gravity and to solve problems related to these concepts.
3. Learn fundamentals of dynamics like velocity, acceleration, angular velocity and acceleration, Newton's laws of motion, simple harmonic motion and to develop the skill of solving simple dynamical problems.
4. Understand concepts of work, power, energy and projectile motion and to solve related problems. Learn about Kepler's laws of the planetary motions.

Recommended Text Books:

1. R. S. Varma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.
2. P.L. Srivastava (1964). *Elementary Dynamics*. Ram Narain Lal, Beni Prasad Publishers Allahabad.
3. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics*. McGraw-Hill.
4. S.L. Loney (1995). *An Elementary Treatise on Statics*, Radha Publishing House.
5. S.L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
6. A. S. Ramsey (2009). *Statics*. Cambridge University Press.
7. A. S. Ramsey (2009). *Dynamics*. Cambridge University Press.
8. A.P. Roberts (2003). *Statics and Dynamics with Background in Mathematics*. Cambridge University Press.

M. Sc. Engineering Physics
Semester-III
Subject: Mathematics
(Course Type-Core, Course Code: MT-303)
Nomenclature: Mathematics practical-III
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. The examiner will set 4 questions at the time of practical examination by taking course outcomes (COs) into consideration.
2. The examinee will be required to write two programs and execute one program successfully.
3. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.
4. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

1. To find greatest and smallest of three numbers.
2. To find the roots of a quadratic equation.
3. To check whether a given year is leap year or not.
4. To check a given number for being palindrome or Armstrong.
5. To generate Fibonacci sequence.
6. To find sum of cosine series and sine series up to n terms.
7. To find sum of any n numbers.
8. To find transpose of a matrix.
9. To find sum and product of two matrices.
10. To find area of circle, triangle and rectangle depending on choice using switch statement.
11. To find factorial of a number using
    (a) iteration (b) function.
12. To find Greatest Common Divisor of two numbers using recursion.
13. Write a function to check a given number for being prime number. Use the same to generate the prime numbers less than or equal to a given number m.
14. To search the element in an array of n elements using
    (a) Linear search method
    (b) Binary search.
15. To sort given numbers in ascending/descending order using
    (a) selection sort (b) bubble sort

16. To prepare electricity bill.
17. To find gross salary of an employee.
18. To perform following operations on strings:
    (a) Show address of each character in string
    (b) Concatenate two strings
    (c) Compare two strings
    (e) Calculate the length of strings
    (f) Convert all lowercase characters to uppercase
    (g) Convert all uppercase characters to lowercase.
    (h) Calculate number of vowels
    (i) Reverse the string
19. To arrange string data (name of students) in alphabetical order using bubble sort.
20. To calculate the Letter grades and Grade points of a student according to marks obtained in 4 subjects on the basis of following table:

Marks	Grade Point	Letter Grade
85-100	10	O (Outstanding)
75-84	9	A+ (Excellent)
65-74	8	A (Very Good)
55-64	7	B+ (Good)
50-54	6	B (Above Average)
41-49	5	C (Average)
40	4	P (Pass)
<40	0	F (Fail)

Course Outcomes: This course will enable the students to:

1. Attain skill of writing and executing elementary programs in the programming language C.
2. Have hands-on experience to write, enter, run and debug programs in C for different mathematical and other practical problems of daily or scientific use.

M. Sc. Engineering Physics
Semester – III
Subject: Chemistry
(Course type-Core, Course Code: CH-301)
Nomenclature: Inorganic Chemistry-III
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section – A (15 hrs)

Chemistry of d-Block elements

Definition of transition elements, position in the periodic table, General characteristic properties of d-Block elements, Comparison of properties of 3d elements with 4d and 5d elements with reference only to ionic radii, oxidation state, magnetic and spectral properties and stereochemistry. Stability of various oxidation states and e.m.f (Latimer and Frost diagrams), Structure and properties of some compounds of transition elements- TiO2, VOCl2, FeCl3, CuCl2 and Ni(CO)4.

Coordination Compounds

Werner's theory of coordination compounds, effective atomic number, chelates, nomenclature of coordination compounds, Isomerism in coordination compounds, valence bond theory of transition metal complexes.

Section – B (15 hrs)

Chemistry of f-Block elements

Lanthanides: Electronic structure, oxidation states, magnetic properties, complex formation, colour, ionic radii and lanthanide contraction, occurrence, separation of lanthanides, Lanthanide compounds. Actinides: General characteristics of actinides, chemistry of separation of Np, Pu and Am from uranium, Transuranic elements, comparison of properties of Lanthanides and actinides with transition elements.

Course Outcomes:

CO1: Have good knowledge about d-block elements particularly of transition elements

CO2: To study the comparison between 3d elements with 4d and 5d elements with reference to ionic radii, oxidation state, magnetic properties and spectral properties some compounds of transition elements

CO3: To know about position of f-block elements in periodic table and their general characteristics

CO4: To study the occurrence and separation of lanthanides and lanthanide compounds

CO5: Have knowledge of actinides their existence and general properties

CO6: To compare the properties of Lanthanides and actinides with transition elements.

CO7: To know about the basic concepts of coordination chemistry like EAN, Werner theory of coordination and isomerism in coordination complexes.

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:Principles of Structure and Reactivity*, Pearson Education India, 2006.
- Pradeep's inorganic chemistry, Volume II
- R Chand, inorganic chemistry, Volume II
- Modern publications,inorganic chemistry, Volume II

M. Sc. Engineering Physics
Semester – III
Subject: Chemistry
(Course Type-Core, Course Code: CH-302)
Nomenclature: Physical Chemistry-III
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section–A (15 Hours)

Energetics

Recapitulation of thermodynamics and the Laws of Thermodynamics.Joule–Thomson coefficient for ideal gas and real gas and inversion temperature. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formations, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature – Kirchhoff's equation.Statement of Third Law of thermodynamics and calculation of absolute entropies of substances.

Electrochemistry-II

Concentration cells with transference and without transference. Liquid junction potential and salt bridge.pH determination using hydrogen electrode and quinhydrone electrode.Potentiometric titrations -qualitative treatment (acid-base and oxidation-reduction only).

Section-B (15 Hours)

Chemical Equilibrium

Equilibrium constant and free energy, concept of chemical potential. Thermodynamic derivation of the law of chemical equilibrium.Temperature dependence of equilibrium constant. Distinction between ΔG and ΔG^o, Le Chatelier's principle.Relationships between K_p, $K_c$and K_x for reactions involving ideal gases. Clausius–Clapeyron equation and its applications. Nernst distribution law and its applications.

Phase Equilibrium

Phases, components and degrees of freedom of a system, criteria of phase equilibrium. Gibbs Phase Rule and its thermodynamic derivation. Derivation of Clausius – Clapeyron equation and its importance in phase equilibria. Phase diagrams of one-component systems (water and sulphur) and two component systems involving eutectics (Pb-Ag system only), desilverisation of lead.

Course Outcomes :

CO1: To know about the laws and concepts of chemical thermodynamics and their applications in thermochemical calculations

CO2: To have knowledge about electrolytic concentration cells with and without transference and their EMF calculation, applications of the concept to determine liquid junction potential, pH determination using potentiometry and potentiometric titrations

CO3: To understand the basic terms related to chemical equilibrium and derive the law thermodynamically, deduce relation between various equilibrium constants and determining partition coefficient of a solvent dissolved in two immiscible solvents

CO4: To have good knowledge about fundamental concepts of phase equilibrium and their applications in studying one and two-component systems including eutectics

Reference Books:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- B. R. Puri, Madan S. Pathania , L. R. Sharma*Principles of Physical Chemistry* Vishal Publications
- Peter Atkins , Julio de Paula , James Keeler *Atkins' Physical Chemistry*, Oxford University Press
- S.Glasstone, *An Introduction To Electrochemistry,* Affiliated East West Press Pvt. Limited, New Delhi
- S. Glasstone *Thermodynamics For Chemists*

M. Sc. Engineering Physics
Semester – III
Subject: Chemistry
(Course Type-Core, Course Code: CH-303)
Nomenclature: Organic Chemistry-III
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section-A (15 h)

Ultraviolet (UV) absorption spectroscopy

Absorption laws (Beer-Lambert law), molar absorptivity, presentation and analysis of UV spectra, types of electronic transitions, effect of conjugation. Concept of chromophore and auxochrome. Bathochromic, hypsochromic, hyperchromic and hypochromic shifts. UV spectra of conjugated enes and enones,Woodward-Fieser rules, calculation of λmax of simple conjugated dienes and $\alpha\beta$-unsaturated ketones (upto one DB extension)

Infrared (IR) absorption spectroscopy

Molecular vibrations, Hooke's law, selection rules, intensity and position of IR bands, measurement of IR spectrum, fingerprint region, characteristic absorptions of various functional groups and interpretation of IR spectra of simple organic compounds (Acetaldehyde, acetone, nitrobenzene, methylbenzoate, phenylacetate, aniline, phenol).

Amines

Structure and nomenclature of amines, physical properties. Separation of a mixture of primary, secondary and tertiary amines. Structural features affecting basicity of amines.

Preparation of alkyl and aryl amines (reduction of nitro compounds, nitriles, reductive amination of aldehydic and ketonic compounds. Gabriel phthalimide reaction, Hofmann bromamide reaction. Electrophilic aromatic substitution in aryl amines, reactions of amines with nitrous acid.

Section-B (15 h)

Diazonium Salts

Mechanism of diazotization, structure of benzene diazonium chloride, Replacement of diazo group by H, OH, F, Cl, Br, I, NO_2 and CN groups, reduction of diazonium salts to hydrazines and coupling reaction

Aldehydes and Ketones

Nomenclature and structure of the carbonyl group. Synthesis of aldehydes and ketones with particular reference to the synthesis of aldehydes from acid chlorides, advantage of oxidation of alcohols with chromium trioxide (Sarett reagent) pyridinium chlorochromate (PCC) and pyridinium dichromate. Physical properties, Comparison of reactivities of aldehydes and ketones. Mechanism of nucleophilic additions to carbonyl group with particular emphasis on benzoin, aldol, Perkin and Knoevenagel condensations. Condensation with ammonia and its derivatives. Wittig reaction. Mannich reaction. Oxidation of aldehydes, Baeyer– Villiger oxidation of ketones, Cannizzaro reaction. MPV, Clemmensen, Wolff-Kishner, LiAlH4 and NaBH4 reductions.

Enolates

Keto-enol tautomerism of ethyl acetoacetate, Acidity of α-hydrogens, alkylation of diethyl malonate (synthesis of butyric acid, isovaleric acid) and ethyl acetoacetate. Synthesis of ethyl acetoacetate: the Claisen condensation.

Course Outcomes:

CO1: Have knowledge of various absorption laws (Beer-Lambert law), molar absorptivity, analysis UV spectra and application of UV spectroscopy in structure elucidation

CO2: Able To describe absorptions of various functional groups and applications of IR spectroscopy

CO3: To synthesize and know reactions of amines

CO4: To discuss synthetic application of diazonium salt

CO5: Know about the preparation of aliphatic, aromatic aldehydes and ketones and various important name reactions of aldehydes and ketones and

CO6: Get knowledge about the acidity of α-hydrogens of diethyl malonate, ethyl acetoacetate and the synthesis and Keto-enol tautomerism of ethyl acetoacetate

Reference Books:

- Brian Smith: Infrared Spectral Interpretations: A Systematic Approach.
- Kotz, J.C., Treichel, P.M. & Townsend, J.R. *General Chemistry*, Cengage Learning India Pvt. Ltd.: New Delhi (2009).
- Mahan, B.H. *University Chemistry*, 3rd Ed. Narosa (1998).
- Petrucci, R.H. *General Chemistry*, 5th Ed., Macmillan Publishing Co.: New York (1985).
- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 1*), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Pradeep's organic chemistry, Volume II & III
- R Chand, organic chemistry, Volume II & III
- Modern publications, organic chemistry, Volume II & III
- New Age International (P) Ltd, Publishers, Volume II

M. Sc. Engineering Physics
Semester-III
Subject: Chemistry
(Course Type-Core, Course Code: CH-304)
Nomenclature: Chemistry practical-III
Credits: 2

Max. Marks: 50
Time: 6hrs.

Special Note: -

The Practical examination will be held in two sessions of 3 hours each & the students are required to perform two experiments during the examination.

Distribution of Marks:

Experiment	15+15 marks
Viva- voce	5+5 marks
Lab Record	10 marks
Total	50 marks

1. Colorimetry:
   To verify Beer - Lambert law for $KMnO_4$ /$K_2Cr_2O_7$ and determine the concentration of the given $KMnO_4$ /$K_2Cr_2O_7$ solution.
2. Preparations: Preparation of Cuprous chloride, tetra ammine cupric sulphate, chrome alum, potassium trioxalatochromate(III) and Nickel Hexammine chloride.
3. To determine the Critical Solution Temperature of phenol – water system.
4. To determine the solubility of benzoic acid at various temperatures and to determine the ▲H of the dissolution process.
5. To determine the enthalpy of neutralisation of a weak acid/weak base vs. strong base/strong acid and determine the enthalpy of ionisation of the weak acid/weak base.
6. To determine the enthalpy of solution of solid calcium chloride.
7. To study the distribution of iodine between CCl_4 and water.
8. Determine rate constant of hydrolysis of ethyl acetate.

Course Outcomes:

CO1: To verify the Beer's lambert law using potassium permanganate and potassium dichromate and also quantitation of these analytes

CO2: To prepare simple coordination complexes viz.Cuprous chloride, tetra-ammine cupric sulphate, chrome alum, potassium trioxalatochromate(III) and Nickel Hexammine chloride

CO3: Able to find out critical solution temperature of phenol water system

CO4: To determine the enthalpy of solution of calcium chloride enthalpy of neutralization and ionization using different combinations of acids and bases

CO5: To perform hydrolysis of ethyl acetate and find out rate constant of the reaction

M. Sc. Engineering Physics
Semester – IV
Subject: Physics
(Course type-Skill Enhancement, Course Code: SEC-401(A))
Nomenclature: Applied Optics
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine Questions will be set in total and attempt five questions in all.
2. Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have at least five parts and the answer should be in brief but not in Yes/ No.
3. For more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts.

UNIT-I

INTRODUCTION TO LASER

Spontaneous and Stimulated Absorption and Emission of radiation, main features of a laser: Directionality, high intensity, high degree of coherence, spatial and temporal coherence, Einstein's coefficients and possibility of amplification, Kinetic of optical absorption, Population inversion: A necessary condition for light amplification, resonant cavity and laser pumping.

(8 Lectures)

UNIT-II

LASER SYSTEM

Laser rate equation; Three and Four level Lasers. Principle, Construction & working of He-Ne Laser, Ruby Laser, Semiconductor junction Laser, N_2-Laser, CO_2 laser.

(7 Lectures)

UNIT-III

LASER APPLICATIONS

Spatial Frequency Filtering, Holography, Laser induced Fusion, Lasers in Isotope Separation. Application of Laser Technology in material processing (Drilling, Cutting, Welding), Medicine, Industry and Military.

(7Lectures)

UNIT-VI

THE OPTICAL FIBER

Optical fibres and their properties, Principal of light propagation through an optical fibre, The numerical aperture, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating.

(8 Lectures)

CO No.	Course code (SEC-401(A)) : Applied Optics **After successfully completing the course, student will be able to:**
CO-1	Familiar with optical phenomena and different concepts related laser physics.
CO-2	Qualitative understanding of basic lasing mechanism, types of Lasers, characteristics of Laser Light, types of Lasers.
CO-3	Understand and appreciate the applications of Lasers in developing LED, Holography, in materials processing, in Medicine, Industry and Military.
CO-4	Have the idea of optical fibres, their properties and principle of propagation of electromagnetic waves through optical fibres.

REFERENCES

1. Optical Electronics, A.K. Ghatak and K. Thyagarajan, Cambridge University Press
2. Laser, Theory & Applications, K. Thyagarajan and A.K. Ghatak, Macmillan India limited
3. Lasers and Non-Linear Optics, B.B.Laud, New Age International (P) Ltd., Publishers, New Delhi
4. Lasers, Principles, Types and Applications, K.R. Nambiar, New Age International (P) Ltd., Publishers, New Delhi
5. Fundamental of optics, F. A. Jenkins & H. E. White, 1981, Tata McGraw Hill.
6. Optical Systems and Processes, Joseph Shamir, 2009, PHI Learning Pvt. Ltd.
7. Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learning Pvt. Ltd.
8. Optical Physics, A. Lipson, S.G. Lipson, H. Lipson, 4th Edn., 1996, Cambridge Univ. Press

M. Sc. Engineering Physics
Semester – IV
Subject: Physics
(Course type-Skill Enhancement, Course Code: SEC-401(B))
Nomenclature: Renewable Energy and Energy Harvesting
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine Questions will be set in total and attempt five questions in all.
2. Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have at least five parts and the answer should be in brief but not in Yes/ No.
3. For more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts.

UNIT-I

FOSSIL FUELS, ALTERNATE SOURCES OF ENERGY AND SOLAR ENERGY

Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore different types of energy. Solar Energy; its importance, storage of solar energy, solar pond, non -convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems.

(8 Lectures)

UNIT-II

OCEAN, GEOTHERMAL AND HYDRO ENERGY

Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. Geothermal Energy: Geothermal Resources, Geothermal Technologies. Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

(8 Lectures)

UNIT-IV

WIND AND PIEZOELECTRIC ENERGY HARVESTING

Wind Energy harvesting**;** Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, piezoelectric parameters and modeling piezoelectric generators, piezoelectric energy harvesting applications.

(8 Lectures)

UNIT-IV

ELECTROMAGNETIC ENERGY HARVESTING

Linear Generators, Physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability

(6 Lectures)

CO No.	**Course code (SEC-401(B)) : Renewable Energy and Energy Harvesting**
	After successfully completing the course, student will be able to:
CO-1	Learn not only the theories of the renewable sources of energy, but also to have hands-on experiences on them wherever possible.
CO-2	Learn about the potential of Ocean, Geothermal, hydrothermal energies and the related technologies and also about their impact on environment.
CO-3	Understand and appreciate the technology of wind and piezoelectric energy harvesting.
CO-4	Have the idea of electromagnetic energy harvesting through carbon- captured technologies like cells, batteries.

REFERENCES

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal, S. Chand and Co. Ltd., New Delhi
3. Solar energy - Suhas P Sukhative Tata McGraw Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assesment Handbook, 2009
6. J. Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

M. Sc. Engineering Physics
Semester-IV
Subject: Physics
(Course Type- Core course, Course Code: EP-401)
Nomenclature: Waves & Optics
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hours

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

INTERFERENCE

Interference by Division of Wave front: Young's double slit experiment, Coherence, Conditions of interference, Fresnel's biprism and its applications to determine the wavelength of sodium light and thickness of a mica sheet, phase change on reflection. Interference by Division of Amplitude: Plane parallel thin film, production of colors in thin films, classification of fringes in films, Interference due to transmitted light and reflected light, wedge shaped film, Newton's rings.

(15 Lectures)

UNIT-II

DIFFRACTION-I

Huygens-Fresnel's theory, Fresnel's assumptions, rectilinear propagation of light, Fresnel's half period zones, zone plate, diffraction at a straight edge, rectangular slit and diffraction at a circular aperature. Diffraction due to a narrow slit, diffraction due to a narrow wire.

(15 Lectures)

UNIT-III

DIFFRACTION- II

Fraunhoffer diffraction: one slit diffraction, two slit diffraction, N-slit diffraction, plane transmission grating spectrum, dispersive power of grating, limit of resolution, Rayleigh's criterion, resolving power of telescope and a grating.

(15 Lectures)

UNIT-IV

POLARIZATION

Polarization: Polarisation by reflection, refraction and scattering, Malus Law, Phenomenon of double refraction, Huygens's wave theory of double refraction (Normal and oblique incidence), Analysis of polarized Light. Nicol prism, Quarter wave plate and half wave plate, production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light. Optical activity, Fresnel's theory of optical rotation, Specific rotation, Polarimeters (half shade and Biquartz).

(15 Lectures)

CO No.	**Course code (EP-401) : Waves & Optics**
	After successfully completing the course, student will be able to:
CO-1	Have understanding of Interference - by Division of Wave front, by Division of Amplitude and Interference due to transmitted light & reflected light.
CO-2	Learn about Huygens-Fresnel's theory, diffraction at a straight edge and at a circular aperture, diffraction due to a narrow slit and due to a narrow wire.
CO-3	Understand and explain the Fraunhoffer diffraction, dispersive power of grating, Rayleigh's criterion and resolving power of telescope & a grating.
CO-4	Understand the theories and laws of polarization along with understanding of the production and detection of (i) Plane polarized light (ii) Circularly polarized light and (iii) Elliptically polarized light.

REFERENCES

1. Principles of Optics, M. Born and E. Wolf, Pergamaman Press
2. Fundamentals of Optics, Jenkins and White, McGraw Hill Book Co. Ltd., New Delhi
3. Optics, K.D. Muller, University Science Books, Mill ally California
4. An Introduction to Interferometery, Tolansky, John Wiley & Sons, New Delhi
5. Polarized Light Production and Use, Shurcliff, Harward University Press, Cambridge, M A (USA)
6. Refresher Course in Physics Vol. II, C.L. Arora, S Chand and Co, New Delhi

M. Sc. Engineering Physics
Semester-IV
Subject: Physics
(Course Type- Core course, Course Code: EP-402)
Nomenclature: Quantum Mechanics
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hours

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

THE ORIGIN QUANTUM PHYSICS

Overview, scale of quantum physics, boundary between classical and quantum phenomena: Blackbody radiation, Planck's quantum theory; Quantum theory of light, Photon, Photoelectric effect, Compton effect (theory and result), Frank-Hertz experiment, de-Broglie hypothesis. Davisson and Germer experiment, wave packet, phase velocity, group velocity and their relation. Heisenberg's uncertainty principle. Time energy and angular momentum, position uncertainty. Uncertainty principle from de Broglie wave. (Wave-particle duality). Gamma Ray Microscope, Electron diffraction from a slit.

(15 Lectures)

UNIT-II

THE SCHRODINGER WAVE EQUATION

Time dependent Schrodinger equation and dynamical evolution of a quantum state ; properties of Wave Function, Interpretation of Wave Function, probability and probability current densities in three dimensions; Condition for physical acceptability of Wave Functions. Normalization, Linearity and Superposition Principles, Eigenvalues and Eigenfunctions, Position, Linear momentum & Energy operators; commutator of position and linear momentum operators; Expectation values of position and linear momentum; Wave Function of a free Particle; Time-independent Schrodinger wave equation, Stationary states, Eigen functions, Eigen values and their significance.

(15 Lectures)

UNIT-III

APPLICATION OF SCHRODINGER WAVE EQUATION TO ID PROBLEMS

(i) Particle in one-dimensional box (solution of Schrodinger wave equation, Eigen functions, Eigen values, quantization of energy, nodes and anti-nodes, zero point energy).

(ii) One dimensional step potential: E > Vo (reflection and transmission coefficients).

(iii) One dimensional step potential: E < Vo (calculation of penetration depth).

(iv) One dimensional potential barrier: E > Vo (reflection and transmission Coefficients).

(v) One-dimensional potential barrier, E < Vo (calculation of reflection and penetration or tunnelling coefficients).

(vi) Solution of Schrodinger equation for harmonic oscillator: energy eigen functions and eigen values, Zero-point energy.

(15 ectures)

UNIT-IV

APPLICATION OF SCHRODINGER WAVE EQUATION TO 3D PROBLEMS

Separation of Schrodinger wave equation in Cartesian coordinates; Free particle: energy eigenfunctions and eigenvalues; Particle in a cubic potential box: normalized energy eigenfunctions and eigenvalues, non-degenerate and degenerate eigenstates; Three-dimensional anisotropic and isotropic harmonic oscillator: normalized energy eigenfunctions and eigenvalues, degeneracy; Central potentials: Separation of Schrödinger equation in spherical polar coordinates, radial and angular equations.

(15 Lectures)

CO No.	**Course code (EP-402) : Quantum Mechanics**
	After successfully completing the course, student will be able to:
CO-1	Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and understand the theory of quantum measurements, wave packets and uncertainty principle.
CO-2	Understand the central concepts of quantum mechanics: wave functions, Interpretation of Wave Function, momentum and energy operator, expectation values, the Schrodinger equation, time dependent and time independent cases, probability density, the normalization techniques, Eigen functions, Eigen values and their significance.
CO-3	Understanding the behavior of quantum particle encountering a i) barrier & ii) potential.
CO-4	Solve Schrodinger equation for ground state energy and wave functions of various simple quantum mechanical one dimensional and three dimensional potentials.

REFERENCES

1. Quantum Mechanics, Leonard I. Schiff , 3rd Edn 2010, Tata McGraw Hill.
2. A Text book of Quantum Mechanics, P.M. Mathews and K. Venkatesan, 2nd Edn, 2010, McGraw Hill.
3. Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn, 2002, Wiley.
4. Quantum Mechanics, G. Aruldhas, 2nd Edn 2002, PHI Learning of India.
5. Quantum Mechanics, B.H. Bransden and C.J. Joachain, Pearson Education, New Delhi.
6. Introductory Quantum Mechanics, David J. Griffith, 2nd Ed. 2005, Pearson Education.
7. Quantum Physics of Atoms Molecules, Solids, Nuclei and Particles, R.M. Eisberg and R. Resnick, Wiley Eastern Ltd, New Delhi

M. Sc. Engineering Physics
Semester-IV
Subject: Physics
(Course Type- Core Course, Course Code: EP-403)
Nomenclature: Physics Practical-IV
Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. Do any eight experiments from the given list of experiments.
2. The students are required to calculate the error involved in a particular experiment.
3. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

LIST OF EXPERIMENTS

1. To measure the (a) area of a window (b) height of an inaccessible object using a sextant.
2. To determine Refractive index of the material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using Mercury discharge source.
4. To draw a graph between wave length and minimum deviation for various lines from a Mercury discharge source.
5. Determination of wave length of sodium light and the number of lines per centimetre using a diffraction grating.
6. Determination of wave length of sodium light using Newton's Rings.
7. Resolving power of a telescope.
8. Comparison of Illuminating Powers by a Photometer.
9. Measurement of (a) Specific rotation (b) concentration of sugar solution using polarimeter.
10. Ordinary and extra ordinary refractive indices for calcite or quartz.
11. To find the equivalent focal length of a lens system by nodal slide assembly.

CO No.	Course code (EP-403) : Physics Practical-IV
	After successfully completing the course, student will be able to:
CO-1	Hands-on experience of using various optical instruments and making finer measurements of wavelength of light using Newton Rings experiment, Fresnel Biprism etc. and resolving power of optical equipment.
CO-2	Understand various optical phenomena, principles, workings and applications optical instruments through Experiments.
CO-3	Learn to present observations, results and analysis in suitable and presentable form.

REFERENCES

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics, S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, Asia Publishing House

M. Sc. Engineering Physics
Semester – IV
Subject: Mathematics
(Course Type-Core, Course Code: MT-401)
Nomenclature: Abstract Algebra
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

UNIT-I

Definition and examples of a group including Permutation group, quaternion group, Abelian and Non-abelian groups. The Group Zn of integers under addition modulo n and under multiplication modulo n . Elementary properties of groups. Order of a group. Order of an element of a group . Subgroup and Subgroup tests. Centralizer, Normalizer, Center of a group. Cyclic group and properties of cyclic groups. Cycle notation for permutations. Properties of permutations. Even and odd permutations. Alternating groups.

UNIT –II

Cosets. Index of a subgroup , Lagrange's theorem , Normal subgroup , Quotient groups . Group homomorphism, Group isomorphisms. Cayley's theorem. Properties of isomorphisms. First, Second and Third isomorphism theorems for groups.

UNIT-III

Definition and examples of rings. Commutative and non-commutative rings. Rings from number system ,Z_n ring of integers modulo n , Ring of matrices. Properties of rings. Subrings. Characteristic of a ring. Integral Domain and Field. Examples of fields: Z_n, Q, R and C.

Ideals. Ideal generated by a subset of a ring. Prime and maximal ideals.

UNIT-IV

Quotient ring. Ring homomorphisms. Properties of ring homomorphisms. First, Second and Third Isomorphism theorems for rings. Euclidean ring.

Course Outcomes: The course will enable the students to:

1. Recognize the mathematical objects called groups, their elementary properties, order of a group, subgroup, cyclic groups and their properties.
2. Understand the notions of cosets, normal subgroups, and quotient groups. Know homomorphisms, isomorphisms and their properties and to prove three isomorphism theorems.
3. Learn about ring, subring, integral domain, field and ideal and related results.
4. Understand quotient rings, Euclidean ring, ring homomorphisms, ring isomorphisms and fundamental isomorphism theorems.

Recommended Text Books:

1. Joseph A. Gallian (2013). *Contemporary Abstract Algebra* (8th ed.). Cengage Learning India Private Limited, Delhi.
2. John B. Fraleigh (2002). *A First Course in Abstract Algebra* (7th ed.). Pearson**.**
3. M. Artin (2011). *Abstract Algebra* (2nd ed.). Pearson.
4. Rotman, Joseph J. (1995). *An Introduction to The Theory of Groups* (4th ed.). Springer Verlag, New York.
5. Beachy, John A., & Blair, William D. (2006). *Abstract Algebra* (3rd ed.). Waveland Press.

M. Sc. Engineering Physics
Semester – IV
Subject: Mathematics
(Course Type-Core, Course Code: MT-402)
Nomenclature: Numerical Analysis
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.
3. Use of a non-programmable scientific calculator is allowed in the examination.

Unit-I:

Round-off error and computer arithmetic, Local and global truncation errors, Algorithms and convergence. Numerical methods for solving algebraic and transcendental Equations: Bisection method, false position method, fixed point iteration method, Newton-Raphson method and secant method. Newton's iterative method for finding pth root of a number.

Unit-II:

Numerical methods for solving simultaneous linear equations: Gauss-elimination method, Gauss-Jordan method, Triangularization method (LU decomposition method). Crout's method, Cholesky Decomposition method. Iterative method; Jacobi's method, Gauss-Seidal method, relaxation method.

Unit-III:

Finite Differences operators and their relations. Interpolation with equal intervals: Gregory–Newton forward and backward difference interpolations. Interpolation with unequal intervals: Newton's divided difference formulae, Lagrange's Interpolation formulae.

Central Differences: Gauss forward and Gauss's backward interpolation formulae. Sterling formula, Bessel's formula.

Piecewise linear interpolation, Cubic spline interpolation.

Numerical Differentiation: First and second derivative of a function using interpolation formulae.

Unit-IV:

Numerical Integration: Newton-Cote's Quadrature formula, Trapezoidal rule, Simpson's one-third and three-eighth rule, Chebychev formula, Gauss Quadrature formula.

Numerical solution of ordinary differential equations: Single step methods- Picard's method. Taylor's series method, Euler's method, Runge-Kutta Methods. Multiple step methods; Predictor-corrector method, Modified Euler's method, Milne-Simpson's method.

Course Outcomes: This course will enable the students to:

1. Understand errors and their types. Learn techniques to obtain numerical solutions of algebraic and transcendental equations.
2. Attain numerical skills to find solutions of system of linear equations by different methods.
3. Learn different interpolation and extrapolation methods and their applications. Apply numerical methods to obtain derivatives.
4. Understand numerical methods for evaluating integrals and solving differential equations and to develop skill of applying these methods for future use in scientific problems.

Recommended Text Books:

1. Brian Bradie (2006), *A Friendly Introduction to Numerical Analysis.* Pearson.
2. C. F. Gerald & P. O. Wheatley (2008). *Applied Numerical Analysis* (7^{th} edition), Pearson Education, India.
3. M.K. Jain, S. R. K. Iyengar & R. K. Jain (2012). *Numerical Methods for Scientific and Engineering Computation* (6^{th} edition). New Age International Publishers.
4. Robert J. Schilling & Sandra L. Harris (1999). *Applied Numerical Methods for Engineers Using* MATLAB *and C*. Thomson-Brooks/Cole.
5. S.D. Conte and Carl de Boor (2017). *Elementary Numerical Analysis: An algorithmic Approach*. SIAM.
6. A. Gupta and S.C. Bose (1989). *Introduction to Numerical Analysis*. Academic Publishers.
7. F.B. Hildebrand (1987). *Introduction to Numerical Analysis*. Dover Publications.

M. Sc. Engineering Physics
Semester – IV
Subject: Mathematics
(Course Type-Core, Course Code: MT-403)
Nomenclature: Mathematics practical-IV
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. The examiner will set 4 questions at the time of practical examination by taking course outcomes (COs) into consideration.
2. The examinee will be required to write two programs and execute one program successfully.
3. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.
4. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

1. To find roots of algebraic and transcendental equations using Bisection method.
2. To find roots of algebraic and transcendental equations using Newton Raphson method.
3. To find roots of algebraic and transcendental equations using Regula Falsi method.
4. To find solution of system of equations using Gauss Elimination method.
5. To find solution of system of equations using Gauss Seidal method.
6. To find inverse of a square matrix using Gauss Jordan method
7. To find approximate value of a function by Newton Forward Interpolation formula.
8. To find approximate value of a function by Newton Backword Interpolation formula.
9. To find approximate value of a function using Lagrange's Interpolation formula.
10. To fit a curve by Least Squares Approximation method.
11. To find first and second order derivatives using interpolation formulas.
12. To evaluate a definite integral using Trapezoidal Rule.
13. To evaluate a definite integral using Simpson 1/3 rule.
14. To evaluate a definite integral using Simpson 3/8 rule.
15. To solve an ordinary differential equation using Euler's method.
16. To find solution of an ordinary differential equation using Euler's modified method.
17. To solve an ordinary differential equation using Runge-Kutta second order and fourth order methods.

Course Outcomes: This course will enable the students to:

1. Attain skill of computer programming and to use that a tool for problem solving.
2. Solve scientific problems by applying numerical techniques in C programing language.
3. Write and execute programs of numerical methods in C.
4. Apply knowledge of numerical analysis in investigation of problems and solving them at individual level and as member of a group.

M. Sc. Engineering Physics
Semester – IV
Subject: Chemistry
(Course Type-Core, Course Code: CH-401)
Nomenclature: Inorganic Chemistry-IV
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section – A (15 hrs.)

Metal- Ligand Bonding in Transition Metal complexes

Limitations of valence bond theory, an elementary idea of crystal field theory, crystal field splitting in octahedral, tetrahedral and square planar complexes, factors affecting the crystal field parameters.

Thermodynamics and Kinetic Aspects of metal complexes

A brief outline of thermodynamic stability of metal complexes and factors affecting the stability, Irving William Series, substitution reactions of square planer complexes of Pt[II], Trans effect.

Magnetic properties of Transition metal complexes

Types of magnetic materials, magnetic susceptibility, method of determining magnetic susceptibility, spin only formula, L-S coupling, correlation of μ_s and μ_{eff} values, orbital contribution to magnetic moments, application of magnetic moment data for 3d metal complexes.

Section –B(15 hrs.)

Electronic spectra of Transition metal complexes

Selection rules for d-d transition, spectroscopic ground states, spectrochemical series, orgel energy level diagram for d1 and d9 states, discussion of electronic spectrum of $[Ti(H2O)6]^{+3}$ complex ion.

Theory of Qualitative and Quantitative Analysis

Chemistry of analysis of various groups of basic and acidic radicals, chemistry of identification of acid radicals in typical combination, chemistry of interference of acid radicals including their removal in the analysis of basic radicals, common ion effect, solubility product, theory of precipitation, co-precipitation, post precipitation, purification of precipitates.

Course Outcomes:

CO1: To recapitulate the concept of valence bond theory and know the concept of crystal field theory with reference to splitting of d orbital's in octahedral, tetrahedral and square planar complexes and factors affecting the crystal field parameters

CO2: To explain the factors responsible for the stability of coordination complexes and various substitution reactions of square planar complexes with reference to trans effect

CO3: To study the magnetic properties of transition metal complexes and various types of magnetic materials and their magnetic susceptibility

CO4: To explain the methods for the determination of magnetic susceptibility

CO5: To apply the magnetic moment data for 3d metal complexes and study the selection rules for the d-d transitions

CO5: Able to calculate the spectroscopic terms for various metal ions

CO6: Have knowledge about orgal level diagrams for d1 and d9 electronic states and the electronic spectrum of $[Ti(H2O)6]^{+3}$complex ion.

Reference Books:

- Lee, J.D. *Concise Inorganic Chemistry* ELBS, 1991.
- Cotton, F.A., Wilkinson, G. &Gaus, P.L. *Basic Inorganic Chemistry*, 3rd ed., Wiley.
- Douglas, B.E., McDaniel, D.H. & Alexander, J.J. *Concepts and Models in Inorganic Chemistry*, John Wiley & Sons.
- Huheey, J.E., Keiter, E.A., Keiter, R.L. & Medhi, O.K. *Inorganic Chemistry:Principles of Structure and Reactivity*, Pearson Education India, 2006.
- Pradeep's inorganic chemistry, Volume III
- R Chand, inorganic chemistry, Volume III
- Modern publications,inorganic chemistry, Volume III
- Coordination chemistry by Ajai kumar, Aaryush publications, Delhi

M. Sc. Engineering Physics
Semester – IV
Subject: Chemistry
(Course Type-Core, Course Code: CH-402)
Nomenclature: Physical Chemistry-IV
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each.

Section-A (15 Hours)

Quantum Mechanics-I

Black-body radiation, Planck's radiation law, photoelectric effect, postulates of quantum mechanics, quantum mechanical operators, Role of operators in quantum mechanics, commutation relations, Hamiltonian operator, Hermitian operator, average value of square of Hermitian as a positive quantity. Schrödinger equation (basic idea), Determination of wave function & energy of a particle in one dimensional box.

Physical Properties and Molecular Structure

Optical activity, polarization – (Clausius – Mossotti equation derivation excluded). Orientation of dipoles in an electric field, dipole moment, induced dipole moment, measurement of dipole moment -temperature method and refractivity method, dipole moment and structure of molecules, Magnetic permeability, magnetic susceptibility and its determination. Application of magnetic susceptibility, magnetic properties – paramagnetism, diamagnetism and ferromagnetism.

Section-B (15 Hours)

Spectroscopy

Introduction: Electromagnetic radiation, regions of spectrum, basic features of spectroscopy, statement of Born-Oppenheimer Approximation, Degrees of freedom.

Rotational Spectrum

Selection rules, Energy levels of rigid rotator (semi-classical principles), rotational spectra of diatomic molecules, spectral intensity distribution using population distribution (Maxwell-Boltzmann distribution), determination of bond length and isotopic effect.

Vibrational spectrum

Selection rules, Energy levels of simple harmonic oscillator, pure vibrational spectrum of diatomic molecules, determination of force constant and qualitative relation of force constant and bond energy, idea of vibrational frequencies of different functional groups.

Raman Spectrum

Concept of polarizability, pure rotational and pure vibrational Raman spectra of diatomic molecules, selection rules, Quantum theory of Raman spectra. Give more stress on numerical problems of all spectroscopy.

Course Outcomes:

CO1: To know about dual characteristic of matter and extend this fact to obtain postulates of quantum mechanics and quantum-mechanical operators, apply Schrödinger equation to determine the physical observables for particle in a box

CO2: To be able to explain about the physical and magnetic properties associated with various molecular substances

CO3: To have sound knowledge about the consequences of interaction of radiation with matter resulting into various types of spectra

CO4: To be able to solve various numerical problems related to spectroscopy

Reference Books:

- Barrow, G.M. *Physical Chemistry* Tata McGraw-Hill (2007).
- Castellan, G.W. *Physical Chemistry* 4th Ed. Narosa (2004).
- B. R. Puri, Madan S. Pathania , L. R. Sharma*Principles of Physical Chemistry* Vishal Publications
- Chandra, A. K. *Introductory Quantum Chemistry* Tata McGraw-Hill (2001).
- House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA(2004).
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
- Banwell, C. N. & McCash, E. M. *Fundamentals of Molecular Spectroscopy* 4th Ed. Tata McGraw-Hill: New Delhi (2006)
- Pradeep's physical chemistry, Volume III.
- R Chand, physical chemistry, Volume III.
- Modern publications, physical chemistry, Volume III.

M. Sc. Engineering Physics
Semester – IV
Subject: Chemistry
(Course Type-Core, Course Code: CH-403)
Nomenclature: Organic Chemistry-IV
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section A (15 hrs.)

NMR Spectroscopy

Principle of nuclear magnetic resonance, the PMR spectrum,number of signals, peak areas, , magnetic equivalent and nonequivalent protons, positions of signals and chemical shift, shielding and deshielding of protons, proton counting, splitting of signals and coupling constant. Discussion of PMR spectra of the molecules: ethyl bromide, n-propyl bromide, isopropyl bromide, 1,1-dibromoethane, ethanol, acetaldehyde, ethyl acetate, toluene, benzaldehyde and acetophenone.

Organometallic Compounds

Grignard reagents: formation, structure and chemical reactions. Organozinc compounds: formation and chemical reactions. Organolithium compounds: formation and chemical reactions. Reactions of Grignard and organolithium reagents with epoxides.

Section–B (15hrs.)

Carbohydrates

Classification and nomenclature of Monosaccharides, mechanism of osazone formation, interconversion of glucose, fructose and mannose, chain lengthening and chain shortening of aldoses. Configuration of monosaccharides. Determination of ring size of glucose and fructose. Open chain and cyclic structure of D(+)-glucose & D(-) fructose. Mechanism of mutarotation. An introduction to disaccharides (maltose, sucrose and lactose; reducing and non-reducing) and polysaccharides (starch and cellulose) without involving structure determination.

Amino Acids and Peptides sequencing

Classification α-of amino acids. Acid-base behavior, isoelectric point, Preparation (Gabriel phlamide, Erlenmeyer azlactone, Strecker method) and properties of α-amino acids(ester of –COOH group, acetylation of $–NH_2$ group, complexation with Cu^{2+} ions, ninhydrin test, Hydantoin formation), Structure and nomenclature of peptides, Peptide structure determination, end group analysis (DNFB, Edman thiohydantoin and carboxypeptidase method), selective hydrolysis of peptides.

Introduction to Heterocyclic Compounds

Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Comparison of basicity of pyridine, piperidine and pyrrole.

Course Outcomes:

CO1: Get knowledge about the principle of nuclear magnetic resonance and the PMR spectra of the various molecules

CO2: Brief description of organometallic compounds

CO3: To have knowledge about classification, structures and important reactions of carbohydrates and amino acids

CO4: Get knowledge aromatic behaviour and basicity of simple heterocyclic compounds

Reference Books:

- Morrison, R. T. & Boyd, R. N. *Organic Chemistry*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- C.N. Banwell: Fundamentals of Molecular Spectroscopy.
- Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Berg, J.M., Tymoczko, J.L. &Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.,* W. H. Freeman.
- Berg, J.M., Tymoczko, J.L. &Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Pradeep's organic chemistry, Volume III.
- R Chand, organic chemistry, Volume III.
- Modern publications, organic chemistry, Volume III.
- New Age International (P) Ltd, Publishers Volume, I and III

M. Sc. Engineering Physics
Semester – IV
Subject: Chemistry
(Course Type-Core, Course Code: CH-404)
Nomenclature: Chemistry practical-IV
Credits: 2

Max. Marks: 50
Time: 6 hrs.

Special Note: -

The Practical examination will be held in two sessions of 3 hours each & the students are required to perform two experiments during the examination.

Distribution of Marks:

Experiment	15+15 marks
Viva- voce	5+5 marks
Lab Record	10 marks
Total	50 marks

1. Systematic identification (detection of extra elements, functional groups, determination of melting point or boiling point and preparation of at least one pure solid derivative) of the following simple mono and bifunctional organic compounds: Naphthalene, anthracene, acenaphthene, benzyl chloride, *p*-dichlorobenzene, *m*-dinitrobenzene, *p*-nitrotoluene, resorcinol, hydroquinone, -naphthol, -naphthol, benzophenone, ethyl methyl ketone, benzaldehyde, vanillin, oxalic acid, succinic acid, benzoic acid, salicylic acid, aspirin, phthalic acid, cinnamic acid, benzamide, urea, acetanilide, benzanilide, aniline hydrochloride, p-toluidine, phenyl salicylate (salol), glucose, fructose, sucrose, *o*-, *m*-, *p*-nitroanilines, thiourea.

2. Gravimetric Analysis:
   Quantitative estimations of, Cu^{2+} as copper thiocyanate, Ni^{2+} as Ni^{-} dimethylglyoxime and Al^{3+} as oxinate.

Course Outcomes:

CO1: To identify extra elements present in various solid organic compounds

CO2: Able to identify functional group present in organic compounds

CO2: Able to measure melting point, solubility behaviour, pH range, flame testing etc. of organic compounds

CO4: To perform gravimetric analysis and also able to analyze quantitatively copper, nickel and aluminum in the given solution

KURUKSHETRA UNIVERSITY KURUKSHETRA

Five Years Integrated
M. Sc. Engineering Physics (3 Years BSc+2Years M.Sc.)
Under CBCS-LOCF
(Effective from the Academic Session 2022-23)

Department of Physics
INSTITUTE OF INTEGRATED & HONORS STUDIES
Kurukshetra University
Kurukshetra - 136 119
Haryana (INDIA)

Scheme and Syllabi of five years integrated
M. Sc. ENGINEERING PHYSICS Programme
(From 1st to 6th semester)
Under CBCS-LOCF

(w. e. f. from the Academic Session 2022-23)

(After 3 Years / 6 Semesters, students may be awarded B. Sc.-Engineering Physics Degree)

3rd Year (5th and 6th semesters)

5th Semester

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks			Duration of Examination (Hrs.)
					Internal Assessment*	End-semester Examination	Total	
Skill Enhancement Course-III (Mathematics)	SEC-501	(A) Vector Calculus (B) Special Functions	2+0+0	2	10	40	50	3
Discipline Specific Elective-I (Physics)	EP-501	(A) Nuclear Physics (B) Mathematical Physics	3+0+0	3	15	60	75	3
Discipline Specific Elective-II (Physics)	EP-502	(A) Solid State Physics (B) Medical Physics	3+0+0	3	15	60	75	3
Discipline Specific Elective III (Physics)	EP-503	(A) / (B) Physics Practical-V	0+0+2	4	----------	50	50	3
Discipline Specific Elective-I (Mathematics)	MT-501	(A) Linear Algebra (B) Partial Differential Equations and Integral Transforms	3+0+0	3	15	60	75	3
Discipline Specific Elective-II (Mathematics)	MT-502	(A) Analytical Geometry (B) Mechanics – II	3+0+0	3	15	60	75	3
Discipline Specific Elective III (Mathematics)	MT-503	Mathematics Practical-V	0+0+2	4	-----------	50	50	3
Discipline Specific Elective-I (Chemistry)	CH-501	(A) Heterocyclic and photochemistry (B) Bio-organic Chemistry	2+0+0	2	10	40	50	3
Discipline Specific Elective II (Chemistry)	CH-502	(A) Organometallic chemistry, Inorganic polymers and Quantum mechanics (B) Applied chemistry	2+0+0	2	10	40	50	3
Discipline Specific Elective-III (Chemistry)	CH-503	Chemistry practical-V	0+0+2	4	-----------	50	50	6
Total Credits/Marks in semester-V			**24**				**600**	

*Internal Assessment marks

20% marks in each theory paper shall be reserved for Internal Assessment. The following parameters (with weightage of each) forming the basis of award of Internal Assessment:-

(i) One test/Seminar for each paper (one period duration)	: 50%
(ii) One Assignment for each paper	: 25%
(iii) Attendance	: 25%

6th Semester

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks			
					Internal Assessment*	End-semester Examination	Total	
Skill Enhancement Course-IV (Chemistry)	SEC-601	(A) Clinical chemistry (B) Chemistry lab-maintenance and handling	2+0+0	2	10	40	50	3
Discipline Specific Elective-IV (Physics)	EP-601	(A) Atomic & Molecular Spectroscopy (B) Elements of Modern Physics	3+0+0	3	15	60	75	3
Discipline Specific Elective-V (Physics)	EP-602	(A) Digital and Analog circuits & Instrumentation (B) Embedded System: Introduction to Microcontroller	3+0+0	3	15	60	75	3
Discipline Specific Elective VI (Physics)	EP-603	(A) (B) Physics Practical-VI	0+0+2	4	-----------	50	50	3
Discipline Specific Elective-IV (Mathematics)	MT-601	(A) Real Analysis–II (B) Complex Analysis	3+0+0	3	15	60	75	3
Discipline Specific Elective-V (Mathematics)	MT-602	(A) Linear Programming (B) Probability and Statistics	3+0+0	3	15	60	75	3
Discipline Specific Elective VI (Mathematics)	MT-603	Mathematics Practical-VI	0+0+2	4	-----------	50	50	3
Discipline Specific Elective-IV (Chemistry)	CH-601	(A)Applied physical Chemistry (B)Green Chemistry, organosulphur compounds and organic polymers	2+0+0	2	10	40	50	3
Discipline Specific Elective V (Chemistry)	CH-602	(A) Analytical chemistry (B)Nuclear chemistry, organosulphur compounds and catalysis	2+0+0	2	10	40	50	3
Discipline Specific Elective-VI (Chemistry)	CH-603	A B Chemistry practical-VI	0+0+2	4	------------	50	50	6
Total Credits/Marks in semester-VI			**24**				**600**	

M. Sc. Engineering Physics
Semester – V
Subject: Mathematics
(Course Type- Skill Enhancement, Course Code: SEC-501(A))
Nomenclature: Vector Calculus
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Scalar and vector product of vectors. Vector differentiation; Scalar Valued point functions, vector valued point functions, derivative along a curve, directional derivatives.

Unit-II:

Gradient of a scalar point function, geometrical interpretation of grad Φ. Divergence and curl of vector point function, their characteristics and examples.

Unit-III:

Gradient, divergence and curl of sum and product of functions and their related vector identities. Laplacian operator.

Vector integration; Line integral.

Unit-IV:

Surface integral, Volume integral.

Theorems of Gauss, Green & Stokes and problems based on these theorms.

Course Outcomes: This course will enable the students to:

1. Understand and solve problems related to scalar and vector product of vectors. Learn vector differentiation and directional derivatives and their problem solving.
2. Learn gradient, divergence and curl operators. Apply knowledge and these tools in problem solving.
3. Understand vector identities, Laplacian operator. Learn vector integration and line integral. Solve problems using these concepts.
4. Learn surface and volume integral formulations and their evaluation. Prove Gauss Divergence, Green's and Stoke's theorems. Realize importance of Green, Gauss and Stokes' theorems.

Recommended Text Books:

1. Murray Spiegel and Seymour Lipschutz (2017) *Vector Analysis*, Schaum Outline Series.
2. N. Saran and S.N. Nigam (2001). *Introduction to Vector Analysis*. Pothishala Pvt. Ltd., Allahabad.
3. Shanti Narayan and P.K. Mittal (2003). A Text Book of Vector Calculus. S. Chand.
4. Howard Anton, I. Bivens & Stephan Davis (2016). *Calculus* (10th edition). Wiley India.
5. Gabriel Klambauer (1986). *Aspects of Calculus*. Springer-Verlag.
6. George B. Thomas Jr., Joel Hass, Christopher Heil & Maurice D. Weir (2018). *Thomas*' *Calculus* (14th edition). Pearson Education.
7. James Stewart (2012). *Multivariable Calculus* (7th edition). Brooks/Cole. Cengage.
8. Monty J. Strauss, Gerald L. Bradley & Karl J. Smith (2011). *Calculus* (3rd edition). Pearson Education. Dorling Kindersley (India) Pvt. Ltd.

M. Sc. Engineering Physics
Semester – V
Subject: Mathematics
(Course Type- Skill Enhancement, Course Code: SEC-501(B))
Nomenclature: Special Functions
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I

Series solution of differential equations – Power series method. Hypergeometric Series. Hypergeometric function, its integral representation. Hypergeometric differential equation and solutions. Contiguous function relations, simple transformations.

Unit-II

Bessel equation and its solution: Bessel functions and their properties-Convergence, Recurrence relations and generating functions. Bessel's Integral. Orthogonality of Bessel functions.

Unit-III

Legendre differentials equation and its solution; Legendre functions and their properties; Recurrence relations and generating functions. Orhogonality of Legendre polynomials. Rodrigues' Formula for Legendre Polynomials, Laplace Integral Representation of Legendre polynomial.

Unit-IV

Hermite differentials equations and its solutions; Hermite function and its properties; Recurrence relations and generating functions. Orhogonality of Hermite polynomials. Rodrigues' Formula for Hermite Polynomial,

Course Outcomes: This course will enable the students to:

1. Understand singular points of a differential equation and to solve such differential equation by power series method. Learn Hypergeometric differential equation, Hypergeometric function and its properties.
2. Know Bessel's differential equation and its solution. Understand recurrence relations, generating function and othogonality of Bessel's function. Understand Bessel integral. Attain skills to make use of Bessel functions in scientific problem solving.
3. Familiarise with Legendre's differential equation and its solution in the form of Legendre functions. Understand recurrence relations, generating function and othogonality of Legendres function, Rodrigues' formula. Apply knowledge in problem solving.
4. Know Hemite's differential equation and its solution in the form of Hemite functions. Understand recurrence relations, generating function and othogonality of Hemite function, Rodrigues' formula. Attain skill to apply these tools for investigation and solution of problems.

Recommended Text Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10^{th} edition). Wiley.
2. Shepley L. Ross (2007). *Differential Equations* (3^{rd} edition), Wiley India. James Stewart (2012). *Multivariable Calculus* (7^{th} edition). Brooks/Cole. Cengage.
3. Earl. D. Ranvillie (1960). *Special Functions*. Macmillan.
4. W.W. Bell (2004). Special Functions for Scientists & Engineers. Dover Books on Mathematics.
5. L.C. Andrews (1992). Special Functions of Mathematics for Engineers, SPIE Press.

M. Sc. Engineering Physics
Semester-V
Subject: Physics
(Course Type- Discipline Specific Elective, Course Code: EP-501(A))
Nomenclature: Nuclear Physics
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

NUCLEAR STRUCTURE AND PROPERTIES OF NUCLEI

Nuclear composition (p-e and p-n hypotheses), Nuclear properties; Nuclear size, spin, parity, statistics, magnetic dipole moment, quadruple moment (shape concept). Determination of mass by Bain-Bridge, Bain-Bridge and Jordan mass spectrograph. Determination of charge by Mosley Law. Determination of size of nuclei by Rutherford Back Scattering.

(15 Lectures)

UNIT-II

NUCLEAR RADIATIONS DECAY PROCESS AND INTERACTION

Alpha-disintegration and its theory, Energetic of alpha-decay, Origin of continuous beta spectrum (neutrino hypothesis), types of beta-decay and energetic of beta-decay, Nature of gamma rays, Energetic of gamma rays, Interaction of heavy charged particles (Alpha particles); Energy loss of heavy charged particle (idea of Bethe formula; no derivation), Range and straggling of alpha particles. Geiger-Nuttal law, Interaction of light charged particle (Beta-particle), Energy loss of beta-particles (ionization), Range of electrons, absorption of beta-particles. Interaction of Gamma Ray; Passage of Gamma radiations through matter (Photoelectric, Compton and pair production effect), electron-positron annihilation, Absorption of Gamma rays (Mass attenuation coefficient) and its application.

(15 Lectures)

UNIT-III

NUCLEAR ACCELERATORS AND NUCLEAR RADIATION DETECTORS

Linear accelerator, Tendem accelerator, Cyclotron and Betatron accelerators, Gas filled counters; Ionization chamber, proportional counter, G.M. Counter (detailed study), Scintillation counter and semiconductor detector.

(15 Lectures)

UNIT-IV

NUCLEAR REACTIONS AND NUCLEAR REACTORS

Nuclear reactions, Elastic scattering, Inelastic scattering, nuclear disintegration, Photonuclear reaction, Radiative capture, Direct reaction, Heavy ion reactions and spallation Reactions, Conservation laws, Q-value and reaction threshold, Nuclear Reactors, General aspects of Reactor design, Nuclear fission and fusion reactors, (Principle, construction, working and uses in brief).

(15 Lectures)

CO No.	**Course code (EP-501(A)): Nuclear Physics** **After successfully completing the course, student will be able to:**
CO-1	Learn about nuclear composition & nuclear properties like nuclear size, spin, parity, statistics, magnetic dipole moment, quadruple moment and also be able to understand the basics of experimental techniques/methods to determine the mass and size of nuclei.
CO-2	Learn about the emission of alpha, beta and gamma rays, the mechanisms of the emissions of these rays, outlines of theory of alpha decay and Pauli's theory of beta decay with the neutrino hypothesis. Also Learn some basic aspects of interaction Interaction of heavy charged particles (Alpha particles) and interaction of gamma ray by photoelectric effect, Compton scattering and pair production, energy loss due to ionization.
CO-3	Understand the principles and basic constructions of particle accelerators and the detectors of nuclear radiations.
CO-4	Learn the basic aspects of nuclear reactions, the Q-value of such reaction & its derivation from conservation laws and understand the Principle, construction, working and uses of Nuclear fission and fusion reactors.

REFERENCES

1. Nuclear Physics, 2nd Ed (1962), I. Kaplan, Oxford and IBH, New Delhi
2. Nuclear Measurement Techniques, K. Sriram, AEWP, New Delhi
3. Introduction to Experimental Nuclear Physics, R.M. Singru, John Wiley & Sons
4. Nuclear Physics , D.C. Tayal, Himalayan Publishing House, Bombay
5. Atomic and Nuclear Physics Vol II (1994), S.N. Ghoshal, S Chand & Co New Delhi

6. Basic Nuclear Physics, B.N. Srivastava, (1993), Pragati Prakashan Meerut
7. Introductory Nuclear Physics, Halliday, Asia Publishing House, New Delhi
8. Fundamentals of Radiochemistry, D. D. Sood, A. V. R. Ready and Ramamoorthy, IANCAS (2007), BARC, Bombay.
9. Concepts of Nuclear Physics (1998), B. L. Cohen, Tata Mc Graw Hill, New Delhi
10. Introductory Nuclear Physics (1988), K. S. Krane, John Wiley & Sons New Delhi
11. Nuclear Physics (1992), S.B. Patel, Wiley Eastern Ltd, New Delhi
12. Nuclear Physics (1993), R.R. Roy and B.P. Nigam, Wiley Eastern Ltd. New Delhi.

M. Sc. Engineering Physics
Semester-V
Subject: Physics
(Course Type- Discipline Specific Elective, Course Code: EP-501(B))
Nomenclature: Mathematical Physics
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

FOURIER SERIES

Periodic functions, Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only), Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, Complex representation of Fourier series, Expansion of functions with arbitrary period, Expansion of non-periodic functions over an interval, Even and odd functions and their Fourier expansions, Application, Summing of Infinite Series.

SOME SPECIAL INTEGRALS

Beta and Gamma Functions, Relation between them. Expression of Integrals in terms of Gamma Functions, Error Function (Probability Integral).

(15 Lectures)

UNIT-II

CALCULUS OF FUNCTIONS OF MORE THAN ONE VARIABLE

Partial derivatives, exact and inexact differentials, Integrating factor, with simple illustration, Constrained Maximization using Lagrange Multipliers.

PARTIAL DIFFERENTIAL EQUATIONS

Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry.

(15 Lectures)

UNIT-III

FROBENIUS METHOD AND SPECIAL FUNCTIONS

Singular Points of Second Order Linear Differential Equations and their importance, Frobenius method and its applications to differential equations, Legendre, Bessel, Hermite and Laguerre Differential Equations, Properties of Legendre Polynomials: Rodrigues Formula, Orthogonality, Simple recurrence relations.

(15 Lectures)

UNIT-IV

COMPLEX ANALYSIS

Brief Revision of Complex Numbers and their Graphical Representation, Euler's formula, De Moivre's theorem, Roots of Complex Numbers, Functions of Complex Variables, Analyticity and Cauchy-Riemann Conditions, Examples of analytic functions, Singular functions: poles and branch points, order of singularity, branch cuts, Integration of a function of a complex variable, Cauchy's Inequality, Cauchy’s Integral formula.

(15 Lectures)

CO No.	Course code (EP-501(B)): Mathematical Physics
	After successfully completing the course, student will be able to:
CO-1	Learn the Fourier analysis of periodic functions and their applications in physical problems. Learn the beta, gamma and the error functions and their applications in doing integrations.
CO-2	Acquire knowledge of methods to solve partial differential equations with the examples of important partial differential equations in Physics.
CO-3	Learn about the special functions, such as the Hermite polynomial, the Legendre polynomial, the Laguerre polynomial and Bessel functions and their differential equations and their applications in various physical problems.
CO-4	Learn about the complex numbers and their properties, functions of complex numbers and their properties such as analyticity, poles and residues.

REFERENCES

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. An Introduction to Ordinary Differential Equations, Earl A Coddington, 1961, PHI Learning.
5. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
6. Essential Mathematical Methods, K.F. Riley and M.P. Hobson, 2011, Cambridge University Press
7. Partial Differential Equations for Scientists and Engineers, S.J. Farlow, 1993, Dover Publications.

8. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Books.

M. Sc. Engineering Physics
Semester-V
Subject: Physics
(Course Type- Discipline Specific Elective, Course Code: EP-502(A))
Nomenclature: Solid State Physics
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

CRYSTAL STRUCTURE I

Crystalline and glassy forms, liquid crystals, crystal structure, periodicity, lattice and basis, crystal translational vectors and axes. Unit cell and Primitive Cell, Winger Seitz primitive Cell, symmetry operations for a two dimensional crystal, Bravais lattices in two and three dimensions. Crystal planes and Miller indices, Interplaner spacing, Crystal structures of Zinc Sulphide, Sodium Chloride and Diamond.

(15 Lectures)

UNIT-II

CRYSTAL STRUCTURE II

X-ray diffraction, Bragg's Law and experimental X-ray diffraction methods. K-space and reciprocal lattice and its physical significance, reciprocal lattice vectors, reciprocal lattice to a simple cubic lattice, b.c.c. and f.c.c. lattice.

(15 Lectures)

UNIT-III

ELECTRONIC PROPERTIES OF METALLIC SOLIDS

Free electron gas model, Energy levels and density of states in one and three dimensions, Fermi momentum, Fermi energy, Fermi temperature, Effect of temperature, heat capacity of electron gas (explicit calculation), Experimental heat capacity of metals, Concept of thermal effective mass, Electrical conductivity and Ohm's law, Experimental resistivity of metals, Matthiessen's rule, Motion in magnetic fields and Hall effect, Thermal conductivity of metals and Wiedmann-Franz law.

(15 Lectures)

UNIT-IV

SUPERCONDUCTIVITY

Historical introduction, Survey of superconductivity, Super conducting systems, High Tc Super conductors, Isotopic Effect, Critical Magnetic Field, Meissner Effect, London Theory and Pippards' equation, Classification of Superconductors (type I and Type II), BCS Theory of Superconductivity, Flux quantization, Josephson Effect (AC and DC), Practical Applications of superconductivity and their limitations, power application of superconductors.

(15 Lectures)

CO No.	**Course code (EP-502(A)): Solid State Physics**
	After successfully completing the course, student will be able to:
CO-1	Have brief idea about crystalline and amorphous substances, about lattice, unit cell, primitive cell, miller indices, Bravais lattices in two & three dimensions and crystal structures of Zinc Sulphide, Sodium Chloride and Diamond.
CO-2	Acquire knowledge about X-ray diffraction, Bragg's Law and experimental X-ray diffraction methods and about the reciprocal lattice to a simple cubic lattice, b.c.c. and f.c.c. lattice.
CO-3	Acquire knowledge about the electronic properties like electrical conductivity, resistivity, thermal conductivity, heat capacity etc. of metallic solids.
CO-4	Understand the basic idea about superconductors, their classifications and practical applications.

REFERENCES

1. Introduction to Solid State Physics, 7th Ed (1996) , C. Kittel, John Wiley & Sons, New Delhi
2. Solid State Physics, *An Introduction to Theory and Experiment*, H. Ibach and H. Lüth, Springer-Verlag, Berlin, 1991
3. Solid State Physics, S.O. Pillai, New Age International Publishers (2007) New Delhi
4. Introduction to Superconductivity, M. Tinkham, McGraw-Hill, New York
5. Solid State Physics (2000), A.J. Dekkar, Mc Millan India Ltd New Delhi
6. Solid State Physics (2003), N.W. Ascroft N W and N.D. Mermin, Harcourt Asia, Singapore
7. Solid State Physics: An introduction to theory and Experiment, H. Ibach and H.Luth

8. Solid State Physics (1993), H.V. Keer, Wiley Eastern Ltd, New Delhi
9. Solid State Physics (1990), C.M. Kachhava, Tata Mc Graw Hill Co Ltd, New Delhi
10. Solid State Physics (1995), Gupta, Vikas Publishing House Pvt Ltd, New Delhi

M. Sc. Engineering Physics
Semester-V
Subject: Physics
(Course Type- Discipline Specific Elective, Course Code: EP-502(B))
Nomenclature: Medical Physics
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

UNIT-I

PHYSICS OF THE BODY-I

Basic Anatomical Terminology: Standard Anatomical Position, Planes, Familiarity with terms like- Superior, Inferior, Anterior, Posterior, Medial, Lateral, Proximal and Distal, Mechanics of the body: Skeleton, forces, and body stability. Muscles and dynamics of body movement, Physics of Locomotors Systems: joints and movements, Stability and Equilibrium. Energy household of the body: Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation. Pressure system of body: Physics of breathing, Physics of cardiovascular system.

PHYSICS OF THE BODY-II

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. Optical system of the body: Physics of the eye. Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer.

(15 Lectures)

UNIT-II

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-I

X-Rays: Electromagnetic spectrum, production of X-rays, X-ray spectra, Bremsstrahlung, Characteristic X-ray. X-ray tubes & types: Coolidge tube, X-ray tube design, tube cooling stationary mode, Rotating anode X-ray tube, Tube rating, quality and intensity of X-ray. X-ray generator circuits, half wave and full wave rectification, filament circuit, kilo voltage circuit, types of X-Ray Generator, high frequency generator, exposure timers and switches, HT cables, HT generation.

RADIATION PHYSICS

Radiation units exposure, absorbed dose, units: rad, gray, relative biological effectiveness, effective dose, inverse square law, Interaction of radiation with matter Compton & photoelectric effect, Rem & Sievert, linear attenuation coefficient.

RADIATION DETECTORS

Thimble chamber, condenser chambers, Geiger Muller counter, Scintillation counters and Solid State detectors, ionization chamber, Dosimeters, survey methods, area monitors, TLD, Semiconductor detectors.

(15 Lectures)

UNIT-III

MEDICAL IMAGING PHYSICS

Evolution of Medical Imaging, X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Ultrasound imaging, Physics of Doppler with applications and modes, Vascular Doppler. Radiography: Filters, grids, cassette, X-ray film, film processing, fluoroscopy. Computed tomography scanner- principle & function, display, generations, mammography. Thyroid uptake system and Gamma camera (Only Principle, function and display).

PHYSICS OF DIAGNOSTIC AND THERAPEUTIC SYSTEMS-II

Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography. Therapeutic nuclear medicine: Interaction between radiation and matter Dose and isodose in radiation treatment. Medical Instrumentation: Basic Ideas of Endoscope and Cautery, Sleep Apnea and Cpap Machines, Ventilator and its modes.

(15 Lectures)

UNIT-IV

RADIATION ONCOLOGY PHYSICS

External Beam Therapy (Basic Idea): Telecobalt, Conformal Radiation Therapy (CRT), 3DCRT, IMRT, Image Guided Radiotherapy, EPID, Rapid Arc, Proton Therapy, Gamma Knife, Cyber Knife, Contact Beam Therapy (Basic Idea): Brachytherapy-LDR and HDR, Intra Operative Brachytherapy, Radiotherapy, kilo voltage machines, deep therapy machines, Telecobalt machines, Medical linear accelerator, Basics of Teletherapy units, deep x-ray, Telecobalt units, medical linear accelerator, Radiation protection, external beam characteristics, dose maximum and build up – bolus, percentage depth dose, tissue maximum ratio and tissue phantom ratio, Planned target Volume and Gross Tumour Volume.

RADIATION AND RADIATION PROTECTION

Principles of radiation protection, protective materials-radiation effects, somatic, genetic stochastic and deterministic effect. Personal monitoring devices: TLD film badge, pocket dosimeter, OSL dosimeter, Radiation dosimeter, Natural radioactivity, Biological effects of radiation, Radiation monitors, Steps to reduce radiation to Patient, Staff and Public, Dose Limits for Occupational workers and Public. AERB: Existence and Purpose.

(15 Lectures)

CO No.	**Course code (EP-502(B)): Medical Physics**
	After successfully completing the course, student will be able to:
CO-1	Learn about the human body, its anatomy, physiology and biophysics, the Physics of the senses, exploring its performance as a physical machine.
CO-2	Gain knowledge with reference to working of various diagnostic tools, medical imaging techniques, how ionizing radiation interacts with matter, how it affects living organisms and how it is used as a therapeutic technique and radiation safety practices.
CO-3	Have functional knowledge regarding need for radiological protection and the sources of an approximate level of radiation exposure for treatment purposes.
CO-4	Gain a broad and fundamental understanding of Physics while developing particular expertise in medical applications.

REFERENCES

1. Medical Physics, J.R. Cameron and J.G. Skofronick, Wiley (1978)
2. Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
3. Christensen’s Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
4. Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Third edition (2003)
5. Physics of the human body, Irving P. Herman, Springer (2007).
6. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
7. Handbook of Physics in Diagnostic Imaging: R.S. Livingstone: B.I. Publication Pvt Ltd.

M. Sc. Engineering Physics
Semester-V
Subject: Physics
(Course Type- Discipline Specific Elective, Course Code: EP-503 (A)
Nomenclature: PHYSICS PRACTICAL-V (A)
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. Do any eight experiments from the given list of experiments.
2. The students are required to perform and calculate the error involved in a particular experiment in the final examination.
3. The Practical examination will be held in single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

LIST OF EXPERIMENTS

1. Study of Hysteresis curve by CRO.
2. To measure the resistivity of a semiconductor (Ge) crystal with temperature by Four Probe Method (from room temperature to 150 ^{o}C) and to determine its band gap.
3. To measure the Dielectric constant of a dielectric materials with frequency.
4. To determine the elastic constant of quartz crystal.
5. Velocity of Ultrasonic waves by grating formation in CCl_4.
6. To determine the Hall coefficient of a semiconductor sample.
7. To find the magnetic susceptibility of a solids.
8. To study the PE Hysteresis curve of a ferroelectric crystal.
9. To draw the Platue of G.M. Counter.
10. To draw the Mass Attenuation coefficient by G.M. Counter.

CO No.	Course code (EP-503(A)) : Physics Practical-V-A
	After successfully completing the course, student will be able to:
CO-1	Perform experiments to determine resistance & band gap of semiconductor materials and be able to study the ferroelectric properties of ferroelectric materials.
CO-2	Familiar with the use and proper handling of different instruments such as CRO, dielectric setup, G.M.Counter, Gauss meter etc.
CO-3	Draw the platue of G.M. Counter & determine the Mass Attenuation coefficient by G.M. Counter.
CO-4	Learn to present observations, results and analysis in suitable and presentable form.

REFERENCES

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi
4. Practical Physics , S.L. Gupta and V. Kumar, Pragati Prakashan Meerut
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop,1971, Asia Publishing House

M. Sc. Engineering Physics
Semester-V
Subject: Physics
(Course Type- Discipline Specific Elective, Course Code: EP-503 (B))
Nomenclature: Physics Practical V (B)
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. Do any eight experiments from the given list of experiments.
2. The students are required to perform and calculate the error involved in a particular experiment in the final examination.
3. The Practical examination will be held in single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

MATHEMATICAL PHYSICS

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- Highlights the use of computational methods to solve physical problems.
- Use of computer language as a tool in solving physics problems (applications).
- The course will consist of lectures (both theory and practical) in the Computer Lab.
- Evaluation done not on the programming but on the basis of formulating the problem.
- Aim at teaching students to construct the computational problem to be solved.
- Students can use anyone operating system Linux or Microsoft Windows

Topics	Description with Applications
Introduction and Overview	Computer architecture and organization, memory and Input/output devices.
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and

	printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While-Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops), Arrays (1D&2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.
Programs: using C/C++ language	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending-descending order, Binary search.
Random number generation	Area of circle, area of square, volume of sphere, value of pi (π)
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan \alpha$; $I = I_o((Sin\ \alpha \mid \alpha\ )^2$ in optics
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. Sin θ, Cos θ, tan θ, etc.
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice-versa. Find the area of B-H Hysteresis loop
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Attempt following problems using RK 4 order method: • Solve the coupled differential equations $\frac{dx}{dy} = y + x - \frac{x3}{3}$; $\frac{dy}{dx} = -x$ for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4. Plot x vs y for each of the four initial conditions on the same screen for 0 ≤ t ≤ 15 The differential equation describing the motion of a pendulum is $\frac{d2\theta}{dt2} = -Sin\theta.$ The pendulum is released from rest at an angular displacement α, i.e. υ (0)= α and υ'(0) = 0. Solve the equation for α = 0.1, 0.5 and 1.0 and plot υ as a function of time in the range 0 ≤ t ≤ 8π. Also plot the analytic solution valid for small υ (sin(υ) = υ

MEDICAL PHYSICS

1. Understanding the working of a manual Hg Blood Pressure monitor and measure the Blood Pressure.
2. Understanding the working of a manual optical eye-testing machine and to learn eye-testing.
3. Correction of Myopia (short sightedness) using a combination of lenses on an optical bench/breadboard.
4. Correction of Hypermetropia/Hyperopia (long sightedness) using a combination of lenses on an optical bench/breadboard.
5. To learn working of Thermoluminescent dosimeter (TLD) badges and measure the background radiation.
6. Familiarization with Geiger-Muller (GM) Counter and to measure background radiation.
7. Familiarization with Radiation meter and to measure background radiation.
8. Familiarization with the Use of a Vascular Doppler.

CO No.	Course code (EP-503(B)) : Physics Practical-B
	After successfully completing the course, student will be able to:
CO-1	Acquire proficiency in computing integrations and in solving differential equations by various methods. Also be able to learn about the basic theory of errors, their analysis, and estimation with examples of simple experiments in Physics.
CO-2	Learn the fundamentals of the C and C++ programming languages and their applications in solving simple physical problems involving interpolations, differentiations, integrations, differential equations as well as finding the roots of equations.
CO-3	Have hands-on and gain knowledge with reference to working of various diagnostic tools and medical equipment.
CO-4	Acquire a broad and fundamental understanding of Physics while developing particular expertise in medical applications and appreciate the applications of Physics to clinical medicine.

REFRENCES

1. Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.
2. Schaum's Outline of Programming with C++. J.Hubbard, 2000, McGraw-Hill Publications.
3. Numerical Recipes in C++: The Art of Scientific Computing, W.H. Pressetal., 3rdEdn., 2007, Cambridge University Press.
4. A first course in Numerical Methods, Uri M. Ascher and Chen Greif, 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3rdEdn., 2007, Wiley India Edition.

6. Numerical Methods for Scientists and Engineers, R.W. Hamming, 1973, Courier Dover Pub.
7. An Introduction to Computational Physics, T. Pang, 2ndEdn., 2006, Cambridge Univ. Press.
8. Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003).
9. Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
10. Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Third edition (2003).
11. The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002).
12. The Physics of Radiology-H E Johns and Cunningham.
13. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
14. Handbook of Physics in Diagnostic Imaging: Roshan S. Livingstone: B. I. Publications Pvt Ltd.
15. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

M. Sc. Engineering Physics
Semester – V
Subject: Mathematics
(Course Type- Discipline Specific Elective, Course Code: MT-501(A))
Nomenclature: Linear Algebra
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Vector spaces. Subspaces. Algebra of subspaces. Quotient space. Linear combination of vectors. Linear span. Linear dependence and independence of vectors. Bases and dimension. Dimension of subspaces.

Linear transformations. Null space. Range space. Matrix representation of a linear transformation. Rank and nullity of a linear transformation. Algebra of linear transformations.

Unit-II:

Isomorphism of vector spaces, Isomorphism theorems. Dual and second dual of a vector space, Transpose of a linear transformation, Eigen vectors and eigen values of a linear transformation, Characteristic polynomial and Cayley−Hamilton theorem, Minimal polynomial.

Unit-III:

Inner product spaces and orthogonality, Cauchy−Schwarz inequality, Gram−Schmidt orthogonalisation, Diagonalisation of symmetric matrices.

Unit-IV:

Adjoint of a linear operator; Hermitian, unitary and normal linear transformations; Jordan canonical form, Triangular form, Trace and transpose, Invariant subspaces.

Course Outcomes: This course will enable the students to:

1. Understand the concepts of vector spaces, subspaces, bases and their properties; linear transformations and their rank and nullity and to use those concepts for problem solving.
2. Learn isomorphism of vector spaces, dual of a vector space, eigen values, eigen vectors and characteristic polynomial of linear transformations and their further use in investigation and solution of problems.
3. Have knowledge of inner product spaces, orthogonalisation and diagonalization of matrices/ linear transformations and to apply that in further learning and for scientific applications.
4. Learn adjoint operation, Hermitian, unitary, normal, canonical and triangular forms of linear transformations and related problem solving.

Recommended Text Books:

1. Stephen H. Friedberg, Arnold J. Insel & Lawrence E. Spence (2003). *Linear Algebra* (4^{th}edition). Prentice-Hall of India Pvt. Ltd.
2. Kenneth Hoffman & Ray Kunze (2015). *Linear Algebra* (2^{nd} edition). Prentice-Hall.
3. I. M. Gel'fand (1989). *Lectures on Linear Algebra.* Dover Publications.
4. Nathan Jacobson (2009). *Basic Algebra* I & II (2^{nd} edition). Dover Publications.
5. Serge Lang (2005). *Introduction to Linear Algebra* (2^{nd} edition). Springer India.
6. Vivek Sahai & Vikas Bist (2013). *Linear Algebra* (2^{nd} Edition). Narosa Publishing House.
7. Gilbert Strang (2014). *Linear Algebra and its Applications* (2^{nd} edition). Elsevier.

M. Sc. Engineering Physics
Semester – V
Subject: Mathematics
(Course Type- Discipline Specific Elective, Course Code: MT-501(B))
Nomenclature: Partial Differential Equations and Integral Transforms
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Classification of linear partial differential equations of second order, Hyperbolic, parabolic and elliptic types, Reduction of second order linear partial differential equations to Canonical (Normal) forms and their solutions. Cauchy's problem for second order partial differential equations, Characteristic equations and characteristic curves of second order partial differential equation.

Unit-II:

Solution of linear hyperbolic equations. Monge's method for solving non-linear second order partial differential equations.

Laplace equation: elementary solutions of Laplace's equation, families of equipotential surfaces.

Method of separation of variables: Solution of Laplace's equation, Wave equation and Diffusion (Heat) equation in one and two dimensions Cartesian Co-ordinate system.

Unit-III:

Laplace Transforms – Existence theorem for Laplace transforms, Linearity of the Laplace transforms, Shifting proprties, Laplace transforms of derivatives and integrals, Differentiation and integration of Laplace transforms, Convolution theorem, Inverse Laplace transforms, convolution theorem, Inverse Laplace transforms of derivatives and integrals, solution of differential equations using Laplace transform.

Unit-IV:

Fourier transforms: Linearity property, Shifting, Modulation, Convolution Theorem, Fourier Transform of Derivatives, Parseval's identity for Fourier transforms, relation between Laplace and Fourier transform. Solution of differential Equations using Fourier Transforms.

Course Outcomes: This course will enable the students to:

1. Learn classification of second order partial differential equations, their canonical forms, and methods of solving those. Find characteristic equations and curves. Apply this knowledge to solve problems of science and society.
2. Model physical phenomena using partial differential equations such as the Laplace, heat and wave equations and to solve these equations. Learn solving non-linear equations by Monge's method. Apply these methods as a tool for modelling and solving real world problems.
3. Know about Laplace transforms and its properties in detail and to apply those in solving differential equations.
4. Familiarize with Fourier transforms of functions, properties of Fourier transform, inverse Fourier transforms and relation between Laplace and Fourier transforms. Develop skill of applying Fourier transforms to solve differential equations.

Recommended Text Books:

1. Erwin Kreyszig (2011). *Advanced Engineering Mathematics* (10^{th} edition). Wiley.
2. Tyn Myint-U & Lokenath Debnath (2013). *Linear Partial Differential Equation for Scientists and Engineers* (4^{th} edition). Springer India.
3. H. T. H. Piaggio (2004). An Elementary Treatise on *Differential Equations and Their Applications.* CBS Publishers.
4. S. B. Rao & H. R. Anuradha (1996). *Differential Equations with Applications*. University Press.
5. Ian N. Sneddon (2006). *Elements of Partial Differential Equations*. Dover Publications.
6. Murray R. Spiegel (2005). *Laplace Transforms*. Schaum's Outline Series.
7. Ian N. Sneddon (1974). *The Use of Integral Transforms*. McGraw Hill.

M. Sc. Engineering Physics
Semester – V
Subject: Mathematics
(Course Type- Discipline Specific Elective, Course Code: MT-502(A))
Nomenclature: Analytical Geometry
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

General equation of second degree: Classification of conic sections; centre, asymptotes, axes, eccentricity, foci and directrices of conics. Tracing of conics. Tangent at any point to the conic, chord of contact, pole of line to the conic, director circle of conic. Polar equation of a conic, tangent and normal to the conic.

Unit-II:

System of conics. Confocal conics.

Sphere: General form, Plane section of a sphere. Sphere through a given circle. Intersection of two spheres, tangent plane and line, polar plane and line, orthogonal spheres, length of tangent radical plane of two spheres, co-axial system of spheres

Unit-III:

Cone: Equation of a cone, right circular cone, quadric cone, enveloping cone. Tangent plane and condition of tangency, reciprocal cone. Conditions for having mutually perpendicular generatoes and for tangent palnes.

Cylinder: Right circular cylinder and enveloping cylinder.

Unit-IV:

Central Conicoids: Equation of tangent plane. Director sphere. Normal to the conicoids. Polar plane of a point. Enveloping cone of a coincoid. Enveloping cylinder of a coincoid. Paraboloids.

Course Outcomes: This course will enable the students to:

1. Understand the concept of a second degree equation representing different conic sections and its classification and properties. Learn terms related to conic sections and their use in problem solving.
2. Know representation of system of conics and confocal conics and related results. Learn general form of equation of a sphere and to solve problems related to intersection of spheres, tangent plane and line, orthogonality, length of tangent and co-axial system of spheres. Apply this knowledge to investigate and solve problems.
3. Learn equations of cones and cylinders and then to solve related problems. Apply knowledge for problem solving and life-long learning.
4. Familiarize with concepts of conicoids and related tangent plane, director sphere, normal, envelop and to make further use thereof.

Recommended Text Books:

1. Robert J. T. Bell (1994). *An Elementary Treatise on Coordinate Geometry of Three Dimensions*. Macmillan India Ltd.
2. D. Chatterjee (2009). *Analytical Geometry: Two and Three Dimensions*. Narosa Publishing House.
3. Shanti Narayan and P.K. Mittal (2007). *Analytical Solid Geometry*. S. Chand.
4. J.H. Kindle (1990). *Analytic Geometry*. Schaum Outline Series
5. Gordon Fuller and Dalton Tarwater (1992). *Analytic Geometry*. Pearson.

M. Sc. Engineering Physics
Semester – V
Subject: Mathematics
(Course Type- Discipline Specific Elective, Course Code: MT-502(B))
Nomenclature: Mechanics – II
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Virtual work. Forces in three dimensions. Poinsot's central axis.

Unit-II:

Wrenches. Null lines and planes. Stable and unstable equilibrium.

Unit-III:

Concepts of Conservative forces and Impulsive forces. Motion on smooth and rough plane curves.

Motion of a particle in three dimensions. Velocity and acceleration in terms of different co-ordinate systems. Moving axes.

Unit-IV:

Equation of motion under a central force, Differential equation of the orbit, (p, r) equation of the orbit, Apses and apsidal distances, Areal velocity, Characteristics of central orbits, Kepler's laws of planetary motion and their relation with Newton's laws of motion.

Course Outcomes: This course will enable the students to:

1. Understand the equilibrium of a body acted upon by forces in three dimensions and learn the principle of virtual work for a system of coplanar forces acting on a rigid body and central axis. Apply this knowledge to investigate and solve scientific problems.
2. Determine the stability of equilibrium of bodies. Understand wrenches, null lines and

planes.

3. Understand particle motion on a smooth or rough path in a plane and general motion of a rigid body. Apply theoretical concepts to problem solving.
4. Understand equation of motion of a body moving under a central force and Kepler's laws of the planetary motions. Solve problems of central orbits and planetary motion.

Recommended Text Books:

1. R. S. Varma (1962). *A Text Book of Statics*. Pothishala Pvt. Ltd.
2. P.L. Srivastava (1964). *Elementary Dynamics*. Ram Narain Lal, Beni Prasad Publishers Allahabad.
3. J. L. Synge & B. A. Griffith (1949). *Principles of Mechanics*. McGraw-Hill.
4. S.L. Loney (1995). *An Elementary Treatise on Statics*, Radha Publishing House.
5. S.L. Loney (2006). *An Elementary Treatise on the Dynamics of a Particle and of Rigid Bodies*. Read Books.
6. A. S. Ramsey (2009). *Statics*. Cambridge University Press.
7. A. S. Ramsey (2009). *Dynamics*. Cambridge University Press.
8. A.P. Roberts (2003). *Statics and Dynamics with Background in Mathematics*. Cambridge University Press.

M. Sc. Engineering Physics
Semester-V
Subject: Mathematics
(Course Type- Discipline Specific Elective, Course Code: MT-503)
Nomenclature: Mathematics practical-V
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. This course has two components, Problem Solving and Practical using LATEX software.
2. The examiner will set 4 questions at the time of practical examination asking two questions from the part (a) and two questions from the part (b) by taking course outcomes (COs) into consideration.
3. The examinee will be required to solve one problem from the part (a) and to execute one program successfully from the part (b). Equal weightage will be given to both the parts.
4. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.
5. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

c) **Problem Solving**- Questions related to the following problems will be solved and record of those will be maintained in the Practical Notebook:

Linear Algebra;

1. Practical problems to obtain basis by extending a given set of linearly independent set of vectors.
2. Practical problems to determine matrix representation of a linear transformation and to determine its rank and nullity.
3. Practical problems to determine Eigen Values & Eigen Vectors of a Linear Transformation.
4. Practical problems to find Dual of a Vector Space.
5. Practical problems to determine minimal polynomial of a linear transformation.
6. Practical problems to find orthogonal basis using Gram-Schmidt orthogonalisation

process.

7. Practical problems to diagonalise symmetric matrices.
8. Practical problems to determine Jordan Canonical Form of a matrix.

OR

PDE and Integral Transforms;

1. Practical problems to reduce PDEs into canonical form and then solving those.
2. Practical problems of finding the characteristics of second order partial differential equations.
3. Practical problems to solve PDEs with Monge's method.
4. Practical problems to solve wave equation (one and two dimensional).
5. Practical problems to solve Laplace equation.
6. Practical problems to solve heat equation.
7. Practical problems to solve differential equations by Laplace transform method.
8. Practical problems to solve differential equations by Fourier transform method.

d) **LATEX Practicals**- Following practicals of typing documents using LATEX software will be done and records of those will be maintained in the practical notebook and the candidates will be asked by the examiner to type a document using more than one of these listed commands at the time of Semester end practical examination:

1. Create a new file in the work directory with the name note1.tex and to write a simple document in latex using following commands:

```
\documentclass [a4paper, 12pt]{article}
\begin{document}
A paragraph of text
\end{document}
```

2. Create a document to write code for a title page using \title{...}, \author{...}, \date{...}, \today{...}, \maketitle {...} commands and \emph{...}, \texbf{...}, \texit{...} etc. commands.

3. Create a document to write a code to using \section{...}, \subsection{...}, \subsubsection{...}, \paragraph{...}, \subparagraph{…} commands and using environments to left justify, right justify, center and justify text.

4. Create a document to illustrate Latex commands for paper size, font size, font types and styles.
5. Create a document involving the mathematical equations.

   Use of $...$ and $$...$$ symbols and use of Power and Indices(^, _), Fractions(\frac{numerator}{denominator}), Roots(\sqrt{...}, \sqrt[…]{...}), Sums (\sum_{…}^{…}{…}), Product (\prod_{…}^{…}{…}), Integral (\int_a^b f(x) dx) within $...$ or $$...$$ symbols.
5. Use of commands for Greek letters and the commands \Re, \Im, \partial, \infty, \forall, \exists, \prime, \emptyset, \nabla, \surd,\parallel, \angle, \triangle, \backslash, \div, \vee, \wedge, \cap, \cup, \propto, \perp, \cong for Mathematical symbols and operations.
6. Use of \pm, \mp, \setminus, \cdot, \times,\ast, \hat, \bar,\dot, \ddot, \vec, \leq, \geq, \subset, \supset, \subseteq, \supseteq, \in, \neq,\equiv, \sim, \simeq, \approx commands for mathematical symbols and operators.
7. Create a document to produce equations using \begin{equation} … \end{equation} command and involving mathematical symbols, Greek letters and fractions.
8. Create a Latex document to illustrate the effect of enumerate listing and itemize listing.

Course Outcomes: This course will enable the students to:

1. Attain practical skills to solve problems of Linear Algebra

   OR
1. Attain practical skills to solve problems of Partial Differential Equations.
2. Have hands-on skills to type a document using LATEX software. Learn LATEX commands to create document and its type, sections; paper size, font type, size and styles; type mathematical and Greek symbols, mathematical equations and item listing.

M. Sc. Engineering Physics
Semester – V
Subject: Chemistry
(Course Type- Discipline Specific Elective, Course Code: CH-501(A))
Nomenclature: Heterocyclic and photochemistry
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section A

Heterocyclic compounds

Recapitulation of concept of Molecular orbital picture and aromatic characteristics of pyrrole, furan, thiophene and pyridine. Comparison of basicity of pyridine, piperidine and pyrrole. Mechanism of nucleophilic substitution reactions in pyridine derivatives.Introduction to condensed five and six-membered heterocycles. Preparation and reactions of indole, quinoline and isoquinoline with special reference to Fisher indole synthesis, Skraup synthesis and Bischler-Napieralski synthesis. Mechanism of electrophilic substitution reactions of, quinoline and isoquinoline.

(15 Hrs.)

Section B

Photochemistry:

Interaction of radiation with matter, difference between thermal and photochemical processes. Laws of photochemistry: Grotthus-Draper law, Stark-Einstein law (law of photochemical equivalence), Jablonski diagram depicting various processes occurring in the excited state, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing), quantum yield, photosensitized reactions-energy transfer processes (simple examples), chemiluminescence. Brief introduction and description of photochemical reactions of simple carbonyl compounds, alkenes and aromatic compounds, Barton Reaction, Hofmann-Loffler-Freytag reaction

(15 Hrs.)

Course Outcomes:

CO1: Knowledge about condensed five and six-membered heterocyclic rings, basicity of pyridine, piperidine and pyrrole and the preparation and reactions of indole, quinoline and isoquinoline

CO2: Basic information of photochemistry and laws of photochemistry

CO3: To learn about Phosphorescence and fluorescence

Reference Books:

- Seymour, R.B. & Carraher, C.E. *Polymer Chemistry: An Introduction,* Marcel Dekker, Inc. New York, 1981.
- Odian, G. *Principles of Polymerization*, 4th Ed. Wiley, 2004.
- Billmeyer, F.W. *Textbook of Polymer Science,* 2nd Ed. Wiley Interscience, 1971.
- Ghosh, P. *Polymer Science & Technology*, Tata McGraw-Hill Education, 1991.
- K.K Rohatgi, Mukherjee,*Fundamentals of Photochemistry* , New Age International
- Pradeep's organic chemistry, Volume III.
- R Chand, organic chemistry, Volume III.
- Modern publications, organic chemistry, Volume III.
- New Age International (P) Ltd, Publishers, Volume III

M. Sc. Engineering Physics
Semester – V
Subject: Chemistry
(Course Type- Discipline Specific Elective, Course Code: CH-501(B))
Nomenclature: Bio-organic Chemistry
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

SECTION A

Nucleic Acids

Components of Nucleic acids: Adenine, guanine, thymine and Cytosine (Structure only), other components of nucleic acids, Nucleosides and nucleotides (nomenclature), Structure of polynucleotides; Structure of DNA (Watson-Crick model)

Peptides and Proteins

Structural and functional classification of proteins. Primary & Secondary structures of peptides and proteins,Tertiary and Quaternary structure of proteins. Synthesis of simple peptides (upto dipeptides) by N-protection (t-butyloxycarbonyl and phthaloyl) & C-activating groups and Merrifield solid phase synthesis

15Hrs

SECTION B

Lipids

Introduction to lipids and their classification. Waxes-Introduction, structure and functions of bees wax, wool Wax, spermaceti wax, carnauba wax. Fatty acid classification-cis and trans fatty acid, saturated and unsaturated fatty acid, Essential fatty acids and their functions, Structure and functions of triacylglycerol and sphingolipids. Fluid mosaic model of cell membrane.

Concept of Energy in Biosystems

Calorific value of food. Standard caloric content of carbohydrates, proteins and fats. Oxidation of foodstuff (organic molecules) as a source of energy for cells. Introduction to Metabolism (catabolism, anabolism), ATP: the universal currency of cellular energy, ATP hydrolysis and free energy change.

15hrs

Course Outcomes

CO1: Know about nucleic acids, nucleosides and nucleotides

CO2: Structure of DNA and RNA

CO3: Know about concept of lipids and their classification

CO4: Have knowledge about Structural and functional classification of proteins

Reference Books:

-

M. Sc. Engineering Physics
Semester – V
Subject: Chemistry
(Course Type- Discipline Specific Elective, Course Code: CH-502(A))
Nomenclature: Organometallic chemistry, Inorganic polymers and Quantum mechanics
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

SECTION-A

Organometallic chemistry **15 hrs**

Definition, classification and nomenclature of organometallic compounds, preparation, properties and bonding of alkyls of Li, Al, Hg and Sn, concept of hapticity of organic ligand, Structure and bonding in metal-ethylenic complexes, Structure of Ferrocene, classification in metal carbonyls, preparation, properties and bonding in mononuclear carbonyls

Silicones and Phosphazenes

Nomenclature, classification, prepration and uses of silicones, elastomers, polysiloxane copolymers, poly phosphazenes and bonding in triphosphazene.

SECTION-B

Quantum Mechanics-II

To show quantum mechanically that position and momentum cannot be predicated simultaneously, Extension of Schrödinger wave equation to two and three dimensional boxes, separation of variables, probability distribution, energy, degeneracy.

Qualitative treatment of simple harmonic oscillator model of vibrational motion:Setting up of Schrödinger equation and discussion of solution and wavefunctions.Vibrational energy of diatomic molecules and zero-point energy.

Angular momentum: Commutation rules, quantization of square of total angular momentum and z-component.

Rigid rotator model of rotation of diatomic molecules. Schrödinger equation,transformation to spherical polar coordinates. Separation of variables. Spherical harmonics. Discussion of solution.

Course Outcomes:

CO1: To study the nomenclature, classification, preparation and bonding in organometallic compounds and of metal carbonyls also.

CO2: To know about various inorganic clusters compounds with special reference to silicones and phosphazenes

CO3: To have sound knowledge about the concepts of dual nature of matter and its applications to obtain Schrödinger wave equation and angular momentum

CO4: To solve Schrödinger equation for a particle present in various systems viz., two and three-dimensional boxes, harmonic oscillator and rigid rotator

Reference books

- B. R. Puri, Madan S. Pathania , L. R. Sharma*Principles of Physical Chemistry* Vishal Publications
- Chandra, A. K. *Introductory Quantum Chemistry*Tata McGraw-Hill (2001).
- House, J. E. *Fundamentals of Quantum Chemistry* 2nd Ed. Elsevier: USA(2004).
- Lowe, J. P. & Peterson, K. *Quantum Chemistry*, Academic Press (2005).
- Pradeep's organic chemistry, Volume II and III.
- R Chand, organic chemistry, Volume III.
- Modern publications, organic chemistry, Volume II andIII.
- New Age International (P) Ltd, Publishers, Volume II and III

M. Sc. Engineering Physics
Semester – V
Subject: Chemistry
(Course Type- Discipline Specific Elective, Course Code: CH-502(B))
Nomenclature: Applied chemistry
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-
1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

SECTION-A (15Hrs.)

Bio inorganic chemistry

Metal ions present in biological system, classification on the basis of action (essential, non essential, trace, toxic), Metalloporphyrins with special reference to haemoglobin and myoglobin. Biological role of Na+, K+, Ca+2, Mg+2, Fe+2 ions, Cooperative effect, Bohr effect.

Acids and Bases

Arrhenius, Bronsted-lowry, Lux-flood, solvent system and Lewis concept of acids and bases, relative strength of acids and bases, levelling solvents, hard and soft acids and bases(HSAB), Applications of HSAB principle.

SECTION-B (15Hrs.)

Chemical Bonding

Chemical bonding: Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations.

Spectroscopy-II

Electronic spectroscopy: Franck-Condon principle, electronic transitions, singlet and triplet states, fluorescence and phosphorescence, dissociation and predissociation,calculation of electronic transitions of polyenes using free electron model.

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

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

Course Outcomes:

CO1: To know about basic concepts of bioinorganic chemistry with reference to metal ions present in biological systems

CO2: To study the biochemistry of dioxygen carriers especially hemoglobin and myoglobin

CO3: Introduce the concept of acids and bases to the students and also able to explain the various theories associated with them

CO4: To understand and apply valence bond and molecular orbital approaches to the treatment of hydrogen molecule and its ion

CO5: To have sound knowledge of the concept of interaction of electromagnetic radiation with matter and to be able to describe electronic, NMR and ESR spectra of various molecules

Reference Books:

- Pradeep's organic chemistry, Volume II and III.
- R Chand, organic chemistry, Volume III.
- Modern publications, organic chemistry, Volume II and III.
- New Age International (P) Ltd, Publishers, Volume III

M. Sc. Engineering Physics
Semester-V
Subject: Chemistry
(Course Type- Discipline Specific Elective, Course Code: CH-503)
Nomenclature: Chemistry practical-V
Credits: 2

Max. Marks: 50
Time: 6 hrs.

Special Note: -

The Practical examination will be held in two sessions of 3 hours each & the students are required to perform two experiments during the examination.

Distribution of Marks:

Experiment	15+15 marks
Viva- voce	5+5 marks
Lab Record	10 marks
Total	50 marks

Semimicro qualitative analysis of mixture containing not more than four radicals (excluding interfering, Combinations and insoluble's): Pb^{2+}, Hg^{2+}, Hg_2^{2+}, Ag^{+}, Bi^{3+}, Cu^{2+}, Cd^{2+}, As^{3+}, Sb^{3+}, Sn^{2+}, Fe^{3+}, Cr^{3+}, Al^{3+}, Co^{2+}, Ni^{2+}, Mn^{2+}, Zn^{2+}, Ba^{2+}, Sr^{2+}, Ca^{2+}, Mg^{2+}, NH_4^{+}, CO_3^{2-}, S^{2-}, SO_3^{2-}, $S_2O_3^{2-}$, NO^{2-}, CH_3COO^{-}, Cl^{-}, Br^{-}, I^{-}, NO^{3-}, SO_4^{2-}, $C_2O_4^{2-}$, PO_4^{3-}, BO_3^{3-}

Thin Layer Chromatography

(Determination of R_f values and identification of organic Compounds) Separation of a mixture of coloured organic compounds using common organic solvents.

Find out the temporary and permanent hardness in given water sample by EDTA method.

Course Outcomes:

CO1: To analyze the given inorganic mixture qualitatively for various cations and anions present in them

CO2: Able to determine R_f values

CO3: Identification of organic compounds

CO4: Able to perform thin layer chromatography to separate various components present in the Mixture, determination of hardness of water.

M. Sc. Engineering Physics
Semester – VI
Subject: Chemistry
(Course Type-Skill Enhancement, Course Code: SEC-601(A))
Nomenclature: Clinical chemistry
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

SECTION A

Definition, uses and side effects of the following categories of drugs:

Antipyretics, analgesics & anti-inflammatory agents (paracetamol, asprin, mefenamic acid, ibuprofen and diclofenac); **Anti-tussive and expectorant** (dextromethorphan, bromhexene); **Decongestant** (Theophyline, pseudoephedrine, phenylpropanolamine); **Anti-alergic** (Citrizine, diphenhydramine); **Antiasthematic** (prednisone, budesonide)**; Antibacterial drugs** (ampicillin, amoxycillin, doxycycline, cephalexin, ciprofloxacin)**; antimalarial** (Chloroquine, cloroguanide),

Anti-amoebic (Metronidazole, tinidazole)**;Anthelmintic and anti-parasitic** (Mebendazole, Albendazole)**; Anticancer** (Chlorambucil, cyclophosphamide**), Antihypertensive** (amlodepin, atenolol)**; Cardiovascular drugs** (sorbitrate, diltiazem),

SECTION B

Common clinical chemistry tests: Normal range and significance of following clinical tests

Electrolytes (Sodium, Potassium, Chloride**), Renal (Kidney) Function Tests** (Creatinine, Blood urea nitrogen)**, Liver Function Tests** (Total protein (serum), Bilirubin; direct; indirect; total)**, Cardiac Markers, Minerals** (Calcium, Magnesium, Phosphate, Potassium)**, Blood Disorders** (Iron, Vitamin B12, Vitamin D, Folic acid), **Miscellaneous** (Glucose, Glycosylated hemoglobin, Uric acid)

Nutritional Chemistry: Fat soluble and water soluble vitamins (Sources, recommended levels and deficiency diseases; vitamin A, vitamin B_{1}, vitamin B_{2}, vitamin B_{3}, vitamin B_{5}, vitamin B_{6}, vitamin B_{7}, vitamin B_{9}, vitamin B_{12}, vitamin C, vitamin D, vitamin E, and vitamin K), **Reference Daily Intake and Roles in biological processes of following essential**

dietary minerals (Major minerals- calcium, phosphorus, potassium, sodium, and magnesium; Trace elements-sulfur, iron, chlorine, cobalt, copper, molybdenum, iodine, and selenium)

Course Outcomes:

CO1: To have a knowledge about different categories of drugs their uses and side effects

CO2: To know sources, recommended levels and deficiency diseases of fat soluble and water soluble vitamins

CO3: To get knowledge Reference Daily Intake and Roles in biological processes of following essential dietary minerals

Recommended Text Books:

1. Medicinal chemistry by Ashutosh kar
2. Medicinal chemistry by D. sriram and P. yogeeshwari
3. Berdanier, Carolyn D.; Dwyer, Johanna T.; Heber, David. Handbook of Nutrition and Food, Third Edition. CRC Press.
4. The vitamins: fundamental aspects of nutrition and health; G. F. Combs jr. and G.F. combs Sr, Academic press

M. Sc. Engineering Physics
Semester – VI
Subject: Chemistry
(Course Type-Skill Enhancement, Course Code: SEC-601(B))
Nomenclature: Chemistry lab- maintenance and handling
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section A (15hrs.)

Familiarization with chemical labeling, Handling of hazardous chemicals, Handling of glassware

Sodium metal disposal, Familiarization with chemical concepts related to solution preparation and standardization: Equivalent mass, molar mass, specific gravity, concentration (Normality, Molarity, Molality, %w/v, %w/w, %v/v, ppm, ppb solutions), Basicity, acidity, solutions of oxidizing and reducing agents. Determination of concentration and percentage purity. Standardization of solutions, Knowledge about primary and secondary standards.

Knowledge about indicators and preparation of indicator solutions, Knowledge about buffers and preparation of buffer solutions, Preparation of complexometric solutions (e.g. EDTA solutions) and titrations, Management of chemical waste.

Section B (15hrs.)

Purification of chemicals through distillation, crystallization, sublimation etc. Operating knowledge including calibration, handling and maintenance of Potentiometers. Knowledge about different electrodes (e.g. Ag, Pt, SCE, Ag|AgCl) and their upkeep, Operating knowledge including calibration and maintenance of pH-meters and glass electrode, Operating knowledge including calibration and maintenance of refractometer, polarimeter, Operating knowledge including calibration and maintenance of conductometer, Operating knowledge including calibration and maintenance of Flame-photometer, Spectrophotometer, Interferometer, Dipole meter

Course Outcomes:

CO1: Have basic knowledge about chemicals and instruments present in the chemistry lab and also their handling and maintenance

CO2: Able to know about different concept of preparations of solution, indicators and buffer solutions in chemistry lab.

CO3: To know about various methods for the purification of various chemicals used in the lab

CO4: Have knowledge about the calibration, handling and maintenance of various instruments used in the chemistry laboratory

Reference Books:

- A text book of qualitataive analysis by A.I. Vogel
- A text book of quantitative analysis by A. I. vogel

M. Sc. Engineering Physics
Semester-VI
Subject: Physics
(Course Type-Discipline Specific Elective, Course Code: EP-601(A))
Nomenclature: Atomic & Molecular Spectroscopy
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

HISTORICAL BACKGROUND OF ATOMIC SPECTROSCOPY

Introduction of early observations, emission and absorption spectra, atomic spectra, wave number, spectrum of Hydrogen atom in Balmer series, Bohr atomic model(Bohr's postulates) , spectra of Hydrogen atom , explanation of spectral series in Hydrogen atom, un-quantized states and continuous spectra, spectral series in absorption spectra, effect of nuclear motion on line spectra (correction of finite nuclear mass), variation in Rydberg constant due to finite mass, short comings of Bohr's theory, Wilson sommerfeld quantization rule, de-Broglie interpretation of Bohr quantization law, Bohr's corresponding principle, Sommerfeld's extension of Bohr's model, Sommerfeld relativistic correction, Short comings of Bohr-Sommerfeld theory, Vector atom model**;** space quantization, electron spin, coupling of orbital and spin angular momentum, spectroscopic terms and their notation, quantum numbers associated with vector atom model, transition probability and selection rules.

(15 Lectures)

UNIT-II

VECTOR ATOM MODEL (SINGLE VALANCE ELECTRON)

Orbital magnetic dipole moment (Bohr megnaton), behavior of magnetic dipole in external magnetic filed; Larmors' precession and theorem Penetrating and Non-penetrating orbits, Penetrating orbits on the classical model**;** Quantum defect, spin orbit interaction energy of the single valance electron, spin orbit interaction for penetrating and non-penetrating orbits. quantum mechanical relativity correction, Hydrogen fine spectra, Main features of Alkali Spectra and their theoretical interpretation, term series and limits, Rydeburg-Ritze combination principle, Absorption spectra of Alkali atoms. observed doublet fine structure in the spectra of alkali metals and its Interpretation, Intensity rules for doublets, comparison of Alkali spectra and Hydrogen spectrum .

(15 Lectures)

UNIT-III

VECTOR ATOM MODEL (TWO VALANCE ELECTRON)

Essential features of spectra of Alkaline-earth elements, Vector model for two valance electron atom: application of spectra. Coupling Schemes;LS or Russell – Saunders Coupling Scheme and JJ coupling scheme, Interaction energy in L-S coupling (sp, pd configuration), Lande interval rule, Pauli principal and periodic classification of the elements. Interaction energy in JJ Coupling (sp, pd configuration), equivalent and non-equivalent electrons, Two valance electron system-spectral terms of non-equivalent and equivalent electrons, comparison of spectral terms in L-S And J-J coupling. Hyperfine structure of spectral lines and its origin; isotope effect, nuclear spin.

(15 Lectures)

UNIT-IV

ATOM IN EXTERNAL FIELD

Zeeman Effect (normal and Anomalous),Experimental set-up for studying Zeeman effect, Explanation of normal Zeeman effect(classical and quantum mechanical), Explanation of anomalous Zeeman effect(Lande g-factor), Zeeman pattern of D1 and D2 lines of Na-atom, Paschen-Back effect of a single valence electron system. Weak field Stark effect of Hydrogen atom.

MOLECULAR PHYSICS

General Considerations, Electronic States of Diatomic Molecules, Rotational Spectra (Far IR and Microwave Region), Vibrational Spectra (IR Region), Rotator Model of Diatomic Molecule, Raman Effect, Electronic Spectra.

(15 LECTURES)

CO No.	**Course code (EP-601(A)) : Atomic & Molecular spectroscopy** **After successfully completing the course, student will be able to:**
CO-1	Acquire knowledge about the historical background and developments of atomic spectroscopy through the study of spectral series in Hydrogen atom, effect of nuclear motion on line spectra (correction of finite nuclear mass), short comings of Bohr's theory, Wilson sommerfeld quantization rule, Sommerfeld's extension of Bohr's model, Sommerfeld relativistic correction, Short comings of Bohr-Sommerfeld theory and finally Vector atom model.
CO-2	Understand and explain the vector atom model, various coupling schemes and atomic spectra of one and two electron atoms.
CO-3	Explain the influence on the spectra of atoms in the presence of external applied electric and magnetic field i.e. Zeeman effect, Paschen-Back effect, Stark effect.
CO-4	Have basic idea about the rotational, vibrational and rotational-vibrational spectra of diatomic molecules and basic idea of Raman Effect.

REFERENCES

1. Concept of Modern Physics (1987), A. Beiser, Mc Graw Hill Co Ltd. New Delhi
2. Atomic Physics (2007), J.B. Rajab, S Chand & Co, New Delhi
3. Atomic Physics Vol II (1991), J.H. Fewkes and J. Yarwood, Oxford University Press
4. Physics of Atoms and Molecules 2^{nd} Ed (2009), B.H.Bransden and C.J. Joachain, Pearson Education, New Delhi
5. Fundamental of Molecular Spectroscopy,Colin N. Banwell and Elaine M. McCash, McGraw Hill Co Ltd. New Delhi
6. Atomic and Nuclear Physics Vol I (1996) S.N. Ghoshal, S. Chand & Com., New Delhi
7. Atomic and Nuclear Physics (1982), K. Gopalkrishnan, Mc Millan India, New Delhi
8. Elements of Spectroscopy S.L.Gupta, V. Kumar and R.C.Sharma, Pragati Prakashan, Meerut.

M. Sc. Engineering Physics
Semester-VI
Subject: Physics
(Course Type-Discipline Specific Elective, Course Code: EP-601(B))
Nomenclature: Elements of Modern Physics
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

UNIT-I

INTRODUCTION TO MODERN PHYSICS

Planck's quantum, Planck's constant and light as a collection of photons; Photo-electric effect and Compton scattering, De Broglie wavelength and matter waves; Davisson Germer experiment, Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra.

(15 Lectures)

UNIT-II

HEISENBERG UNCERTAINTY PRINCIPLE AND SCHRODINGER WAVE EQUATION

Position measurement-gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle- impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave function, probabilities and normalization; Probability and probability current densities in one dimension.

(15 Lectures)

UNIT-III

APPLICATION OF SCHRODINGER WAVE EQUATION

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension -across a step potential and across a rectangular potential barrier, Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.

(15 Lectures)

UNIT-IV

BASIC CONCEPT IN NUCLEAR PHYSICS

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α-decay; β-decay-energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission. Fission and fusion, mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with U^{235} Fusion and thermonuclear reactions. **(15 LECTURES)**

CO No.	Course code (EP-601(B)) : Elements of Modern Physics
	After successfully completing the course, student will be able to:
CO-1	Know main aspects of the inadequacies of classical mechanics and understand historical development of quantum mechanics and ability to discuss and interpret experiments that reveal the dual nature of matter.
CO-2	Understand the theory of quantum measurements, wave packets and uncertainty principle.
CO-3	Understand the central concepts of quantum mechanics: wave functions, momentum and energy operator, the Schrodinger equation, time dependent and time independent cases, probability density and the normalization techniques, skill development on problem solving e.g. one dimensional rigid box, tunneling through potential barrier, step potential, rectangular barrier.
CO-4	Understanding the properties of and structure of atomic nuclei, liquid drop model and nuclear shell model and mass formula. Acquire the ability to calculate the decay rates and lifetime of radioactive decays like alpha, beta, gamma decay.

REFERENCES

1. Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
2. Modern Physics, John R. Taylor, Chris D. Zafiratos, Michael A.Dubson,2009, PHI Learning
3. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003, McGraw Hill
4. Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
5. Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning.
9. Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill

M. Sc. Engineering Physics
Semester-VI
Subject: Physics
(Course Type-Discipline Specific Elective, Course Code: EP-602(A))
Nomenclature: Digital and Analog Circuits & Instrumentation
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

UNIT-I

DIGITAL CIRCUITS

Difference between Analog and Digital Circuits, Binary Numbers, Decimal to Binary and Binary to Decimal Conversion, Logic Gates: AND, OR and NOT (Their realization using Diodes and Transistor), NAND and NOR Gates as Universal Gates, XOR and XNOR Gates. De Morgan's Theorems, Boolean Laws, Simplification of Logic Circuit using Boolean Algebra. Fundamental Products: Minterms and Maxterms. Conversion of a Truth Table into an Equivalent Logic Circuit by (i) Sum of Products Method and (ii) Karnaugh Map.

(15 Lectures)

UNIT-II

COMBINATIONAL LOGIC CIRCUITS

Binary Addition, Binary Subtraction (using 2's Complement Method). Half Adders and Full Adders, and Subtractors, 4-bit binary Adder-Subtractor. Decoder: Binary-coded-decimal (BCD) system, BCD-to-decimal decoder, Demultiplexer: 4-to-16 line decoder, decoder/lamp driver, Multiplexer (Data selector): Applications- Parallel to serial conversion, sequential data selection; Encoders. Seven segment Display, BCD-to-seven segment decoder.

(15 Lectures)

UNIT-III

OPERATIONAL AMPLIFIERS (BLACK BOX APPROACH)

Characteristics of an Ideal and Practical Op-Amp (IC 741), Open-loop & Closed-loop Gain. CMRR, concept of Virtual ground. Applications of Op-Amps: (i) Inverting and Non-inverting Amplifiers, (ii) Adder, (iii) Subtractor, (iv) Differentiator, (v) Integrator, (vi) Zero Crossing Detector (vii) Electronic analog computation (viii) Square wave generator (ix) Triangular wave generator.

(15 Lectures)

UNIT-IV

INSTRUMENTATIONS

Digital to analog converters: Weighted resistor type D/A converter, Ladder type D/A converter; Analog to Digital converter. Timer IC: IC 555 Pin diagram and its application as Astable & Monostable Multivibrator. Introduction to CRO: Block diagram of CRO, Applications of CRO (i) Study of Waveform (ii) Measurement of Voltage, Current, Frequency and Phase Difference.

(15 Lectures)

CO No.	**Course code (EP-602(A)) : Digital and Analog Circuits & Instrumentation** **After successfully completing the course, student will be able to:**
CO-1	Difference between analog and digital circuits and acquire knowledge about number systems, their interconversions, Basic logic gates, synthesis of circuits using Boolean algebra and Conversion of a Truth Table into an Equivalent Logic Circuit by (i) Sum of Products Method and (ii) Karnaugh Map.
CO-2	Understand and explain about the various Combinational digital systems like Half adders, full adders, BCD-to-decimal decoder, Demultiplexer, Multiplexer etc. and also be able to appreciate the applications of these devices.
CO-3	Realize the basics characteristics and implementation of operational amplifier for various applications like addition, subtraction, differentiation, integration, Waveform generator-square wave generator.
CO-4	Acquire knowledge about digital to analog and analog to digital signal conversion. Also understand the working and application of CRO.

REFERENCES

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronic devices and circuits, S. Salivahanan and N. Suresh Kumar, 2012, Tata Mc-Graw Hill.
3. Microelectronic Circuits, M.H. Rashid, 2^{nd} Edn.,2011, Cengage Learning.
4. Modern Electronic Instrumentation & Measurement Tech., Helfrick & Cooper, 1990, PHI Learning.
5. Digital Principles & Applications, A.P. Malvino, D.P. Leach & Saha, 7th Ed., 2011,Tata Mc-Graw Hill
6. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
7. Fundamentals of Digital Circuits, A. Anand Kumar, 2nd Edition, 2009, PHI Learning Pvt. Ltd.
8. OP-AMP and Linear Digital Circuits, R.A. Gayakwad, 2000, PHI Learning Pvt. Ltd.

M. Sc. Engineering Physics
Semester-VI
Subject: Physics
(Course Type-Discipline Specific Elective, Course Code: EP-602(B))
Nomenclature: Embedded System: Introduction to Microcontroller
No. of credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

UNIT-I

EMBEDDED SYSTEM ITRODUCTION, DESIGN & DEVELOPMENT

Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems, challenges and design issues in embedded systems, operational and non-operational quality attributes of embedded systems, Embedded system design and development: Embedded system development environment, file types generated after cross compilation, disassembler/ decompiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry.

(15 Lectures)

UNIT-II

REVIEW OF MICROPROCESSORS

Organization of Microprocessor based system, 8085μp pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts. 8051 microcontroller: Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Data types and directives, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.

(15 Lectures)

UNIT-III

8051 I/O PORT PROGRAMMING

Introduction of I/O port programming, pin out diagram of8051 microcontroller, I/O port pins description and their functions, I/O port programming in 8051, (Using Assembly Language), I/O programming: Bit manipulation. Programming of 8051: 8051 addressing modes and accessing memory using various addressing modes, assembly language instructions using each addressing mode, arithmetic & logic instructions, 8051 programming in C:- for time delay and I/O operations and manipulation, for arithmetic & logic operations, for ASCII and BCD conversions.

(15 Lectures)

UNIT-IV

TIMER AND COUNTER PROGRAMMING

Programming 8051 timers, counter programming. SERIAL PORT PROGRAMMING WITH AND WITHOUT INTERRUPT: Introduction to 8051 interrupts, programming timer interrupts, programming external hardware interrupts and serial communication interrupt, interrupt priority in the 8051. INTERFACING 8051 MICROCONTROLLER TO PERIPHERALS: Parallel and serial ADC, DAC interfacing, LCD interfacing. PROGRAMMING EMBEDDED SYSTEMS: Structure of embedded program, infinite loop, compiling, linking and locating, downloading and debugging.

(15 LECTURES)

CO No.	**Course code (EP-602(B)) : Embedded System: Introduction to Microcontroller** **After successfully completing the course, student will be able to:**
CO-1	Acquire knowledge about the embedded systems including its generic architecture, design and classifications, Embedded processors and microcontrollers.
CO-2	Learn about the organization of intel microprocessor 8085, its architecture, pin diagram, timing diagram, instruction set and programming in assembly language.
CO-3	Understand the organization of Intel 8051 microcontroller, its architecture, instruction set, programming and its memory organization, timing diagram and Input/output operations and manipulation for arithmetic and logical operations.
CO-4	Acquire knowledge about programming with and without interrupt service request. Interfacing parallel and serial ADC and DAC.

REFERENCES

1. Embedded Systems: Architecture, Programming & Design, R. Kamal, 2008, Tata McGraw Hill
2. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
3. Embedded Microcomputer System: Real Time Interfacing, J.W. Valvano, 2000, Brooks/Cole
4. Embedded Systems and Robots, Subrata Ghoshal, 2009, Cengage Learning
5. Introduction to embedded system, K.V. Shibu, 1st Edition, 2009, McGraw Hill
6. Microcontrollers in practice, I.Susnea and M.Mitescu, 2005, Springer.
7. Embedded Systems: Design & applications, 1/e S.F. Barrett, 2008, Pearson Education India
8. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011,Cengage Learning

M. Sc. Engineering Physics
Semester-VI
Subject: Physics
(Course Type-Discipline Specific Elective, Course Code: EP-603(A))
Nomenclature: PHYSICS PRACTICAL-VI (A)
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. Do any eight experiments from the given list of experiments.
2. The students are required to perform and calculate the error involved in a particular experiment in the final examination.
3. The Practical examination will be held in single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

LIST OF EXPERIMENTS

1. Determination of specific charge (e/m) by Thomson method.
2. To find Plank's constant.
3. Rydberg Constant by Hydrogen gas spectrum.
4. To determine the ionization potential of mercury.
5. To study the absorption spectra of iodine and to determine its dissociation energy.
6. To design a CB & CE amplifier of a given gain (mid-gain) using voltage divider bias.
7. To measure (a) Voltage, and (b) Frequency of a periodic waveform using a CRO
8. To verify and design AND, OR, NOT and XOR gates using NAND gates.
9. To minimize a given logic circuit. 4. Half adder, Full adder and 4-bit Binary Adder.
10. Adder-Subtractor using Full Adder I.C.
11. To study IV characteristics of PN diode, Zener and Light emitting diode
12. To design an inverting amplifier of given gain using Op-amp 741 and study its frequency response.
13. To design a non-inverting amplifier of given gain using Op-amp 741 and study its Frequency Response.
14. To study a precision Differential Amplifier of given I/O specification using Op amp.
15. To investigate the use of an op-amp as a Differentiator
16. To design a Wien Bridge Oscillator using an op-amp.

CO No.	Course code (EP-603A) : PHYSICS PRACTICAL-VI(A)
	After successfully completing the course, student will be able to:
CO-1	Perform experiments to determine specific charge (e/m) by Thomson method, Plank's constant, Rydberg Constant etc.
CO-2	Perform experiments to realize the applications of different analog and digital devices like Operational amplifier, basic logic gates, Half & Full adders/Subtractors, Zener and Light emitting diode etc.
CO-3	Design and study CB & CE amplifier and also be able to carry out the Measurement of voltage and frequency of a periodic waveform using CRO.
CO-4	Have in-depth knowledge about the electronic circuit fundamentals, making of electrical connections and handling of instruments.

REFERENCES

1. B.Sc. Practical Physics, C.L. Arora, S. Chand Publisher, New Delhi.
2. Advanced Level Practical Physics, M. Nelkon and Ogborn, Henemann Education Books Ltd., New Delhi.
3. Practical Physics, S.S. Srivastava and M.K. Gupta, Atma Ram & Sons, Delhi.
4. Practical Physics , S.L. Gupta and V. Kumar, Pragati Prakashan Meerut.
5. Modern Approach to Practical Physics, R.K. Singla, Modern Publishers, Jalandhar.
6. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop,1971, Asia Publishing House.
7. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
8. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
9. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
10. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.

M. Sc. Engineering Physics
Semester-VI
Subject: Physics
(Course Type-Discipline Specific Elective, Course Code: EP-603(B))
Nomenclature: Physics Practical VI (B)
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. Do any eight experiments from the given list of experiments.
2. The students are required to perform and calculate the error involved in a particular experiment in the final examination.
3. The Practical examination will be held in single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

List of Experiments

1. To determine value of Boltzmann constant using V-I characteristic of PN diode.
2. To determine work function of material of filament of directly heated vacuum diode.
3. To determine value of Planck's constant using LEDs of at least 4 different colours.
4. To determine the ionization potential of mercury.
5. To determine the absorption lines in the rotational spectrum of Iodine vapour.
6. To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photo sensor and compare with incoherent source – Na light.
7. To determine the value of e/m by magnetic focusing.
8. To setup the Millikan oil drop apparatus and determine the charge of an electron.
9. To find that the given numbers is prime or not using 8051.
10. To find the factorial of a number using 8051.
11. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number using 8051.
12. Using 8051,Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's.
13. Using 8051; Program to glow first four LED then next four using TIMER application.
14. Program to rotate the contents of the accumulator first right and then left using 8051.
15. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard Using 8051.

CO No.	Course code (EP-603B) : Physics Practical-VI (B)
	After successfully completing the course, student will be able to:
CO-1	Perform experiments to determine value of Boltzmann constant, work function of material of filament of directly heated vacuum diode, ionization potential of mercury etc.
CO-2	Study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photo sensor and compare with incoherent source – Na light.
CO-3	Design, fabricate, test and run the programs using 8051 microprocessor.
CO-4	Learn the applications of embedded systems such as temperature measurement, acquiring some information on LCD display and interfacing a keyboard Using 8051.

REFERENCES

1. Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4. Embedded Systems: Architecture, Programming & Design, R. Kamal, 2008, Tata McGraw Hill
5. The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
6. Embedded Microcomputor System: Real Time Interfacing, J.W. Valvano, 2000, Brooks/Cole
7. Embedded System, B.K. Rao, 2011, PHI Learning Pvt. Ltd.
8. Embedded Microcomputer systems: Real time interfacing, J.W.Valvano 2011, Cengage Learning.

M. Sc. Engineering Physics
Semester – VI
Subject: Mathematics
(Course Type-Discipline Specific Elective, Course Code: MT-601(A))
Nomenclature: Real Analysis–II
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Riemann integral, Integrabililty of continuous and monotonic functions, The Fundamental theorem of integral calculus. Mean value theorems of integral calculus.

Unit-II:

Improper integrals and their convergence, Comparison tests, Abel's and Dirichlet's tests, Frullani's integral, Integral as a function of a parameter. Continuity, Differentiability and integrability of an integral of a function of a parameter.

UNIT-III:

Definition and examples of metric spaces, Open spheres and closed spheres, Neighbourhoods, Open sets, Interior, exterior and boundary points, Closed sets, Limit points and isolated points, Interior and closure of a set, Boundary of a set, Bounded sets, Distance between two sets, Diameter of a set, Subspace of a metric space. Cauchy and Convergent sequences, Completeness of metric spaces, Cantor's intersection theorem.

UNIT-IV:

Dense sets and separable spaces, Nowhere dense sets and Baire's category theorem, Continuous and uniformly continuous functions, Homeomorphism, Banach contraction principle.

Compact spaces, Sequential compactness, Bolzano−Weierstrass property, Compactness and finite intersection property, Heine−Borel theorem.Continuous functions on compact spaces.

Course Outcomes: This course will enable the students to:

1. Learn basic theory of Riemann integration. Learn fundamental theorem and mean value theorem of integral calculus.
2. Understand improper integrals and to have knowledge to test their convergence. Understand integral as a function of a parameter. Apply this knowledge for problem solving.
3. Understand concepts of metric spaces, sub spaces and their properties. Learn open, closed and bounded sets, interior and limit points , Cauchy sequence and completeness.
4. Learn dense sets, compact and separable metric spaces and related results. Learn important theorems viz. Baire's category theorem, Banach contraction principle, Bolzano–Weierstrass property, Heine–Borel theorem. Use this basic knowledge for life -long learning purposes.

Recommended Text Books:

1. T.M. Apostol: Mathematical Analysis, Narosa Publishing House, New Delhi, 1985
2. R.R. Goldberg : Real analysis, Oxford & IBH publishing Co., New Delhi, 1970
3. D. Somasundaram and B. Choudhary : A First Course in Mathematical Analysis, Narosa Publishing House, New Delhi, 1997
4. Shanti Narayan : A Course of Mathematical Analysis, S. Chand & Co., New Delhi
5. E. T. Copson (1988). *Metric Spaces*. Cambridge University Press.
6. P. R. Halmos (1974). *Naive Set Theory*. Springer.
7. P. K. Jain & Khalil Ahmad (2019). *Metric Spaces*. Narosa.
8. S. Kumaresan (2011). *Topology of Metric Spaces* (2^{nd} edition). Narosa.
9. Satish Shirali&Harikishan L. Vasudeva (2006). *Metric Spaces*. Springer-Verlag.
10. MicheálO'Searcoid (2009). *Metric Spaces*. Springer-Verlag.
8. G. F. Simmons (2004). *Introduction to Topology and Modern Analysis*. McGraw-Hill.

Semester – VI
Subject: Mathematics
(Course Type-Discipline Specific Elective, Course Code: MT-601(B))
Nomenclature: Complex Analysis
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Complex numbers and their representation, algebra of complex numbers; Complex plane, Open set, Domain and region in complex plane; Stereographic projection and Riemann sphere.

De Moivre's Theorem and its Applications. Expansion of trigonometrical functions. Direct circular and hyperbolic functions and their properties, Logarithm of a complex quantity, Summation of Trigonometric series.

Unit-II: Analytic Functions and Cauchy–Riemann Equations

Complex functions and their limits including limit at infinity; Continuity and differentiability of a complex valued function. Analytic functions; Cauchy–Riemann equations, Harmonic functions, necessary and sufficient conditions for differentiability. Analyticity and zeros of exponential, trigonometric and logarithmic functions.

Unit-III:

Line integral, Path independence. Branch cut and branch of multi-valued functions. Complex integration, Green's theorem, Anti-derivative theorem, Cauchy–Goursat theorem, Cauchy integral formula, Cauchy's inequality, Derivative of analytic function, Liouville's theorem, Fundamental theorem of algebra, Maximum modulus theorem and its consequences.

Unit-IV:

Sequences, series and their convergence, Taylor series and Laurent series of analytic functions, Power series, Radius of convergence, Integration and differentiation of power series, Absolute and uniform convergence of power series.

Course Outcomes: This course will enable the students to:

1. Visualize complex numbers as points of $\mathbb{R}^2$ and stereographic projection of complex plane on the Riemann sphere. Know De Moivre's Theorem and its Applications. Learn about trigonometric, circular and hyperbolic functions and their properties.
2. Understand the significance of differentiability and analyticity of complex functions leading to the Cauchy–Riemann equations. Apply knowledge to solve related problems.
3. Learn complex integration and other related concepts. Know and understand Green's theorem, Cauchy-Goursat theorem, Liouville's theorem in fundamental theorem of algebra, Maximum modulus theorem. Application of these results in problem solving.
4. Understand sequences, series and their convergence. Learn about Taylor series, Laurent series and Power series. Apply this knowledge to obtain series expansions of analytic functions.

Recommended Text Books:

1. Lars V. Ahlfors (2017). *Complex Analysis* (3rd edition). McGraw-Hill Education.
2. Joseph Bak & Donald J. Newman (2010). *Complex Analysis* (3rd edition). Springer.
3. James Ward Brown & Ruel V. Churchill (2009). *Complex Variables and Applications* (9th edition). McGraw-Hill Education.
4. John B. Conway (1973). *Functions of One Complex Variable*. Springer-Verlag.
5. E.T. Copson (1970). *Introduction to Theory of Functions of Complex Variable*. Oxford University Press.
6. Theodore W. Gamelin (2001). *Complex Analysis*. Springer-Verlag.
7. George Polya & Gordon Latta (1974). *Complex Variables*. Wiley.
8. H. A. Priestley (2003). *Introduction to Complex Analysis*. Oxford University Press.
8. E. C. Titchmarsh (1976). *Theory of Functions* (2nd edition). Oxford University Press.

M. Sc. Engineering Physics
Semester – VI
Subject: Mathematics
(Course Type-Discipline Specific Elective, Course Code: MT-602(A))
Nomenclature: Linear Programming
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Linear Programming Problems, Definition, objective function, constraints, Canonical and Standard forms. Graphical Approach for solving some Linear Programs, limitations of graphical method. Convex and polyhedral sets, Extreme points, Basic solutions, Basic Feasible Solutions, Correspondence between basic feasible solutions and extreme points.

Unit-II:

Theory of simplex method, concept of initial basic feasible solution, Optimality criterion, Improving a basic feasible solution, Unboundedness; Simplex algorithm and its tableau format; Artificial variables, Two-phase method, Big-*M* method.

Unit-III:

Formulation of the dual problem, Duality theorems, Unbounded and infeasible solutions in the primal, Solving the primal problem using duality theory.

Unit-IV:

Formulation of transportation problems, Methods of finding initial basic feasible solutions: North-west corner rule, Least cost method, Vogel approximation method, Algorithm for obtaining optimal solution; Formulation of assignment problems, Hungarian method.

Course Outcomes: This course will enable the students to:

1. Familiarize with terminology of linear programming problems (LPP) and all other associated concepts. Analyze and solve linear programming problems of real life situations. Obtain solution of linear programming problems with graphical method.
2. Understand the theory of Simplex method to solve linear programming problems. Application of knowledge of simplex algorithm in solving real life LPP by several methods.
3. Understand dual problems, duality theorem and to solve linear programming problems by making use of duality theorem. Use these tools for science and society.
4. Learn about transportation problems, their formulation and techniques to solve transportation and assignment problems. Attain skills to solve real life transportation problems by using specified methods.

Recommended Text Books:

1. Mokhtar S. Bazaraa, John J. Jarvis & Hanif D. Sherali (2010). *Linear Programming and Network Flows* (4th edition). John Wiley & Sons.
2. G. Hadley (2002). *Linear Programming*. Narosa Publishing House.
3. Frederick S. Hillier & Gerald J. Lieberman (2015). *Introduction to Operations Research* (10th edition). McGraw-Hill Education.
4. Hamdy A. Taha (2017). *Operations Research*: *An Introduction* (10th edition). Pearson.
5. Paul R. Thie & Gerard E. Keough (2014). *An Introduction to Linear Programming and Game Theory* (3rd edition). Wiley India Pvt. Ltd.

M. Sc. Engineering Physics
Semester – VI
Subject: Mathematics
(Course Type-Discipline Specific Elective, Course Code: MT-602(B))
Nomenclature: Probability and Statistics
No. of Credits: 3

Max. Marks: 75
Theory: 60
Internal Assessment: 15
Time: 3 hrs.

Note:-

1. The examiner will set 8 questions asking two questions from each unit by taking course outcomes (COs) into consideration.
2. The examinee will be required to attempt 5 questions, selecting at least one question from each unit.

Unit-I:

Basic notions of probability, Conditional probability and independence, Baye's theorem; Random variables - Discrete and continuous, Cumulative distribution function, Probability mass/density functions; Transformations, Mathematical expectation, Moments, Moment generating function, Characteristic function.

Unit-II:

Discrete distributions**:** Uniform, Bernoulli, Binomial, Negative binomial, Geometric and Poisson; Continuous distributions**:** Uniform, Gamma, Exponential, Chi-square, Beta and normal; Normal approximation to the binomial distribution.

Unit-III:

Joint cumulative distribution function and its properties, Joint probability density function, Marginal distributions, Expectation of function of two random variables, Joint moment generating function, Conditional distributions and expectations.

Unit-IV:

The Correlation coefficient, Covariance, Calculation of covariance from joint moment generating function, Independent random variables, Linear regression for two variables, The method of least squares, Bivariate normal distribution, Chebyshev's theorem, Strong law of large numbers, Central limit theorem and weak law of large numbers.

Course Outcomes: This course will enable the students to:

1. Learn probability, distribution function, probability density functions, mathematical expectation and moment generating function and use those for problem solving.
2. Understand uniform, binomial, Bernouli, geometric, gamma, exponential and normal distributions their uses in problem solving.
3. Learn joint distribution functions and expectation of function of two random variables.
4. Understand correlation, regression, least square fit and bivariate normal distribution. Learn Chebyshev's theorem, strong and weak law of large numbers and central limit theorem. Apply this knowledge and studied tools in investigation and solution of problems.

Recommended Text Books:

1. Robert V. Hogg, Joseph W. McKean & Allen T. Craig (2013). *Introduction to Mathematical Statistics* (7^{th} edition), Pearson Education.
2. Irwin Miller &Marylees Miller (2014). *John E. Freund's Mathematical Statistics with Applications* (8^{th}edition). Pearson. Dorling Kindersley Pvt. Ltd. India.
3. Jim Pitman (1993). *Probability*, Springer-Verlag.
4. Sheldon M. Ross (2014). *Introduction to Probability Models* (11^{th} edition). Elsevier.
9. A. M. Yaglom and I. M. Yaglom (1983). *Probability and Information*. D. Reidel Publishing Company. Distributed by Hindustan Publishing Corporation (India) Delhi.

M. Sc. Engineering Physics
Semester-VI
Subject: Mathematics
(Course Type-Discipline Specific Elective, Course Code: MT-603)
Nomenclature: Mathematics practical-VI
No. of Credits: 2

Max. Marks: 50
Time: 3 hrs.

Special Note: -

1. This course has two components, Problem Solving and Practical using LATEX software.
2. The examiner will set 4 questions at the time of practical examination asking two questions from the part (a) and two questions from the part (b) by taking course outcomes (COs) into consideration.
3. The examinee will be required to solve one problem from the part (a) and to execute one program successfully from the part (b). Equal weightage will be given to both the parts.
4. The evaluation will be done on the basis of practical record, viva-voce, write up and execution of the program.
5. The Practical examination will be held in a single session of 3 hours.

Distribution of Marks:

Experiment	25 marks
Viva- voce	15 marks
Lab Record	10 marks
Total	50 marks

a. **Linear Programming Problem Solving**- Questions related to the following problems will be solved using scientific calculator and record of those will be maintained in the Practical Notebook:

1) To solve a Linear Programming Problem by Simplex method with unique solution or with unbounded solution.
2) To solve a Linear Programming Problem by Two Phase method.
3) To solve a Linear Programming Problem by Big M- Method.
4) To solve a Linear Programming Problem using duality.
5) To obtain an optimal solution by Dual Simplex Method.
6) To determine optimal solution of a transportation problem using Vogel's method.
7) Determine optimal solution of transportation problem using (**u v**) method.
8) Determine an initial basic feasible solution of transportation problem by matrix method.

OR

a. **Problem Solving of Statistics and Probability-** Questions related to the following problems will be solved using scientific calculator and record of those will be maintained in the Practical Notebook:

1) Practical problems based on measures of dispersion (variance, standard deviation and coefficient of variation).
2) To compute Karl Pearson's coefficient of correlation for given bivariate frequency distribution.
3) To obtain the regression lines for given data.
4) Practical problems based on Binomial distribution.
5) Practical problems based on Poisson distribution.
6) Practical problems based on Normal distribution.
7) To fit a straight line for the given data on pairs of observations.
8) Practical problem solving related to expectation of random variables.

b) **LATEX Practicals-** Following practicals of typing documents using LATEX software will be done and records of those will be maintained in the practical notebook and the candidates will be asked by the examiner to type a document using more than one of these listed commands at the time of Semester end practical examination:

1. Create a document with mixed math and text note. Type some mathematical expressions related to limit, continuity, derivative and differential equations using suitable environment for mathematics formulas and also \begin{eqnarray} ...\end{eqnarray} and \begin{equation} ...

   \end {equation} environment.
2. Create a document to typeset arithmetic operations, subscripts, superscripts, accents, operators, binomial coefficients, congruences, delimiters and integrals.
3. Create a document to produce tables using commands:

\begin{tabular}{…}

l for a column of left-aligned text ,

r for a column of right-aligned text,

c for a column of centre-aligned text,

| for a vertical line

and following \begin command, table data is written by using following symbols;

& is placed between columns,

\\ is placed at the end of a row (to start a new one),

\hline inserts a horizontal line.

\cline{1-2} inserts a partial horizontal line between column 1 and column 2,

the command \end{tabular} finishes the table.

4. Create a document including figures by using following commands:

\usepackage{graphicx} (graphic package is used for figures)

\begin{figure}[h!]

\centering

\includegraphics[width=1\textwidth]{ImageFilename}

\caption{My test image}

\label{…}

\end{figure}

5. Create a document using matrix using the following commands:

\usepackage {amsmath}

\begin{matrix}

…

\end{matrix}

\begin{pmatrix}

…

\end{pmatrix}

\begin{bmatrix}

…

\end{bmatrix}

\begin{vmatrix}

…

\end{vmatrix}

6. Create a document illustrating use of \begin{abstract} ...\end{abstract}, \begin{theorem} ... \end{theorem}, and \begin{definition} ... \end{definition} formats.

7. Create a document illustrating references, citations, footnotes and hyperlinks.

3. Create a document to generate bibliography.

Course Outcomes: This course will enable the students to:

1. Attain skills to solve practical Linear Programming Problems using graphical method, simplex method and other methods.

   OR

1. Attain skills to measure a dispersion, find correlation coefficient, regression line and to fit a curve through given data points.
2. Learn tools for solving practical transportation problems using Vogel's method, (**u v**) method and matrix method.

   OR

2. Apply knowledge to solve practical problems related to Binomial, Normal and Poisson distributions.
3. Attain skills and to have hands-on experience to type a document which includes mathematical symbols, expressions and equations; tables; matrices and references using LATEX software.

M. Sc. Engineering Physics
Semester – VI
Subject: Chemistry
(Course type-Discipline Specific Elective, Course Code: CH-601(A))
Nomenclature: Applied physical Chemistry
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

Section A (15 Hrs.)

Surface Chemistry

Adsorption by solids, Chemisorption, Applications of adsorption, Adsorption of gases by solids, Factors influencing adsorption, The Freundlich adsorption isotherm, The Langmuir theory of adsorption, The BET theory of multilayer adsorption, Derivation of the BET equation, Types of adsorption isotherms, Adsorption from solution, The Gibbs adsorption isotherm.

Synthetic Dyes

Colour and constitution (electronic concept), Classification of dyes, Chemistry and synthesis of Methyl orange, Congo red, Malachite green, Crystal violet, Phenolphthalein, Fluorescein, Alizarin and Indigo.

Section B (15 Hrs.)

Liquid Crystals

The Mesomorphic State, Liquid crystals and its classification, Uses of liquid crystals. Surfactants, its types and methods to determine critical micelle concentration (Electrical conductivity and surface tension), Emulsions, Emulsifiers, Gels, Elastic and non-elastic gels.

Macromolecules

Macromolecules, Molar mass of polymers, Determination of molar masses of macromolecules, Thermodynamics of polymer solution.

Course Outcomes:

CO1: Have knowledge about concept of surface chemistry and their different aspects and applications.

CO2: Get the knowledge about synthetic dyes and their different classification

CO3: Get information about liquid crystals, their classifications and their uses

CO4: Learn about macromolecules and determination of molar masses of macromolecules

Reference Books:

- Finar, I. L. *Organic Chemistry* (*Volume 2)*, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Berg, J.M., Tymoczko, J.L. & Stryer, L. *Biochemistry*, W.H. Freeman, 2002.
- Nelson, D. L. & Cox, M. M. *Lehninger's Principles of Bioch*emistry *7th Ed.*, W. H. Freeman.
- Biochemistry, Voet and Voet,
- Fundamentals of Biochemistry, Jain and Jain, S Chand and company
- B. R. Puri, Madan S. Pathania , L. R. Sharma*Principles of Physical Chemistry* Vishal Publications

M. Sc. Engineering Physics
Semester – VI
Subject: Chemistry
(Course type-Discipline Specific Elective, Course Code: CH-601(B))
Nomenclature: Green Chemistry, organosulphur compounds and organic polymers
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

SECTION-A (15 Hrs)

Green chemistry

What is Green Chemistry? Need for Green Chemistry. Goals of Green Chemistry.

Limitations/ Obstacles in the pursuit of the goals of Green Chemistry, Principles of Green Chemistry and Designing a Chemical synthesis, Twelve principles of Green Chemistry with their explanations and examples.

Principles of Green Chemistry and Designing a Chemical synthesis

Twelve principles of Green Chemistry with their explanations and examples and special emphasis on the following: Designing a Green Synthesis using these principles; Prevention of Waste/ byproducts; maximum incorporation of the materials used in the process into the final products , Atom Economy, calculation of atom economy of the rearrangement, addition, substitution and elimination reactions. Prevention/ minimization of hazardous/ toxic products reducing toxicity.

(Function) hazard × exposure; waste or pollution prevention hierarchy. Green solvents– water as a solvent for organic reactions, ionic liquids, PEG, solvent less processes, immobilized solvents and how to compare greenness of solvents.

SECTION-B (15 Hrs)

Organic Polymers

Addition or chain-growth polymerization. Free radical vinyl polymerization, ionic vinyl polymerization, Ziegler-Natta polymerization and vinyl polymers. Condensation or step growth polymerization.

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

Course Outcomes:

CO1: Know about the principle of green chemistry

CO2: To apply the knowledge of green chemistry

CO3: to know about basics of organic polymers and their applications

Reference Books:

- Ahluwalia, V.K. & Kidwai, M.R. New Trends in Green Chemistry, Anamalaya Publishers (2005). Anastas, P.T. & Warner, J.K.: Green Chemistry - Theory and Practical, Oxford University Press (1998).
- Matlack, A.S. Introduction to Green Chemistry, Marcel Dekker (2001).
- Cann, M.C. & Connely, M.E. Real-World cases in Green Chemistry, American Chemical Society, Washington (2000).
- Ryan, M.A.& Tinnesand, M. Introduction to Green Chemistry, American Chemical Society, Washington (2002).
- Lancaster, M. Green Chemistry: An Introductory Text RSC Publishing, 2nd Edition, 2010.

M. Sc. Engineering Physics
Semester – VI
Subject: Chemistry
(Course type-Discipline Specific Elective, Course Code: CH-602(A))
Nomenclature: Analytical chemistry
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

SECTION A (15hrs.)

Analytical chemistry

Introduction to Analytical Chemistry and its interdisciplinary nature.Concept of sampling. 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.

Analysis of soil, water and food products

Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

a. Determination of pH of soil samples.

b. Estimation of Calcium and Magnesium ions as Calcium carbonate by complexometric titration.

Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.

a. Determination of pH, acidity and alkalinity of a water sample.

b. Determination of dissolved oxygen (DO) of a water sample.

SECTION B (15hrs.)

Analysis of food products: Nutritional value of foods, idea about food processing and food preservatives and adulteration.

a. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

b. Analysis of preservatives and colouring matter.

Analysis of cosmetics

Major and minor constituents and their function

a. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.

b. Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by complexometric titration.

Chromatography

Definition, general introduction on principles of chromatography, paper chromatography, TLC etc.

a. Paper chromatographic separation of mixture of metal ion (Fe^{3+} and Al^{3+}).

b. To compare paint samples by TLC method.

Ion-exchange: Column, ion-exchange chromatography etc.

Determination of ion exchange capacity of anion /cation exchange resin (using batch procedure if use of column is not feasible).

Course Outcomes:

CO1: To know about basics of analytical chemistry

CO2: Aware about analysis of soils, water, cosmetics and food products

CO3: To explain definition and principle of chromatography

CO4: Have idea about analysis of cosmetics

CO5: To know about principles and various types of chromatography techniques

Reference Books:

- Willard, H.H., Merritt, L.L., Dean, J. & Settle, F.A. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
- Skoog, D.A. Holler F.J. &Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
- Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
- Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.

M. Sc. Engineering Physics
Semester – VI
Subject: Chemistry
(Course type-Discipline Specific Elective, Course Code: CH-602(B))
Nomenclature: Nuclear chemistry, organosulphur compounds and catalysis
No. of Credits: 2

Max. Marks: 50
Theory: 40
Internal Assessment: 10
Time: 3 hrs.

Note:-

1. Nine questions will be set in total.
2. Question no. 1 will be compulsory and based on the conceptual aspects of the entire syllabus. This question may have 4 parts and the answer should be in brief but not in Yes/No.
3. There will be four questions from section **A** and four from section **B**. Candidates will be required to attempt five questions in all, selecting at least two questions from each section. Question no.1 carry 8 marks and all questions in Section A & B (not more than 2-3 parts) carry 8 marks each**.**

SECTION A (15hrs.)

Nuclear chemistry

Radioactivity, Rays from radioactive materials, radioactive disintegration, half-life period, radioactive equilibrium. Steady state, Theory of radioactivity, Carbon dating,

Nuclear fission, Calculation of energy released in nuclear fission, the fission chain reaction, The concept of critical mass, Nuclear fusion, Nuclear reactions, Radiation chemistry, Radiolysis of water, Nuclear reactor.

Radioactive isotopes, radiochemical principle in the use of tracers, applications of tracers in chemical investigations, physiochemical methods, analytical applications, age determinations, medical applications, agricultural applications.

SECTION B (15hrs.)

Organosulfur Compounds

Nomenclature, structural features, Methods of formation and chemical reactions of thiols,trioethers, sulphonic acids, sulphonamides and sulphaguanidine.

Catalysis

General characteristics of catalytic reactions, Acid-base catalysis, Enzyme catalysis, Michaelis-Menten equation, Effect of temperature on enzyme catalysis, Heterogeneous catalysis, Surface reactions, Kinetics of surface reactions, Unimolecular surface reactions, Bimolecular surface reactions, Effect of temperature on surface reactions, Autocatalysis and Oscillatory reactions.

Course Outcomes:

CO1: To know the basic concepts of nuclear chemistry and various processes occurs during the nuclear reactions

CO2: Have knowledge about basic of catalysis and their related aspects.

CO3: to know about the types of organosulphur compounds and their studies

Reference Books:

- Willard, H.H., Merritt, L.L., Dean, J. & Settle, F.A. *Instrumental Methods of Analysis*. 7th Ed. Wadsworth Publishing Co. Ltd., Belmont, California, USA, 1988.
- Skoog, D.A. Holler F.J. & Nieman, T.A. *Principles of Instrumental Analysis*, Cengage Learning India Ed.
- Skoog, D.A.; West, D.M. & Holler, F.J. *Fundamentals of Analytical Chemistry 6th Ed.*, Saunders College Publishing, Fort Worth (1992).
- Harris, D. C. *Quantitative Chemical Analysis*, W. H. Freeman.
- Dean, J. A. *Analytical Chemistry Notebook*, McGraw Hill.

M. Sc. Engineering Physics
Semester-VI
Subject: Chemistry
(Course type-Discipline Specific Elective, Course Code: CH-603(A))
Nomenclature: Chemistry practical-VI
Credits: 2

Max. Marks: 50
Time: 6hrs.

Special Note: -

The Practical examination will be held in two sessions of 3 hours each & the students are required to perform two experiments during the examination.

Distribution of Marks:

Experiment	15+15 marks
Viva- voce	5+5 marks
Lab Record	10 marks
Total	50 marks

1. To determine the strength of the given acid solution (mono acid only) conductometrically.

2. To determine the solubility and solubility product of a lead sulphate conductometrically.

3. To determine the strength of a given Mohr's salt solution potentiometrically.

4. To determine the molecular weight of a non-volatile solute by Rast method.

5. Preparation of acidic and basic buffers and comparison of their pH with theoretical values.

6. To determine the specific rotation of an optically active substance (any two).

7. To separate the binary liquid mixtures using distillation.

8. Determination of total reducing sugar (before inversion and after inversion).

9. Synthesis of the following organic compounds:

(a) To prepare salicylic acid from Aspirin.

(b) To prepare p-bromoaniline from p-bromoacetanilide.
(c) To prepare soap from vegetable oil.

Course Outcomes:

CO1: To perform conductometric titrations to find out strength of monobasic acid and also solubility and solubility product of a sparingly soluble salt

CO2: Able to conduct the potentiometric titrations

CO3: Can separate the binary liquid mixture using distillation

CO4: Able to synthesize various organic compounds & soap in the lab

M. Sc. Engineering Physics
Semester-VI
Subject: Chemistry
(Course type-Discipline Specific Elective, Course Code: CH-603(B))
Nomenclature: Chemistry practical-VI
Credits: 2

Max. Marks: 50
Time: 6hrs.

Special Note: -

The Practical examination will be held in two sessions of 3 hours each & the students are required to perform two experiments during the examination.

Distribution of Marks:

Experiment	15+15 marks
Viva- voce	5+5 marks
Lab Record	10 marks
Total	50 marks

1. To determine the strength of the given acid solution (mono acid only) conductometrically.

2. To determine the solubility and solubility product of a barium sulphate conductometrically.

3. To determine the strength of a given Ferrous ammonium sulphate solution potentiometrically.

4. To determine the molecular weight of a non-volatile solute by Rast method.

5. Preparation of acidic and basic buffers and comparison of their pH with theoretical values.

6. To determine the specific rotation of an optically active substance (any two).

7. Determination of Fructose/glucose ratio in honey sample.

8. Quantitation of protein (Casein) in milk/butter.

9. Synthesis of the following organic compounds:

(a) To prepare m-nitroaniline from m-dinitrobenzene.

(b) To prepare S-Benzyl-iso-thiouronium chloride from Thiourea.

Course Outcomes:

CO1: To perform conductometric titrations to find out strength of monobasic acid and also solubility and solubility product of a sparingly soluble salt

CO2: Able to conduct the potentiometric titrations

CO3: Can separate the binary liquid mixture using distillation

CO4: Able to synthesize various organic compounds in the lab

KURUKSHETRA UNIVERSITY KURUKSHETRA

POs & PSOs
(1st to 6th semester)

for

Five Years Integrated
M. Sc. Engineering Physics (3 Years BSc+2Years M.Sc.)
Under CBCS-LOCF
(Effective from the Academic Session 2020-21 in phase manner)

Department of Physics
INSTITUTE OF INTEGRATED & HONORS STUDIES
Kurukshetra University
Kurukshetra - 136 119
Haryana (INDIA)

Program Outcomes (PO) for Under Graduate Programme (1st to 6th semesters of M.Sc. Engineering Physics: Degree to be awarded- B. Sc. -Engineering Physics), Institute of Integrated & Honors Studies, KUK:

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO3	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO4	Individual and Team Work	Capable to learn and work effectively as an individual , and as a member or leader in diverse teams, multidisciplinary settings
PO5	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO6	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO7	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO8	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO9	Environment and Sustainability	Ability to design and develop modern systems which are environmentally sensitive and to understand the importance of sustainable development
PO10	Ethics	Apply ethical principles and professional responsibilities in scientific practices
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

Programme specific outcomes (Physics: For Five Yrs. Integrated MSc. Engineering Physics – 1st to 6th semesters)

After successful completion programme, the students will be able to:

PSO1: Acquire an in-depth understanding and knowledge of the basic concepts of physics and be able to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws through logical reasoning.

PSO2: Be capable of understanding the core physical laws to understand the basic concepts, latest progress and applications of certain sub fields such as nuclear physics, spectroscopy of atoms & molecules, solid state physics, computational physics & electronics.

PSO3: Gain hands-on skills for carrying out basic experiments as well as experiments related to different fields of Physics and attain abilities of critical thinking, problem mapping & solving using fundamental principles of Physics, systematic analysis & interpretation of results.

PSO4: Have a new perspective to look at everything from ‘Scientific’ point of view that enabling them to pursue higher studies at postgraduate & research level

PSO5: Have awareness of the impact of Physics in social, Economical and environmental issues.

Mapping of CO with PO's and PSO's

Course code EP-101															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-101.1	3	3	3	2	2	2	2	3	2	-	2	3	3	3	3	2
EP-101.2	3	3	3	2	3	2	2	3	2	-	2	3	3	3	3	2
EP-101.3	3	3	3	2	3	2	2	3	2	-	2	3	3	3	3	1
EP-101.4	3	3	2	2	2	1	2	2	1	-	2	3	3	3	3	1
Average	3	3	2.75	2	2.5	1.75	2	2.75	1.75	-	2	3	3	3	3	1.5
Note: 3-Strong, 2-Medium, 1-Weak																

Course code: EP-102																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-102.1	3	3	3	2	2	2	2	3	2	-	2	3	3	2	2	2
EP-102.2	3	3	3	3	3	2	2	2	2	-	2	3	3	2	3	2
EP-102.3	3	3	2	2	2	2	2	2	2	-	2	3	3	2	3	2
EP-102.4	3	3	2	2	2	2	2	3	2	-	1	3	3	2	2	2
Average	3	3	2.5	2.25	2.25	2	2	2.5	2	-	1.75	3	3	2	2.5	2

Course code:EP-103																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-103.1	3	3	3	3	2	2	2	3	2	-	2	3	3	3	3	3
EP-103.2	3	3	3	3	2	3	2	3	2	-	2	3	3	2	3	3
EP-103.3	3	3	3	3	2	3	2	2	2	-	2	3	3	3	3	3
EP-103.4	3	3	3	3	3	3	2	3	2	-	3	3	3	3	3	3
Average	3	3	3	3	2.75	2.75	2	2.75	2	-	2.75	3	3	2.75	3	3

Semester-II

Course code EP-201																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-201.1	3	3	3	2	2	2	3	2	2	-	3	3	3	2	3	2
EP-201.2	3	3	3	2	2	2	2	3	2	-	2	3	3	2	3	2
EP-201.3	3	3	3	2	2	2	2	2	2	-	2	3	2	2	2	2
EP-201.4	3	3	3	2	2	2	3	2	2	-	3	3	2	2	2	2
Average	3	3	3	2	2	2	2.5	2.75	2	-	2.5	3	2.5	2	2.5	2
Note: 3-Strong, 2-Medium, 1-Weak																

Course code: EP-202																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-202.1	3	3	3	3	3	2	2	3	2	-	2	3	3	2	3	2
EP-202.2	3	3	3	3	2	2	2	2	2	-	2	3	2	2	3	2
EP-202.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2
EP-202.4	3	3	2	2	2	2	2	2	2	-	2	2	2	2	3	2
Average	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2.25	2	2.5	2

Course code:EP-203																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-203.1	3	3	2	3	3	2	2	3	2	-	2	3	2	2	3	2
EP-203.2	3	3	3	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-203.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2
EP-203.4	3	3	3	3	2	2	2	2	2	-	2	2	2	2	3	2
Average	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2

Mapping of CO with PO's and PSO's
Semester-III

Course code EP-301																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-301.1	3	3	2	2	2	2	2	3	2	-	2	3	2	2	3	2
EP-301.2	3	3	2	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-301.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2
EP-301.4	3	3	2	2	2	2	2	2	2	-	2	2	2	2	3	2
Average	3	3	2	2	2	2	2	2.5	2	-	2	2.5	2	2	2.5	2

Note: 3-Strong, 2-Medium, 1-Weak

Course code: EP-302																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-302.1	3	3	3	3	3	1	2	2	2	-	2	3	2	2	3	2
EP-302.2	3	3	3	3	2	1	2	2	2	-	2	3	2	2	3	2
EP-302.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2
EP-302.4	3	3	2	2	2	1	2	2	2	-	2	2	2	2	3	2

Average	3	3	2.5	2.5	2.75	1.25	2	2	2	-	2	2.5	2	2	2.5	2

Course code:EP-303																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-303.1	3	3	2	3	3	2	2	3	2	-	2	3	2	2	3	2
EP-303.2	3	3	3	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-303.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2
EP-303.4	3	3	3	3	2	2	2	2	2	-	2	2	2	2	3	2
Average	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2

Mapping of CO with PO's and PSO's

Semester-IV

Course code EP-401																
COs	**PO1**- Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-401.1	3	3	2	3	2	2	2	2	2	-	2	3	2	2	3	2
EP-401.2	3	3	2	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-401.3	3	3	2	2	2	2	2	2	2	-	2	2	2	2	2	2
EP-401.4	3	3	3	3	2	2	2	2	2	-	2	2	2	2	2	2
Average	3	3	2.25	2.5	2	2	2	2	2	-	2	2.5	2	2	2.5	2
Note: 3-Strong, 2-Medium, 1-Weak																

Course code: EP-402																
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-402.1	3	3	2	2	2	2	2	2	2	-	2	3	2	2	2	2
EP-402.2	3	3	2	2	2	2	2	2	2	-	2	3	3	2	3	2
EP-402.3	3	3	3	2	2	2	2	2	2	-	2	3	3	2	2	2
EP-402.4	3	3	3	3	2	2	2	2	2	-	2	3	3	2	2	2
Average	3	3	2.5	2.25	2	2	2	2	2	-	2	3	2.75	2	2.25	2

Course code:EP-403																
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-403.1	3	3	2	3	3	2	2	3	2	-	2	3	2	2	3	2
EP-403.2	3	3	3	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-403.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2
EP-403.4	3	3	3	3	2	2	2	2	2	-	2	2	2	2	3	2

Average	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2

Course code:SEC-401A																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
SEC-401A.1	2	2	2	3	2	2	2	2	2	-	2	2	2	2	2	2
SEC-401A.2	3	3	2	2	2	2	2	2	2	-	2	3	2	2	3	2
SEC-401A.3	3	3	3	2	2	2	2	2	2	-	2	3	2	2	2	2

SEC-401A.4	2	2	2	3	2	2	2	2	2	-	2	2	2	2	2	2
Average	2.5	2.5	2.25	2.5	2	2	2	2	2	-	2	2.5	2	2	2.25	2

Course code: SEC-401B

COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
SEC-401B.1	2	2	2	3	2	2	2	2	3	-	2	2	2	2	2	2
SEC-401B.2	3	2	2	2	2	2	2	2	3	-	2	3	2	2	2	2
SEC-401B.3	2	2	2	2	2	2	2	2	2	-	2	2	2	2	2	2

SEC-401B.4	2	2	2	3	2	2	2	2	2	-	2	2	2	2	2	2
Average	2.25	2	2	2.5	2	2	2	2	2.5	-	2	2	2	2	2	2

Mapping of CO with PO's and PSO's
Semester-V

Course code EP-501A																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-501A.1	3	3	3	2	2	2	2	3	2	-	2	3	2	2	2	2
EP-501A.2	3	3	2	2	2	2	2	2	2	-	2	3	2	2	2	2
EP-501A.3	3	3	2	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-501A.4	3	3	3	2	2	2	2	3	2	-	2	3	3	2	3	2
Average	3	3	2.5	2	2	2	2	2.5	2	-	2	3	2.75	2	2.5	2

Note: 3-Strong, 2-Medium, 1-Weak

Course code: EP-501B																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-501B.1	3	3	3	2	2	2	2	3	2	-	2	3	3	2	2	2
EP-501B.2	3	3	3	2	2	2	2	2	2	-	2	3	3	2	2	2
EP-501B.3	3	3	3	2	2	2	2	2	2	-	2	3	3	2	3	2

EP-501B.4	3	3	3	2	2	2	2	3	2	-	2	3	3	2	3	2
Average	3	3	3	2	2	2	2	2.5	2	-	2	3	3	2	2.5	2

Course code EP-502A																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-502A.1	3	3	2	2	2	2	2	2	2	-	2	3	3	2	2	2
EP-502A.2	3	3	2	2	2	2	2	2	2	-	2	3	3	2	2	2
EP-502A.3	3	3	2	2	2	2	2	2	2	-	2	3	3	2	3	2

EP-502A.4	3	3	2	2	2	2	2	2	2	-	2	3	3	2	3	2
Average	3	3	2	2	2	2	2	2	2	-	2	3	3	2	2.5	2
Note: 3-Strong, 2-Medium, 1-Weak																

Course code: EP-502B																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-502B.1	3	3	2	2	2	2	2	3	2	-	2	3	2	2	2	2
EP-502B.2	3	3	2	2	2	2	2	2	2	-	2	3	2	2	2	2
EP-502B.3	3	3	2	2	2	2	2	2	2	-	2	3	2	2	3	2

EP-502B.4	3	3	2	2	2	2	2	3	2	-	2	3	2	2	3	2
Average	3	3	2	2	2	2	2	2.5	2	-	2	3	2	2	2.5	2

Course code EP-503A

COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-503A.1	3	3	2	3	3	2	2	3	2	-	2	3	2	2	3	2
EP-503A.2	3	3	3	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-503A.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2
EP-503A.4	3	3	3	3	2	2	2	2	2	-	2	2	2	2	3	2

Average	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
Note: 3-Strong, 2-Medium, 1-Weak																

Course code: EP-503B																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-503B.1	3	3	2	3	3	2	2	3	2	-	2	3	2	2	3	2
EP-503B.2	3	3	3	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-503B.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2

EP-503B.4	3	3	3	3	2	2	2	2	2	-	2	2	2	2	3	2
Average	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2

Mapping of CO with PO's and PSO's
Semester-VI

Course code EP-601A																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-601A.1	3	3	2	2	2	2	2	2	2	-	2	3	2	2	2	2
EP-601A.2	3	3	3	3	2	2	2	3	2	-	2	3	3	2	3	2
EP-601A.3	3	3	3	3	2	2	2	3	2	-	2	3	3	3	3	2
EP-601A.4	3	3	2	2	2	2	2	2	2	-	2	3	2	2	2	2

Average	3	3	2.5	2.5	2	2	2	2.5	2	-	2	3	2.5	2.25	2.5	2
Note: 3-Strong, 2-Medium, 1-Weak																

Course code: EP-601B																
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-601B.1	3	3	2	2	2	2	2	2	2	-	2	3	3	2	2	2
EP-601B.2	3	3	2	2	2	2	2	2	2	-	2	3	3	2	2	2
EP-601B.3	3	3	3	3	2	2	2	3	2	-	2	3	3	2	3	2

EP-601B.4	3	3	3	3	2	2	2	3	2	-	2	3	3	2	3	2
Average	3	3	2.5	2.5	2	2	2	2.5	2	-	2	3	3	2	2.5	2

Course code EP-602A																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-602A.1	3	3	3	3	2	2	2	3	2	-	2	3	3	3	3	2
EP-602A.2	3	3	3	3	2	2	2	3	2	-	2	3	3	3	3	2
EP-602A.3	3	3	3	3	2	2	2	3	2	-	2	3	3	3	2	2

EP-602A.4	3	3	3	2	2	2	2	2	2	-	2	3	3	2	2	2
Average	3	3	3	2.75	2	2	2	2.75	2	-	2	3	3	2.75	2.5	2
Note: 3-Strong, 2-Medium, 1-Weak																

Course code: EP-602B																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-602B.1	3	3	2	2	2	2	2	2	2	-	2	3	2	2	2	2
EP-602B.2	3	3	2	2	2	2	2	2	2	-	2	3	2	2	3	2

EP-602B.3	3	3	2	2	2	2	2	2	2	-	2	3	2	3	3	2
EP-602B.4	3	3	2	2	2	2	2	2	2	-	2	3	2	3	3	2
Average	3	3	2	2	2	2	2	2	2	-	2	3	2	2.5	2.75	2

Course code EP-603A																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-603A.1	3	3	2	3	3	2	2	3	2	-	2	3	2	2	3	2
EP-603A.2	3	3	3	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-603A.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2
EP-603A.4	3	3	3	3	2	2	2	2	2	-	2	2	2	2	3	2

Average	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
Note: 3-Strong, 2-Medium, 1-Weak																

Course code: EP-603B																
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-603B.1	3	3	2	3	3	2	2	3	2	-	2	3	2	2	3	2
EP-603B.2	3	3	3	2	2	2	2	2	2	-	2	3	2	2	3	2
EP-603B.3	3	3	2	2	2	2	2	3	2	-	2	2	2	2	2	2

EP-603B.4	3	3	3	3	2	2	2	2	2	-	2	2	2	2	3	2
Average	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2

Mapping of Courses with PO's and PSO's for core and elective courses (Physics: For Five Yrs. Integrated MSc. Engineering Physics – 1^{st} to 6^{th} semesters)

COs	PO1- Knowledge	PO2- Communication	PO3- Problem Solving	PO4- Individual and Team Work	PO5- Investigation of Problems	PO6- Modern Tool usage	PO7- Science and Society	PO8- Life-Long Learning	PO9- Environment and Sustainability	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4	PSO5
EP-101	3	3	2.75	2	2.5	1.75	2	2.75	1.75	-	2	3	3	3	3	1.5
EP-102	3	3	2.5	2.25	2.25	2	2	2.5	2	-	1.75	3	3	2	2.5	2
EP-103	3	3	3	3	2.75	2.75	2	2.75	2	-	2.75	3	3	2.75	3	3
EP-201	3	3	3	2	2	2	2.5	2.75	2	-	2.5	3	2.5	2	2.5	2
EP-202	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2.25	2	2.5	2
EP-203	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
EP-301	3	3	2	2	2	2	2	2.5	2	-	2	2.5	2	2	2.5	2
EP-302	3	3	2.5	2.5	2.75	1.25	2	2	2	-	2	2.5	2	2	2.5	2
EP-303	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
EP-401	3	3	2.25	2.5	2	2	2	2	2	-	2	2.5	2	2	2.5	2

EP-402	3	3	2.5	2.25	2	2	2	2	2	-	2	3	2.75	2	2.25	2
EP-403	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
SEC-401A	2.5	2.5	2.25	2.5	2	2	2	2	2	-	2	2.5	2	2	2.25	2
SEC-401B	2.25	2	2	2.5	2	2	2	2	2.5	-	2	2	2	2	2	2
Continued from pre page……..																
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**
EP-501A	3	3	2.5	2	2	2	2	2.5	2	-	2	3	2.75	2	2.5	2
EP-501B	3	3	3	2	2	2	2	2.5	2	-	2	3	3	2	2.5	2
EP-502A	3	3	2	2	2	2	2	2	2	-	2	3	3	2	2.5	2
EP-502B	3	3	2	2	2	2	2	2.5	2	-	2	3	2	2	2.5	2
EP-503A	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
EP-503B	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
EP-601A	3	3	2.5	2.5	2	2	2	2.5	2	-	2	3	2.5	2.25	2.5	2
EP-601B	3	3	2.5	2.5	2	2	2	2.5	2	-	2	3	3	2	2.5	2
EP-602A	3	3	3	2.75	2	2	2	2.75	2	-	2	3	3	2.75	2.5	2
EP-602B	3	3	2	2	2	2	2	2	2	-	2	3	2	2.5	2.75	2

EP-603A	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
EP-603B	3	3	2.5	2.5	2.75	2	2	2.5	2	-	2	2.5	2	2	2.5	2
Note: 3-Strong, 2-Medium, 1-Weak																

Programme specific outcomes (Chemistry: For five Yrs. Integrated MSc. Engineering Physics – 1st to 6th semesters)

PSO1 Acquire good knowledge about the fundamentals and applications of chemical and scientific theories.

PSO2 All branches of Science and Technology are related to Chemistry.

PSO3 Easily assess the properties of all elements discovered.

PSO4 Will become familiar with the different branches of chemistry like analytical, physical, organic, inorganic, environmental and polymer.

PSO5 Will help in understanding the causes of environmental pollution and can open up new methods to control environmental pollution.

PSO6 Will develop analytical skills and problem-solving skills requiring application of chemical principles.

PSO7 Have the ability to synthesize, separate and characterize compounds using laboratory and instrumentation techniques.

Mapping of CO with PO’s and PSO’s
Semester-I

Course code CH-101																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-101.1	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	2	3	3
CH-101.2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
CH-101.3	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-101.4	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-101.5	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2	3	3

CH-101.6	3	3	3	3	3	3	3	3	2	2	3	3	3	3	3	2	3	3
CH-101.7	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-101.8	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.38	2.75	3	2.38	2.88	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-102																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-102.1	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-102.2	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CH-102.3	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-102.4	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-102.5	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CH-102.6	3	3	3	3	3	3	2	3	2	2	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.5	2	3	2	2.83	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-103																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-103.1	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-103.2	3	3	3	2	3	3	1	3	1	1	3	3	3	3	3	2	3	3
CH-103.3	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-103.4	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
Average	3	3	3	2	3	2.25	1	3	1	1	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-104																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-104.1	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-104.2	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-104.3	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-104.4	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Mapping of CO with PO's and PSO's
Semester-II

Course code CH-201																	
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-201.1	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2	3	3
CH-201.2	3	3	3	3	3	2	3	3	3	3	3	3	3	3	3	2	3	3
CH-201.3	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	2	3	3
CH-201.4	3	3	3	3	3	2	3	3	2	3	3	3	3	3	3	2	3	3
CH-201.5	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3

CH-201.6	3	3	3	3	3	2	3	3	2	2	3	3	3	3	3	2	3	3
CH-201.7	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-201.8	3	3	3	3	3	2	2	2	3	3	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.25	2	2.88	2.38	2.88	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-202																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-202.1	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-202.2	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CH-202.3	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-202.4	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.25	2	3	2	3	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-203																		
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-203.1	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
CH-203.2	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
CH-203.3	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
CH-203.4	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
Average	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-204																	
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-204.1	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-204.2	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-204.3	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-204.4	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3

Note: 3-Strong, 2-Medium, 1-Weak

Mapping of CO with PO’s and PSO’s
Semester-III

Course code CH-301																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-301.1	3	3	3	3	3	3	2	3	3	3	3	3	3	3	3	2	3	3
CH-301.2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3	3
CH-301.3	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	2	3	3
CH-301.4	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	2	3	3
CH-301.5	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3

CH-301.6	3	3	3	3	3	2	3	3	3	2	3	3	3	3	3	2	3	3
CH-301.7	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.29	2.29	3	2.72	3	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-302																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-302.1	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-302.2	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CH-302.3	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-302.4	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.25	2	3	3	3	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-303																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-303.1	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-303.2	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-303.3	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-303.4	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-303.5	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-303.6	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
Average	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-304																		
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-304.1	3	3	3	3	3	3	1	3	2	2	3	3	3	2	3	3	3	3
CH-304.2	3	3	3	3	3	3	1	3	2	2	3	3	3	2	3	3	3	3
CH-304.3	3	3	3	3	3	3	1	3	2	2	3	3	3	2	3	3	3	3
CH-304.4	3	3	3	3	3	3	1	3	2	2	3	3	3	2	3	3	3	3
CH-304.5	3	3	3	3	3	3	1	3	2	2	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	3	1	3	2	2	3	3	3	2	3	3	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Mapping of CO with PO's and PSO's
Semester-IV

Course code CH-401																	
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CH-401.1	3	3	3	3	3	2	2	3	3	3	3	3	3	3	3	2	3
CH-401.2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	2	3
CH-401.3	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2	3
CH-401.4	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2	3
CH-401.5	3	3	3	3	3	3	2	1	2	3	3	3	3	3	3	2	3

CH-401.6	3	3	3	3	3	3	3	1	2	2	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.83	2.33	2.33	2.33	2.83	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-402																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-402.1	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-402.2	3	3	3	3	3	3	2	3	2	3	3	3	3	3	3	2	3	3
CH-402.3	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
CH-402.4	3	3	3	3	3	2	2	3	2	3	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.25	2	3	2	3	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-403																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-403.1	3	3	3	2	3	3	1	2	1	1	3	3	3	3	3	2	3	3
CH-403.2	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
CH-403.3	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
CH-403.4	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
Average	3	3	3	2	3	2.25	1	3	1	1	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-404																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-404.1	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-404.2	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-404.3	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-404.4	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Mapping of CO with PO's and PSO's
Semester-V

Course code CH-501A																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-501A.1	3	3	3	3	3	2	1	3	2	1	3	3	3	3	3	2	3	3
CH-501A.2	3	3	3	3	3	3	1	3	2	1	3	3	3	3	3	3	3	3
CH-501A.3	3	3	3	3	3	3	1	3	2	1	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	2.66	1	3	2	1	3	3	3	3	3	2.66	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-501B																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-501B.1	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-501B.2	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-501B.3	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-501B.4	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
Average	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-502A																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-502A.1	3	3	3	3	3	3	2	3	2	1	3	3	3	2	3	3	3	3
CH-502A.2	3	3	3	3	3	3	2	3	2	1	3	3	3	2	3	3	3	3
CH-502A.3	3	3	3	3	3	2	2	3	2	1	3	3	3	3	3	2	3	3
CH-502A.4	3	3	3	3	3	2	2	3	2	1	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.50	2	3	2	1	3	3	3	2.50	3	2.50	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-502B																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-502B.1	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
CH-502B.2	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
CH-502B.3	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
CH-502B.4	3	3	3	3	3	2	1	3	2	1	3	3	3	3	3	2	3	3
CH-502B.5	3	3	3	3	3	2	1	3	2	1	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.60	1	2.40	2	1	3	3	3	2.40	3	2.60	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-503																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-503.1	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-503.2	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-503.3	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-503.4	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Mapping of CO with PO's and PSO's
Semester-VI

Course code CH-601A																	
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-601A.1	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-601A.2	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-601A.3	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	3	3	3

CH-601A.4	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	3	3	3
Average	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2.50	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-601B																		
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-601B.1	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-601B.2	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-601B.3	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
Average	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code CH-602A																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-602A.1	3	3	3	3	3	2	2	3	2	1	3	3	3	3	3	2	3	3
CH-602A.2	3	3	3	3	3	3	2	3	2	1	3	3	3	2	3	3	3	3
CH-602A.3	3	3	3	3	3	3	2	3	2	1	3	3	3	2	3	3	3	3
CH-602A.4	3	3	3	3	3	3	2	3	2	1	3	3	3	2	3	3	3	3
CH-602A.5	3	3	3	3	3	3	2	3	1	1	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	2.80	2	3	1.80	1	3	3	3	2.40	3	2.80	3	3

Note: 3-Strong, 2-Medium, 1-Weak

Course code CH-602B																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-602B.1	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-602B.2	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-602B.3	3	3	3	3	3	2	1	3	2	1	3	3	3	3	3	2	3	3
Average	3	3	3	3	3	2.66	1	3	2	1	3	3	3	2.33	3	2.66	3	3

Note: 3-Strong, 2-Medium, 1-Weak

Course code CH-603																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
CH-603.1	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
CH-603.2	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
CH-603.3	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
CH-603.4	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code SEC-601A																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
SEC-601A.1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
SEC-601A.2	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
SEC-601A.3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Course code SEC-601B																		
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**
SEC-601B.1	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
SEC-601B.2	3	3	3	3	3	3	1	3	2	1	3	3	3	3	3	3	3	3
SEC-601B.3	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
SEC-601B.4	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	3	1	3	2	1	3	3	3	2.25	3	3	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Mapping of Courses with PO's and PSO's for core and elective courses (CHEMISTRY FOR FIVE Yrs. INTEGRATED MSc. ENGINEERING PHYSICS)

COs	PO1- Knowledge	PO2- Communication	PO3- Problem Solving	PO4- Individual and Team Work	PO5- Investigation of Problems	PO6- Modern Tool usage	PO7- Science and Society	PO8- Life-Long Learning	PO9- Environment and Sustainability	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CH-101	3	3	3	3	3	2.38	2.75	3	2.38	2.88	3	3	3	3	3	2	3	3
CH-102	3	3	3	3	3	2.5	2	3	2	2.83	3	3	3	3	3	2	3	3
CH-103	3	3	3	2	3	2.25	1	3	1	1	3	3	3	3	3	2	3	3
CH-104	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-201	3	3	3	3	3	2.25	2	2.88	2.38	2.88	3	3	3	3	3	2	3	3
CH-202	3	3	3	3	3	2.25	2	3	2	3	3	3	3	3	3	2	3	3
CH-203	3	3	3	2	3	2	1	2	1	1	3	3	3	3	3	2	3	3
CH-204	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-301	3	3	3	3	3	2.29	2.29	3	2.72	3	3	3	3	3	3	2	3	3
CH-302	3	3	3	3	3	2.25	2	3	3	3	3	3	3	3	3	2	3	3
CH-303	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-304	3	3	3	3	3	3	1	3	2	2	3	3	3	2	3	3	3	3

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COs	PO1- Knowledge	PO2- Communication	PO3- Problem Solving	PO4- Individual and Team Work	PO5- Investigation of Problems	PO6- Modern Tool usage	PO7- Science and Society	PO8- Life-Long Learning	PO9- Environment and Sustainability	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7
CH-401	3	3	3	3	3	2.83	2.33	2.33	2.33	2.83	3	3	3	3	3	2	3	3
CH-402	3	3	3	3	3	2.25	2	3	2	3	3	3	3	3	3	2	3	3
CH-403	3	3	3	2	3	2.25	1	3	1	1	3	3	3	3	3	2	3	3
CH-404	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-501A	3	3	3	3	3	2.66	1	3	2	1	3	3	3	3	3	2.66	3	3
CH-501B	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-502A	3	3	3	3	3	2.50	2	3	2	1	3	3	3	2.50	3	2.50	3	3
CH-502B	3	3	3	3	3	2.60	1	2.40	2	1	3	3	3	2.40	3	2.60	3	3
CH-503	3	3	3	3	3	3	1	3	2	1	3	3	3	2	3	3	3	3
CH-601A	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2.50	3	3
CH-601B	3	3	3	2	3	2	1	3	1	1	3	3	3	3	3	2	3	3
CH-602A	3	3	3	3	3	2.80	2	3	1.80	1	3	3	3	2.40	3	2.80	3	3
CH-602B	3	3	3	3	3	2.66	1	3	2	1	3	3	3	2.33	3	2.66	3	3
CH-603	3	3	3	3	3	3	1	2	2	1	3	3	3	2	3	3	3	3
SEC-601A	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
SEC-601B	3	3	3	3	3	3	1	3	2	1	3	3	3	2.25	3	3	3	3
Note: 3-Strong, 2-Medium, 1-Weak																		

Program Specific Outcomes (PSO) (Mathematics: For Five Yrs. Integrated MSc. Engineering Physics)

After successful completion of the programme, a student will be able to:

PSO1	Have basic understanding and knowledge in different core areas of Mathematics such as algebra, analysis, calculus, differential equations, mechanics, numerical analysis and in some of the other elective areas. Demonstrate understanding of the concepts /theories/methods from such areas of Mathematics.
PSO2	Have **a broad background** in Mathematics and develop the essential mathematical reasoning, knowledge, skills and aptitude to pursue further studies and research in Mathematics.
PSO3	Communicate mathematics effectively and precisely by written, computational and graphical means.
PSO4	Apply knowledge, understanding, methods, techniques and skills of Mathematics to analyse, evaluate and solve problems of Mathematics and/or the mathematical problems having applications in engineering/science/technology/life sciences/social sciences so as to enhance career prospects in different fields.

Mapping of CO with PO's and PSO's
Semester-I

Course code MT-101															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-101.1	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-101.2	3	3	3	3	3	3	2	3	2	-	3	3	3	3	3
MT-101.3	3	3	3	2	2	3	2	3	2	-	2	3	3	3	3
MT-101.4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
Average	**3**	**3**	**3**	**2.75**	**2.75**	**3**	**2.5**	**3**	**2.5**	**-**	**2.75**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-102															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-102.1	3	3	3	3	3	3	2	3	2	--	2	3	3	3	3
MT-102.2	3	3	3	3	3	3	3	3	3	--	2	3	3	3	3
MT-102.3	3	3	3	3	3	2	2	3	3	--	2	3	3	3	3
MT-102.4	3	3	3	2	2	2	2	3	2	--	2	3	3	2	2
Average	**3**	**3**	**3**	**2.75**	**2.75**	**2.5**	**2.25**	**3**	**2.5**	**--**	**2**	**3**	**3**	**2.75**	**2.75**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-103															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-103.1	3	3	3	3	3	3	2	3	2	-	2	3	3	3	3
MT-103.2	3	3	3	3	3	3	2	3	2	-	2	3	3	3	3
MT-103.3	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-103.4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**2.5**	**3**	**2.5**	**-**	**2.5**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Mapping of CO with PO's and PSO's
Semester-II

Course code MT-201															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-201.1	3	3	3	2	2	2	2	3	2	-	2	3	3	3	3
MT-201.2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-201.3	3	3	3	3	3	3	3	3	3	--	2	3	3	3	3
MT-201.4	3	3	3	3	3	3	2	3	3	-	3	3	3	3	3
Average	**3**	**3**	**3**	**2.75**	**2.75**	**2.75**	**2.5**	**3**	**2.75**	**-**	**2.5**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-202															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-202.1	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-202.2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-202.3	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-202.4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-203															
COs	PO1- Knowledge	PO2- Communication	PO3- Problem Solving	PO4- Individual and Team Work	PO5- Investigation of Problems	PO6- Modern Tool usage	PO7- Science and Society	PO8- Life-Long Learning	PO9- Environment and Sustainability	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4
MT-203.1	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-203.2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-203.3	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-203.4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Mapping of CO with PO's and PSO's
Semester-III

Course code SEC-301															
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
SEC-301.1	3	3	3	3	3	3	3	3	2	-	3	2	3	3	2
SEC-301.2	3	3	3	3	3	3	3	3	2	-	3	2	3	3	3
SEC-301.3	3	3	3	3	3	2	3	3	2	-	3	2	3	3	3
SEC-301.4	3	3	3	3	3	3	3	3	2	-	3	2	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	-	**3**	**2**	**3**	**3**	**2.75**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-301															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-301.1	3	3	3	2	3	2	2	3	2	-	2	3	3	2	3
MT-301.2	3	3	3	2	3	2	2	3	2	-	3	3	3	3	3
MT-301.3	3	3	3	2	3	2	2	3	2	--	3	3	3	3	3
MT-301.4	3	3	3	2	3	2	2	3	2	-	2	3	3	2	2
Average	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**-**	**2.5**	**3**	**3**	**2.5**	**2.75**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-302															
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-302.1	3	3	3	3	3	2	3	3	3	--	3	3	3	3	3
MT-302.2	3	3	3	3	3	2	3	3	3	--	2	3	3	3	3
MT-302.3	3	3	3	3	3	2	3	3	3	--	3	3	3	3	3
MT-302.4	3	3	3	3	3	2	3	3	3	--	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**--**	**2.75**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-303																
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-303.1	3	3	3	3	3	3	3	3	2	-	3	2	3	3	3
MT-303.2	3	3	3	3	3	3	3	3	2	-	3	2	3	3	3
MT-303.3	3	3	3	3	3	3	3	3	2	--	3	2	3	3	3
MT-303.4	3	3	3	3	3	3	3	3	2	-	3	2	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**3**	**2**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak																

Mapping of CO with PO's and PSO's
Semester-IV

Course code MT-401															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-401.1	3	3	3	2	3	2	2	3	-	-	2	3	3	3	3
MT-401.2	3	3	3	2	2	2	2	3	-	-	2	3	3	2	2
MT-401.3	3	3	3	2	3	2	3	3	--	--	2	3	3	2	3
MT-401.4	3	3	3	2	2	2	2	3	-	-	2	3	3	2	2
Average	**3**	**3**	**3**	**2**	**2.5**	**2**	**2.25**	**3**	**-**	**-**	**2**	**3**	**3**	**2.25**	**2.5**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-402															
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-402.1	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-402.2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-402.3	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-402.4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-403															
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-403.1	3	3	3	3	3	3	3	3	3	--	3	2	3	3	3
MT-403.2	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-403.3	3	3	3	3	3	3	3	3	3	--	3	2	3	3	3
MT-403.4	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**--**	**3**	**2.5**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Mapping of CO with PO's and PSO's
Semester-V

Course code SEC-501A															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
SEC-501A.1	3	3	3	3	3	3	3	3	2	-	3	3	3	3	3
SEC-501A.2	3	3	3	3	3	3	3	3	2	-	3	3	3	3	3
SEC-501A.3	3	3	3	3	3	3	3	3	2	--	3	3	3	3	3
SEC-501A.4	3	3	3	3	3	3	3	3	2	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**3**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code SEC-501B															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
SEC-501B.1	3	3	3	3	3	3	2	3	2	-	2	3	3	3	3
SEC-501B.2	3	3	3	3	3	3	3	3	2	-	3	3	3	3	3
SEC-501B.3	3	3	3	3	3	3	3	3	2	--	3	3	3	3	3
SEC-501B.4	3	3	3	3	3	3	2	3	2	-	2	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**2.5**	**3**	**2**	**-**	**2.5**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-501A															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-501A.1	3	3	3	2	3	2	2	3	-	--	2	3	3	3	2
MT-501A.2	3	3	3	3	3	3	2	3	2	--	3	3	3	3	3
MT-501A.3	3	3	3	3	3	3	2	3	2	--	3	3	3	3	3
MT-501A.4	3	3	3	2	3	2	2	3	-	--	2	3	3	3	2
Average	**3**	**3**	**3**	**2.5**	**3**	**2.5**	**2**	**3**	**2**	**--**	**2.5**	**3**	**3**	**3**	**2.5**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-501B															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-501B.1	3	3	3	3	3	3	3	3	2	-	3	3	3	3	3
MT-501B.2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-501B.3	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-501B.4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.75**	**-**	**3**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-502A															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-502A.1	3	3	3	3	3	3	3	3	2	-	2	3	3	3	3
MT-502A.2	3	3	3	2	3	3	3	3	3	-	3	3	3	3	3
MT-502A.3	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-502A.4	3	3	3	2	2	2	2	3	2	-	2	3	3	3	3
Average	**3**	**3**	**3**	**2.5**	**2.75**	**2.75**	**2.75**	**3**	**2.5**	**-**	**2.5**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-502B															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-502B.1	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-502B.2	3	3	3	3	3	3	3	3	2	--	2	3	3	3	3
MT-502B.3	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-502B.4	3	3	3	3	3	2	3	3	2	--	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**2.75**	**3**	**3**	**2.5**	**--**	**2.75**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-503															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-503.1	3	3	3	3	3	2	2	3	2	--	3	3	3	3	3
MT-503.2	3	3	3	3	3	3	3	3	2	--	3	3	3	3	3
MT-503.3	3	3	2	3	2	3	3	3	-	--	3	2	2	3	2
MT-503.4	3	3	2	3	2	3	3	3	-	--	3	2	2	3	2
Average	**3**	**3**	**2.5**	**3**	**2.5**	**2.75**	**2.75**	**3**	**2**	**--**	**3**	**2.5**	**2.5**	**3**	**2.5**
Note: 3-Strong, 2-Medium, 1-Weak															

Mapping of CO with PO's and PSO's
Semester-VI

Course code MT-601A															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-601A.1	3	3	3	3	3	2	2	3	-	--	2	3	3	2	3
MT-601A.2	3	3	3	3	3	3	3	3	2	--	3	3	3	3	3
MT-601A.3	3	3	3	3	3	2	3	3	-	--	2	3	3	2	3
MT-601A.4	3	3	3	2	3	2	2	3	-	--	2	3	3	2	2
Average	**3**	**3**	**3**	**2.75**	**3**	**2.25**	**2.5**	**3**	**2**	**--**	**2.25**	**3**	**3**	**2.25**	**2.75**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-601B															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-601B.1	3	3	3	3	3	2	3	3	2	-	2	3	3	2	3
MT-601B.2	3	3	3	3	3	3	3	3	2	-	3	3	3	3	3
MT-601B.3	3	3	3	3	3	3	3	3	2	--	3	3	3	3	3
MT-601B.4	3	3	3	2	2	2	2	3	2	-	2	3	3	3	3
Average	**3**	**3**	**3**	**2.75**	**2.75**	**2.5**	**2.75**	**3**	**2**	**-**	**2.5**	**3**	**3**	**2.75**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-602A															
COs	**PO1-** Knowledge	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-602A.1	3	3	3	3	3	3	3	3	2	-	2	3	3	3	3
MT-602A.2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-602A.3	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-602A.4	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.75**	**-**	**2.75**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-602B															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-602B.1	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-602B.2	3	3	3	3	3	3	3	3	3	-	3	3	3	3	3
MT-602B.3	3	3	3	3	2	3	3	3	2	-	3	3	3	3	3
MT-602B.4	3	3	3	3	3	3	3	3	2	-	3	3	3	3	3
Average	**3**	**3**	**3**	**3**	**2.75**	**3**	**3**	**3**	**2.5**	**-**	**3**	**3**	**3**	**3**	**3**
Note: 3-Strong, 2-Medium, 1-Weak															

Course code MT-603															
COs	**PO1- Knowledge**	**PO2- Communication**	**PO3- Problem Solving**	**PO4- Individual and Team Work**	**PO5- Investigation of Problems**	**PO6- Modern Tool usage**	**PO7- Science and Society**	**PO8- Life-Long Learning**	**PO9- Environment and Sustainability**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
MT-603.1	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-603.2	3	3	3	3	3	3	3	3	3	--	3	3	3	3	3
MT-603.3	3	3	2	3	2	3	3	3	-	--	3	2	2	3	2
MT-603.4	3	3	2	3	2	3	3	3	-	--	3	2	2	3	2
Average	**3**	**3**	**2.5**	**3**	**2.5**	**3**	**3**	**3**	**3**	**--**	**3**	**2.5**	**2.5**	**3**	**2.5**
Note: 3-Strong, 2-Medium, 1-Weak															

Mapping of Courses with PO's and PSO's for core and elective courses (Mathematics: FOR FIVE Yrs. INTEGRATED MSc. ENGINEERING PHYSICS)

COs	PO1- Knowledge	PO2- Communication	PO3- Problem Solving	PO4- Individual and Team Work	PO5- Investigation of Problems	PO6- Modern Tool usage	PO7- Science and Society	PO8- Life-Long Learning	PO9- Environment and Sustainability	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4
MT- 101	**3**	**3**	**3**	**2.75**	**2.75**	**3**	**2.5**	**3**	**2.5**	**-**	**2.75**	**3**	**3**	**3**	**3**
MT- 102	**3**	**3**	**3**	**2.75**	**2.75**	**2.5**	**2.25**	**3**	**2.5**	**--**	**2**	**3**	**3**	**2.75**	**2.75**
MT- 103	**3**	**3**	**3**	**3**	**3**	**3**	**2.5**	**3**	**2.5**	**-**	**2.5**	**3**	**3**	**3**	**3**
MT- 201	**3**	**3**	**3**	**2.75**	**2.75**	**2.75**	**2.5**	**3**	**2.75**	**-**	**2.5**	**3**	**3**	**3**	**3**
MT- 202	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**3**	**3**
MT- 203	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**--**	**3**	**3**	**3**	**3**	**3**
SEC- 301	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**3**	**2**	**3**	**3**	**2.75**
MT- 301	**3**	**3**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**-**	**2.5**	**3**	**3**	**2.5**	**2.75**
MT- 302	**3**	**3**	**3**	**3**	**3**	**2**	**3**	**3**	**3**	**--**	**2.75**	**3**	**3**	**3**	**3**
MT- 303	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**3**	**2**	**3**	**3**	**3**
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COs	PO1- Knowledge	PO2- Communication	PO3- Problem Solving	PO4- Individual and Team Work	PO5- Investigation of Problems	PO6- Modern Tool usage	PO7- Science and Society	PO8- Life-Long Learning	PO9- Environment and Sustainability	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4
MT- 401	**3**	**3**	**3**	**2**	**2.5**	**2**	**2.25**	**3**	**-**	**-**	**2**	**3**	**3**	**2.25**	**2.5**
MT- 402	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**-**	**3**	**3**	**3**	**3**	**3**
MT- 403	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**--**	**3**	**2.5**	**3**	**3**	**3**
SEC- 501A	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2**	**-**	**3**	**3**	**3**	**3**	**3**
SEC-501B	**3**	**3**	**3**	**3**	**3**	**3**	**2.5**	**3**	**2**	**-**	**2.5**	**3**	**3**	**3**	**3**
MT-501A	**3**	**3**	**3**	**3**	**3**	**3**	**2.5**	**3**	**2**	**-**	**2.5**	**3**	**3**	**3**	**2.5**
MT-501B	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.75**	**-**	**3**	**3**	**3**	**3**	**3**
MT-502A	**3**	**3**	**3**	**2.5**	**2.75**	**2.75**	**2.75**	**3**	**2.5**	**-**	**2.5**	**3**	**3**	**3**	**3**
MT-502B	**3**	**3**	**3**	**3**	**3**	**2.75**	**3**	**3**	**2.5**	**--**	**2.75**	**3**	**3**	**3**	**3**
MT-503	**3**	**3**	**2.5**	**3**	**2.5**	**2.75**	**2.75**	**3**	**2**	**--**	**3**	**2.5**	**2.5**	**3**	**2.5**
MT- 601A	**3**	**3**	**3**	**2.75**	**3**	**2.25**	**2.5**	**3**	**2**	**--**	**2.25**	**3**	**3**	**2.25**	**2.75**
MT-601B	**3**	**3**	**3**	**2.75**	**2.75**	**2.5**	**2.75**	**3**	**2**	**-**	**2.5**	**3**	**3**	**2.75**	**3**
MT-602A	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**3**	**2.75**	**-**	**2.75**	**3**	**3**	**3**	**3**
MT-602B	**3**	**3**	**3**	**3**	**2.75**	**3**	**3**	**3**	**2.5**	**-**	**3**	**3**	**3**	**3**	**3**
MT-603	**3**	**3**	**2.5**	**3**	**2.5**	**3**	**3**	**3**	**3**	**--**	**3**	**2.5**	**2.5**	**3**	**2.5**
Note: 3-Strong, 2-Medium, 1-Weak															

KURUKSHETRA UNIVERSITY KURUKSHETRA

Five Years Integrated
M. Sc. Engineering Physics (3 Years BSc+2Years M.Sc.)
Under CBCS-LOCF

(Effective from the Academic Session 2023-24)

(7^{th} to 10^{th} semester)

Department of Physics
INSTITUTE OF INTEGRATED & HONORS STUDIES
Kurukshetra University
Kurukshetra - 136 119
Haryana (INDIA)

Introduction:

M. Sc. Engineering Physics (5 years Integrated) was started way back in 2009 in the Physics Department, Institute of Integrated and Honors Studies (IIHS) of Kurukshetra University on the advice of Higher Education Department Haryana. This course is of 5 Years (10 Semesters). ***After completion of 3 years (6 Semesters), students will be awarded B. Sc. Engineering Physics which is equivalent to B. Sc. (Non-Medical).*** The programme was prepared by the faculty of Physical Sciences of Kurukshetra University following the guidelines of the model curriculum developed by UGC, New Delhi and looking the need of the students to compete with recent trends in higher education at national and international level. The same has been finalized by inviting comments, suggestions from experts in individual from universities, institutes, industries and alumni of the institute.

Following the guidelines of UGC, New Delhi and looking at the better employability, entrepreneurship possibilities and also to enhance the latent skills of the students Kurukshetra University has adopted the ***Choice Based Credit System*** **(CBCS)** system for assessing performance of the students from the academic year 2020-2021. The CBCS system offers flexibility to the students in choosing courses of their own choice from the exhaustive list comprising core, elective, skill based, specializations and minor components that are evaluated following the grading system. The university shall be implementing the revised syllabus of M. Sc. Engineering Physics (5 years Integrated) First Year from the coming academic year i.e., 2020-2021. This document provides detailed information on methodology of choosing different components of M. Sc. Engineering Physics (5 years Integrated) First to Fifth Year (Semester I through X) theory and practical courses.

Master of Science (M. Sc.) Engineering Physics (5 years Integrated) is a post-graduation course of Kurukshetra University. **The students pursuing this course will develop foundation aspects of Physics, Chemistry and Mathematics during the first 3 years.** *In the next 2 years, the students pursuing the course will*

develop in-depth understanding of various aspects of the core branches of Physics along with the latest trends, developments and role of physics in science and technology or about the Engineering aspects of the physics **through the study of subjects like Mathematical Tools for Physicists & Engineers classical mechanics, quantum mechanics, Electrodynamics and wave propagation Engineering, Engineering Electronics, Engineering Statistical Physics, Solid State Engineering Physics, , Nuclear Engineering physics, Materials Science Engineering, Modern Medical Imaging systems, Laser systems and basics of fiber optics technology, Modern Characterization techniques, Project work for synthesis, design and characterization of advance and smart materials etc.** The course also helps the students in enhancing their analytical skill through the embedded component of the problem solving skills, seminar activities and hands-on and minds-in activities of the course. The courses offered by the University are of student-centric nature and help them to understand the basic laws of nature and develop necessary skills to apply them to the advanced areas of studies in science and engineering.

There are **core or mandatory courses (theory and laboratory courses)** meant to provide adequate knowledge on various aspects of physics discipline and to prepare the students for applying them for advanced courses. In addition, there will be skill based elective (specialization) as well as few open elective courses enabling cross-discipline movement to the students. The skill based elective courses are of more advanced nature and help the students to develop their skills in specific fields through more of the hands-on activities. The details of the courses and activities are given with detailed syllabus.

Scheme and Syllabi of five years integrated
M. Sc. ENGINEERING PHYSICS Programme
(From 7th to 10th semester)
Under CBCS-LOCF
(w. e. f. from the Academic Session 2023-24)

4th Year (7th and 8th semesters)

SEMESTER VII

Course Type & No.	**Course Code**	**Course Nomenclature**	**Credits (L+T+P)**	**Teaching Hours per week**	**Maximum Marks**			**Duration of Examination (Hrs.)**
					Internal Assessment*	End-semester Examination	Total	
Core Course-1	EP- 701	Mathematical Tools for Physicists & Engineers	4+0+0	4	20	80	100	3
Core Course-2	EP-702	Classical Mechanics	4+0+0	4	20	80	100	3
Core Course-3	EP-703	Quantum Mechanics-I	4+0+0	4	20	80	100	3
Core Course-4	EP-704	Engineering Electronics	4+0+0	4	20	80	100	3
Core Course-5	EP-705	Engineering Physics Laboratory-I (General)	0+0+4	8	---------------	100	100	4
Total Credits/Marks in core courses in semester-VII			**20**				**500**	
Number of Elective courses: Nil			**--------**	**-------------------------------**			**------**	

L-Theory Lectures, T- Tutorials, P-Practical

*Internal Assessment marks

20% marks in each theory paper shall be reserved for Internal Assessment. The following parameters (with weightage of each) forming the basis of award of Internal Assessment:-

(i) One test/Seminar for each paper (one period duration) : 50%

(ii) One Assignment for each paper : 25%

(iii) Attendance : 25%

4th Year
SEMESTER VIII

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks			Duration of Examination (Hrs.)
					Internal Assessment*	End-semester Examination	Total	
Core Course-6	EP- 801	Engineering Statistical Mechanics	4+0+0	4	20	80	100	3
Core Course-7	EP-802	Quantum Mechanics-II	4+0+0	4	20	80	100	3
Core Course-8	EP-803	Nuclear Engineering Physics	4+0+0	4	20	80	100	3
Core Course-9	EP-804	Spectroscopy of Atoms and Molecules	4+0+0	4	20	80	100	3
Core Course-10	EP-805	Engineering Physics Laboratory-I I (Electronics)	0+0+4	8	---------------	150	150	4
Total Credits/Marks in core courses in semester-VIII			**20**				550	
Number of Elective/Open Elective courses: 1								
Open Elective-1	*As per the selection of course made by the student from the list of Open elective courses prepared by the Institute*		2+0+0	2	15	35	50	1:30
Total credits/marks in semester-VIII			**22**				**600**	

Structure and Syllabi
M. Sc. ENGINEERING PHYSICS (5 years Integrated) Programme
Under CBCS-LOCF
(w. e. f. from the Academic Session 2024-25)

5th Year (9th and 10th semesters)

SEMESTER-IX

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks: Internal Assessment*	Maximum Marks: End-semester Examination	Maximum Marks: Total	Duration of Examination (Hrs.)
Core Course-11	EP- 901	Solid State Engineering Physics	4+0+0	4	20	80	100	3
Core Course-12	EP-902	Electrodynamics and wave propagation Engineering	4+0+0	4	20	80	100	3
Core Course-13	EP-903	Laser systems and Basics of Fiber optics Technology	4+0+0	4	20	80	100	3
Total Credits/Marks in core courses in semester-IX			**12**				**300**	**------**
Number of Elective/Open Elective courses: 3								
Elective Course-1	EP-904(A): Advance Engineering Electronics-I Or EP-904(B): Radiation Physics - I		4+0+0	4	20	80	100	3
Elective Course-2	EP-905(A): Advance Engineering Electronics Laboratory **or** EP-905(B): Radiation Physics Laboratory		0+0+4	8		100	100	4
Open Elective-II	*As per the selection of course made by the student from the list of Open elective courses prepared by the Institute*		2+0+0	2	15	35	50	1:30
Total Credits/Marks in Elective/open elective courses in semester-IX			**10**				**250**	
Total credits/marks in semester-IX			**22**				**550**	

Note: Elective papers will be offered according to the availability of the Faculty and Laboratory facility in the Department.

SEMESTER-X

Course Type & No.	Course Code	Course Nomenclature	Credits (L+T+P)	Teaching Hours per week	Maximum Marks			Duration of Examination (Hrs.)
					Internal Assessment*	End-semester Examination	Total	
Core Course-13	EP-1001	Materials Science Engineering	4+0+0	4	20	80	100	3
Core Course-14	EP-1002	Modern Characterization Techniques	4+0+0	4	20	80	100	3
Core Course-15	EP-1003	Modern Medical Imaging Systems	4+0+0	4	20	80	100	3
Total Credits/Marks in core courses in semester-X			**12**				**300**	
Number of Elective/Open Elective courses: 2								
Elective Course-3	EP-1004(A): Advance Engineering Electronics-II Or EP-1004(B): Radiation Physics-II		4+0+0	4	20	80	100	3
Elective Course-4	EP-1005(A): Advance Engineering Physics Laboratory		0+0+4	8	---------------	150	150	4
	or							
	EP-1005(B): Project Work - Dissertation (External Evaluation and Viva-Voce)		4	-----------		150$		---------
Total Credits/Marks in Elective/open elective courses in semester-X			**8**				**250**	
Total credits/marks in semester-X			**20**				**550**	

Note: Elective course-3 in 10^{th} semester is to be selected in the same specialization as selected in 9^{th} semester.

$-100 marks for Project and 50 marks for Viva-Voce

Open Elective Papers

<table>
<tr><th colspan="8">For the Students of M.Sc. Engineering Physics</th></tr>
<tr><td colspan="8">A student will earn four credits by selecting one open elective paper of two credits in 8th semester and one more such paper of same credits in 9th semester, out of the open elective papers offered by the departments in the Institute other than the Physics Department.</td></tr>
<tr><th colspan="8">For the Students of M. Sc. Bio-Tech & M. Sc. Economics in IIHS</th></tr>
<tr><td colspan="8">The Department of Physics offers the following open elective papers to the students of
M. Sc. Bio-Tech & M. Sc. Economics in the Institute.</td></tr>
<tr><th rowspan="2">Course Code</th><th rowspan="2">Course Title</th><th rowspan="2">Credits</th><th rowspan="2">Teaching Hours per week</th><th colspan="3">Maximum Marks</th><th rowspan="2">Duration of Examination (Hrs.)</th></tr>
<tr><td>Internal Assessment*</td><td>End-semester Examination</td><td>Total</td></tr>
<tr><td>OE-EP806 (For 8th Semester)</td><td>Weather Forecasting</td><td>2</td><td>2</td><td>15</td><td>35</td><td>50</td><td>1:30</td></tr>
<tr><td>OE-EP906 (For 9th Semester)</td><td>Medical Physics</td><td>2</td><td>2</td><td>15</td><td>35</td><td>50</td><td>1:30</td></tr>
</table>

Note: A paper shall be run only if the number of students opting for it is at least 20. There will be an upper limit of 40 students in each paper.

M. Sc. Engineering Physics
Semester-VII
Subject: Physics (Paper Code: EP 701)
Paper: Mathematical Tools for Physicists & Engineers
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1. Nine Questions will be set in total
2. Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit I

Vector spaces and Matrices

Definition of a linear vector space, Linear independence, basis and dimension, scalar Product, Orthonormal basis, Gram-Schmidt Orthogonalization process, Linear operators, Matrices: Orthogonal, Unitary and Hermitian matrices, Eigenvalues and eigenvectors of matrices, Matrix diagonalization.

Unit II

Differential equations

Second order linear differential equation with variable coefficients, Solution of Bessel's, Legendre’s, Laguerre’s and Hermite's equations.

Complex Variables

Function of a complex variable, Cauchy Riemann conditions, Cauchy’s integral theorem, Cauchy's integral formula, Taylor's and Laurent series, Cauchy's Residue theorem, Singular points and evaluation of residues, Jordan's Lemma.

Unit III

Special Functions

Definition of special functions, Generating functions for Bessel function of integral order Jn(x) , Recurrence relations, Integral representation; Legendre polynomials Pn(x) , Generating functions for Pn(x) , Recurrence relations; Hermite Polynomials, Generating functions, Rodrigue's formula for Hermite polynomials; Laguerre polynomials, Generating function and Recurrence relations.

Unit IV

Integral Transforms

Integral transform, Laplace transform, some simple properties of Laplace transforms such as first and second shifting property, Inverse Laplace Transform by partial fractions method, Laplace transform of derivatives, Laplace Transform of integrals, Fourier series, Evaluation of coefficients of Fourier series Cosine and Sine series, Fourier Transforms, Fourier sine Transforms, Fourier cosine Transforms.

CO No.	**Course code (EP-701) : Mathematical Tools for Physicists & Engineers** **After successfully completing the course, student will be able to:**
CO-1	Understand the basic concept and applications of Linear vector space, matrix algebra & linear operators and be able to solve the related mathematical problems in Physics.
CO-2	Solve the problems based on differential equations and also be able to determine the residues of a complex function and use the residue theorem to compute certain types of integrals.
CO-3	Have good grasp of special functions that would equip the student for effective tackling of specific problems in physics.
CO-4	Learn about the series expansion & different integral transformation and be able to use their expertise to solve the different mathematical problems relevant to the physical sciences.

Text and Reference Books :

Mathematical Physics by P.K. Chattopadhyay (T)

Mathematical Physics by B.S.Rajput

Matrices and Tensors for Physicists, by A W Joshi

Mathematical Physics by Mathews and Walkers

Mathematics for Physicists by Mary L Boas

M. Sc. Engineering Physics
Semester-VII
Subject: Physics (Paper Code: EP 702)
Paper: Classical Mechanics
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

Survey of Elementary Principles and Lagrangian Formulation

Newtonian mechanics: mechanics of one and many particle systems; conservation laws, motion with variable Mass-The rocket Problem, constraints, their classification; virtual displacement, virtual work, D' Alembert's principle, Lagrange's equations; velocity dependent potential, Rayleigh Function, Invariance of Lagrangian Under Galilean Transformation, dissipative forces, generalized coordinates and momenta; integrals of motion; symmetries of space and time and their connection with conservation laws- conservation of Energy, Conservation of Linear Momentum, conservation of angular Momentum.

Unit II

Moving coordinate systems and Motion in a central force field

Rotating frames; inertial forces; terrestrial applications of Coriolis force, Central force: definition and characteristics; two body problem- Reduction to the equivalent one body problem; conservation theorem-First Integral of motion, virial theorem, closure and stability of circular orbits; general analysis of orbits; Kepler's laws, Kepler’s equations and the Kepler Problem ; the Laplace-Runge-Lenz vector, Centre of Mass and Laboratory Coordinate systems, cross section, Rutherford scattering.

Unit III

Hamiltonian Formalism

Legendre transformation, Hamiltonian equations of motion; the physical significance of the Hamiltonian-H; Cyclic/ignorable coordinates; Canonical transformation; generating functions;

Poisson bracket & properties of Poisson bracket, integrals of motion, Poisson's theorem, invariance of Poisson Bracket under canonical Transformation, Lagrange's Brackets, Infinitesimal Contact Transformation; angular momentum and Poisson bracket relations; Liouville's theorem and its applications.

Unit IV

Variational Principle, Equation of motion and Hamilton-Jacobi Equation

Principle of least action; derivation of equations of motion; variation and end points; Hamilton's principle and characteristic functions; Hamilton-Jacobi equation, harmonic oscillator problem as an example of Hamilton Jacobi Method.

Small Oscillations

Small oscillations; stable and unstable equilibrium, normal modes and coordinates.

CO No.	**Course code (EP-702) : Classical Mechanics** **After successfully completing the course, student will be able to:**
CO-1	Learn different mechanical concepts related to advanced problems involving the dynamic motion of classical mechanical systems.
CO-2	Describe and understand the concepts of central force motion and moving co-ordinate systems.
CO-3	Have basic ideas about the canonical transformation & poisson's Bracket which will lead to understand the concepts of quantum mechanics.
CO-4	Understand theory of small oscillations and also be able to apply the Variational Principle to solve the various problems related to mechanical systems.

Text and Reference Books :

Classical Mechanics by N C Rana and P S Joag (Tata Mcgraw Hill, 1991)

Classical Mechanics by H Goldstein (Addison Wesley, 1980)

Mechanics by A Sommerfeld (Academic Press, 1952)

Introduction to Dynamics by I perceival and D Richards (Cambridge Univ. Press, 1982)

M. Sc. Engineering Physics
Semester-VII
Subject: Physics (Paper Code: EP 703)
Paper: Quantum Mechanics-I
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

General formalism of Quantum Mechanics

States and operators; Representation of States and dynamical variables; Linear vector space; Bra Ket notation, Linear operators; Orthonormal set of vectors, Completeness relation; Hermitian operators, their eigenvalues and eigenvectors, The fundamental commutation relation; Schwartz Inequality, Commutation rule and the uncertainty relation; Simultaneous eigenstates of commuting operators; Postulates of quantum mechanics, The unitary transformation; Dirac delta function; Relation between kets and wave functions; Matrix representation of operators; Solution of linear harmonic oscillator problem by operator method (Ladder Operators), Matrix elements of x, p, a, a^+ and H; Uncertainty Product for simple harmonic oscillator.

Unit II

Angular momentum operator

Angular momentum operators and their representation in spherical polar co-ordinates; Eigenvalues and eigenvectors of L^2, spherical harmonics; Commutation relations among Lx, Ly, Lz ; Rotational symmetry and conservation of angular momentum; Eigenvalues of J^2 and Jz and their matrix representation; Pauli spin matrices; Addition of angular momentum, Clebsch-Gordan coefficients and their calculation for $j_1= j_2 =1/2$, $j_1=1$, $j_2 =1/2$ and $j_1= j_2 =1$.

Unit III

Solution of Schrodinger equation for three dimensional problems

The three dimensional harmonic oscillator in both cartesian and spherical polar coordinates, eigenvalues eigenfunctions and the degeneracy of the states; Solution of the hydrogen atom problem, the eigenvalues eigenfunctions and the degeneracy.

Unit IV

Perturbation Theory

Time independent perturbation theory; Non-degenerate case, the energies and wave functions in first order, the energy in second order; Anharmonic perturbations of the form λx^3 and λx^4; Degenerate perturbation theory; Stark effect on the ground and the first excited state of hydrogen.

CO No.	Course code (EP-703) : Quantum Mechanics-I After successfully completing the course, student will be able to:
CO-1	Understand and explain the application of different operators and fundamental commutation relation which are of fundamental importance in Quantum mechanics.
CO-2	Have better understanding of concepts of spherical polar co-ordinates, spherical harmonics, Orbital & Spin angular momentum, as well as the rules for quantization and addition of these angular momenta.
CO-3	Solve the three dimensional harmonic oscillator and hydrogen atom problem and be able to realize the role of such analysis to the world of atoms and molecules.
CO-4	Use perturbation theory to obtain corrections to energy eigen-states and eigen-values when an external electric or magnetic field is applied to a system for e.g. study of Stark effect of the first excited state of hydrogen.

Text and Reference Books:

Quantum Mechanics by Ghatak and Loknathan

Quantum Mechanics by Powell and Craseman

Quantum Mechanics by S. Gasiorowicz

Quantum Mechanics by A.P.Messiah

Modern Quantum Mechanics by J.J.Sakurai

Quantum Mechanics by L.I.Schiff

Quantum Mechanics by Mathews and Venkatesan

M. Sc. Engineering Physics
Semester-VII
Subject: Physics (Paper Code: EP 704)
Paper: Engineering Electronics
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-.
1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

Network theorems

Node theorem, Millman's theorem, Thevenin's theorem, Norton's theorem, superposition theorem.

Introductory Semiconductor Physics

Intrinsic and extrinsic semiconductors, elemental and compound semiconductors, direct and indirect band gap semiconductors, charge densities in p and n type semiconductors, conduction by charge drift and diffusion, the pn junction, derivation of pn diode equation, Zener and avalanche breakdowns, clipping and clamping circuits.

Unit II

Bipolar junction Transistor (BJT): Transistor operating modes, Transistor action, Transistor biasing configurations and characteristics, Transistor h-parameters, The Ebers-Moll model.

Field effect transistors (FET): Basic structure and operation, volt-ampere characteristics of JFET, metal oxide semiconductor field effect transistor (MOSFET), physical structure, operation and characteristics , enhancement and depleted mode of operation, comparison of p and n channel FETS.

Unit III

Photo-electric and other Electronic Devices

Zener Diode, Varactor Diode, Photodiode, Light Emitting Diode (LED), Solar Cell, Piezo-electric Crystals, Diode Lasers, Condition for Laser Action, Optical Gain, Memory Devices: Random Access Memory, Read Only Memory (Basic idea).

Unit IV

Negative Resistance Devices

Tunnel Diode, Backward diode, Unijunction Transistor, p-n-p-n devices, p-n-p-n characteristics, Silicon Controlled switch, SCS Characteristics. Basic Circuit Principles for NR Switching Circuits: Monostable, Bystable and Astable Operations.

CO No.	Course code (EP-704) : Engineering Electronics After successfully completing the course, student will be able to:
CO-1	Solve the complex electrical networks using different network theorems and also be able to understand the basic concept and different applications related to PN junction diode.
CO-2	Understand and describe the basic structure, working principle and characteristics of Bipolar Junction & Field Effect transistors. These devices are of fundamental importance in electronic science.
CO-3	Have basic idea about the various electronic & optoelectronic devices and be able to realize the use of these devices to the fields of science & technology.
CO-4	Understand and explain the working of important negative resistance devices like Tunnel diode, Backward diode, UJT, SCS etc.

Text and Reference Books :

Semiconductor Devices - Physics and Technology by S.M .Sze ,Wiley (1985)

Introduction to Semiconductor Devices by M.S. Tyagi, John Wiley & Sons

Measurement, Instrumentation and Experimental Design in Physics and Engineering

by M.Sayer and A. Mansingh, Prentice Hall, India (2000)

Optical electronics by Ajoy Ghatak and K. Thygarajan, Cambridge Univ. Press.

Semiconductor Electronics by A.K.Sharma ,New Age International Publisher(1996)

Laser and Non-linear optics by B.B.Laud. ,Wiley Eastern Limited (1985)

Pulse, Digital and Switching Waveforms by Jacob Millman and Herbert Taub ,

Mc Graw Hill Book Company (1965)

M. Sc. Engineering Physics
Semester-VII
Subject: Physics (Paper Code: EP 705)
Paper: Engineering Physics Laboratory-I (General)
Credits: 4

Max. Marks: 100
Time: 4 hrs

Special Note: -

4.Do any eight experiments from the given list of experiments.
5.The students are required to calculate the error involved in a particular experiment.
6.The Practical examination will be held in a single session of 4 hours.

Distribution of Marks:

Experiment	50 marks
Viva- voce	30 marks
Lab Record	20 marks
Total	100 marks

List of Experiments

1. Determination of Half Life of 'In'.
2. Determination of Ionization Potential of Lithium.
3. Measurement of resistivity of a semiconductor by four probe method at different temperatures and Determination of band gap.
4. Measurement of Wavelength of He-Ne Laser light using ruler.
5. Measurement of thickness of thin wire with laser
6. e/m of electron by Helical method.
7. To study uncertainty principle using Laser.
8. To study Faraday Effect using He-Ne Laser.
9. To determine Planck’s Constant (h) by measuring the voltage drop across light-emitting diodes (LEDs) of different colours.
10. Measurement of thickness of thin films using Michelson interferometer.
11. Measurement of coherence length using Michelson interferometer.
12. To find Flashing and Quenching voltage of Neon gas and determine the capacitance of a unknown capacitor.
13. To determine the capacitance of a parallel plate Capacitor using Capacitance and permittivity kit
14. Determination of Lande's ‘g’ factor of DPPH using Electron - Spin resonance (E.S.R.) Spectrometer.
15. X-ray diffraction by Telexometer.
16. Measurement of Hall coefficient of given semiconductor: Identification of type of semiconductor and estimation of charge carrier concentration.
17. Energy band gap of Ge Crystal.
18. Magnetic susceptibility by Gauy's method.
19. To determine the plateau characteristics of G.M. Counter and to find out the absorption coefficient foil absorber using B-Delay source.
20. Determination of range of Beta-rays from Ra and Cs.

CO No.	Course code (EP-705) : Engineering Physics Laboratory-I (General)
	After successfully completing the course, student will be able to:
CO-1	Hands on experience with different instruments and appreciate the beauty of different concepts and related experiments in Physics.
CO-2	Verify some fundamental principles, effects and concepts of physics through Experiments.
CO-3	Perform the experiments to determine the values of different parameters like 'e/m', ionization potential of lithium, thickness of a wire using Laser, resistivity, band gap and Hall's coefficient of a Semiconductor, thickness of thin films using Michelson interferometer, plateau characteristics of G.M. Counter etc.
CO-4	Learn to present observations, results and analysis in suitable and presentable form.

Reference Books:

Semiconductor Devices - Physics and Technology by S.M .Sze,Wiley (1985)

Measurement, Instrumentation and Experimental Design in Physics and Engineering

by M.Sayer and A. Mansingh, Prentice Hall, India (2000)

Optical electronics by Ajoy Ghatak and K. Thygarajan, Cambridge Univ. Press.

Laser and Non-linear optics by B.B.Laud. ,Wiley Eastern Limited (1985)

Principles of Condensed Matter Physics,P.M. Chaikin and T.C. Lubensky (Cambridge University Press, 1995)

Teaching laser physics by experiments, Am. J. Phys., (2011), http://doi.org/1-3488984

Radiation Detection and Measurement, G. F. Knoll (John Wiley & Sons, Inc. 3rd Ed.,2000)

Physics & Engineering of Radiation Detection, S. N. Ahmed (Academic Press 2007)

Techniques for Nuclear and Particle Physics Experiments, W.R. Leo (Springer- Verlag 1987)

M. Sc. Engineering Physics
Semester-VIII
Subject: Physics (Paper Code: EP 801)
Paper: Engineering Statistical Mechanics
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

Phase space, Ensembles, Liouville theorem, conservation of extension, Equation of motion, Equal a priori probability, Statistical equilibrium, Microcanonical ensemble, Quantization of phase space, classical limit, symmetry of wave functions effect of symmetry on counting various distributions using micro canonical ensemble.

Unit II

Entropy of an ideal gas, Gibbs paradox, Sackur-Tetrode equation, Entropy of a system in contact with a reservoir, Ideal gas in a canonical ensemble, Grand canonical ensemble, Ideal gas in Grand Canonical ensemble, Comparison of various ensembles. Quantum distribution using other ensembles.

Unit III

Quantum-mechanical ensemble theory: Density matrix, Equation of motion for density matrix, Quantum-mechanical ensemble average; Statistics of indistinguishable particles, Two types of quantum statistics- Fermi-Dirac statistics and Bose-Einstein statistics, Fermi-Dirac and Bose-Einstein distribution functions using microcanonical and grand canonical ensembles (ideal gas only), Statistics of occupation numbers; Ideal Bose gas: Internal energy, Equation of state, Bose-Einstein Condensation and its critical conditions; Ideal Fermi gas: Internal energy, Equation of state, Completely degenerate Fermi gas.

Unit IV

Cluster expansion for a classical gas, virial equation of state, Van der Waals gas, Phase transition of second kind. Ising Model, Bragg Williams Approximation, Fowler Guggenheim Approximation, Ising Model in one and two dimensions, fluctuations in ensembles, Energy fluctuation in quantum statistics, Concentration fluctuation in quantum statistics, One dimensional random walk, Brownian motion.

CO No.	**Course code (EP-801) : Engineering Statistical Mechanics**
	After successfully completing the course, student will be able to:
CO-1	Appreciate cellular nature of phase space and interface of Statistical Mechanics with Thermodynamics.
CO-2	Have better Knowledge of ensemble theory which would result in greater insight into solutions of various complex problems.
CO-3	Analyse the peculiar gas behaviour and are in a position to extend the treatment to complex problems.
CO-4	Explore the applications of Ising Model and to understand different approximations.

Text and Reference Books

Statistical Mechanics by K Huang

Statistical Mechanics by B.K. Aggarwal and M.Eisner

Statistical Mechanics by R.K. Patharia

Statistical Mechanics by Donalad A Mc Quarrie

Elementary Statistical Mechanics by Gupta and Kumar

Statistical Mechanics R Kubo

Statistical Physics Landau and Lifshitz

M. Sc. Engineering Physics
Semester-VIII
Subject: Physics (Paper Code: EP 802)
Paper: Quantum Mechanics-II
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

Variational methods

Ground state of Helium by both variational and perturbation methods; The hydrogen molecule; WKB approximation; Time dependent perturbation theory; Constant perturbation; Harmonic perturbation; Fermi's golden rule; Adiabatic and sudden approximation.

Unit II

Semi-classical theory of radiation

Transition probability for absorption and induced emission; Electric dipole transition and selection rules; Magnetic dipole transitions; Forbidden transitions; Higher order transitions; Einstein's coefficients.

Unit III

Collision in 3D and scattering

Laboratory and C.M. reference frames; scattering amplitude; Differential scattering cross section and total scattering cross section; The optical theorem; Scattering by spherically symmetric potentials; Partial waves and phase shifts; Scattering by a perfectly rigid sphere and by square well potential; Complex potential and absorption; The Born approximation.

Unit IV

Identical particles

The principle of indistinguishability**;** Symmetric and antisymmetric wave functions; Spin and statistics of identical particles; The Slater determinant; The Pauli exclusion principle; Spin states of a two electron system; States of the helium atom; Collision of identical particles-scattering of two spinless boson, scattering of two identical fermions of spin half.

Relativistic Quantum Mechanics

Introduction, Klein-Gordan (KG) and Dirac's relativistic equation, free particle wavefunction, conservation of angular momentum.

CO No.	**Course code (EP-802) : Quantum Mechanics-II**
	After successfully completing the course, student will be able to:
CO-1	Understand and apply the variational and approximation methods to study the ground state of Helium and hydrogen molecule.
CO-2	Analyse various transitions and their selection rules which are useful for research in many areas of Physics.
CO-3	Have better understanding about the collision in 3-dimension and scattering problems in physics.
CO-4	Grasp the basic knowledge about the spin, statistics and collision of identical particles and be capable to calculate spin states of two electron systems.

Text and Reference Books:

Quantum Mechanics by Ghatak and Loknathan

Quantum Mechanics by Powell and Crassman

Quantum Mechanics by S.Gasiorowicz

Quantum Mechanics by A.P.Messiah

Modern Quantum Mechanics by J.J. Sakurai

Quantum Mechanics by L.I..Schiff

Quantum Mechanics by Mathews and Venkatensan.

M. Sc. Engineering Physics
Semester-VIII
Subject: Physics (Paper Code: EP 803)
Paper: Nuclear Engineering Physics
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs.

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

Two nucleon problem and nuclear forces

The deuteron: binding energy, dipole moment quadrupole moment and the evidence of non-central (Tensor) force, spin dependence of nuclear force. Nucleon-nucleon scattering; s-wave effective range theory, charge independence and charge symmetry of nuclear forces, iso-spin formalism.

Unit II

Nuclear Models

Liquid drop model, stability of nuclei, fission; evidence of shell structure, the shell model spin parity and magnetic moment in extreme single particle model.

Nuclear decays

Alpha, Beta and Gamma decays, Selections rules, Fermi's theory of beta decay, selection rules, comparative half lines, Kurie plot Fermi and Gamow –Teller Transitions; parity non-conservation in beta decay.

Unit III

Gas-filled detectors: Proportional counters, Gas multiplication factor, space charge effects, energy resolution. Position-sensitive proportional counters.

Semiconductor detector in X-ray, gamma-ray Spectroscopy, Ge and Si(Li) detectors, Charge production and collection process.

Electronics associated with detectors: Electronic shielding and grounding, Measurement and control, Signal conditioning and recovery. Electronics for pulse signal processing, preamplifiers (voltage and charge-sensitive configurations), Linear amplifiers, CR-$(RC)^n$ and delay-line pulse shaping.

Unit IV

Elementary Particle

Basic interactions in nature: Gravitational Electromagnetic, weak and strong, classification of elementary particles, Leptons, Hadrons, Mesons, Baryons. Conservation Laws for Elementary Particles. Baryon, Lepton and Muon number, Strangeness and Hypercharge, Gelleman - Nishijima formula. Quark model, SU (2) and SU (3) Symmetries Parities of subatomic particles, charge conjugation.

Detector systems for high energy experiments (brief account): Collider physics, Particle Accelerators, Secondary beams, Beam transport, Modern Hybrid experiments - CMS and ALICE.

CO No.	Course code (EP-803) : Nuclear Engineering Physics After successfully completing the course, student will be able to:
CO-1	Familiar with the Nucleon-nucleon scattering & the nature of nuclear forces.
CO-2	Have basic idea about the liquid drop model and nuclear shell model and be able to findout spin, parity, magnetic moments etc. of different nuclei.
CO-3	Grasp the knowledge about various nuclear decays.
CO-4	Have better understanding of basic interactions in nature and classification of elementary particles. A student will also be able to apply the various conservation laws and Quark model to understand the different aspects of elementary particle physics.

Text and Reference Books :

A. Bohr and B.R. Mottelson, Nuclear Structure, Vol. 1(1969) and Vol. 2 (1975),

Benjamin, Reading A, 1975

Kenneth S. Krane, Introductory Nuclear Physics, Wiley, New York, 1988

Ghoshal, S.N Atomic and Nuclear Physics Vol. 2.

P.H. Perkins, Introduction to High Energy Physics, Addison-Wesley, London, 1982

A Preston and A Bhaduri : Nuclear Physics

H. Frauenfelder and E. Henley : Subatomic Physics

Radiation detection and measurement: G.F. Knoll (Wiley, New York) (2000).

M. Sc. Engineering Physics
Semester-VIII
Subject: Physics (Paper Code: EP 804)
Paper: Spectroscopy of Atoms and Molecules
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

One Electron systems

Quantum mechanical results of hydrogen atom, Atomic spectra of Hydrogen, Quantum numbers and their role, atomic orbitals, orbital and spin angular momenta., spin orbit interaction, vector atom model, spectroscopic terms and their notations, Fine structure in hydrogen energy levels, spectra of alkali elements, different series in alkali spectra, the doublet fine structure.

Spectra of two electrons systems and Pauli Principle

Coupling scheme, L-S and j-j coupling, Building up principle: the Aufbau principle, Equivalent and non-equivalent electrons: Pauli's exclusion principle, Hund's rules, spectral terms, Breit's scheme.

Unit II

Atoms in external fields

Two electron system Hyperfine structure and Line broadening: Normal and anomalous Zeeman effect, Paschen Back effect, Stark effect, Two electron systems , interaction energy in LS and jj coupling, Hyperfine structure (magnetic and electric, only qualitative).

Unit III

Rotation of molecules

Classification of molecules, Interaction of radiation with rotating molecules, Rotational spectra of rigid diatomic molecules, Isotope effect in rotational spectra, Intensity of rotational lines, Non Rigid rotator.

Vibrational and Rotational Vibration spectra of Diatomic molecules

Vibrational energy of diatomic molecule, Diatomic molecules as a simple harmonic oscillator, Energy levels and spectrum, Morse potential energy curve, Molecules as vibrating rotator, vibration spectrum of diatomic molecules, PQR Branches.

Unit IV

Raman Spectroscopy

Introduction, Pure rotational Raman spectra, Vibrational Raman spectra, nuclear spin and intensity alternation in Raman spectra, isotope effect, Raman techniques and instrumentation.

Mossbauer spectroscopy

Recoilless emission and absorption, isomer shift, quadrupole interaction, magnetic hyperfine interaction, Experimental techniques.

CO No.	Course code (EP-804) : Spectroscopy of Atoms and Molecules After successfully completing the course, student will be able to:
CO-1	Understand and explain the atomic spectra of one and two electron atoms.
CO-2	Explain the influence on the spectra of atoms in the presence of external applied electric and magnetic field.
CO-3	Have basic idea about the rotational, vibrational and rotational-vibrational spectra of diatomic molecules.
CO-4	Describe the basic principle and instrumentation of Raman spectroscopy Mossbauer spectroscopy.

Text and Reference Books :

Introduction to Atomic and Molecular Spectroscopy by V.K.Jain

Introduction to Atomic spectra by H.E. White

Fundamentals of molecular spectroscopy by C.B. Banwell

Spectroscopy Vol I and II by Walker and Straughen

Introduction to Molecular spectroscopy by G. M. Barrow

Spectra of diatomic molecules by Herzberg

Molecular spectroscopy by Jeanne . L. McHale

Molecular spectroscopy by J.M. Brown

Spectra of atoms and molecules by P. F. Bemath

Modern spectroscopy by J.M. Holias

Molecular Structure and Spectroscopy by G. Aruldhas.

M. Sc. Engineering Physics
Semester-VIII
Subject: Physics (Paper Code: EP 805)
Paper: Engineering Physics Laboratory-II (Electronics)
Credits: 4

Max. Marks: 150
Time: 4 hrs

Special Note: -

1. Do any eight experiments from the given list of experiments.
2. Each student will deliver one seminar of about 40minutes duration to be conducted once a week during the laboratory hrs.
3. The Practical examination will be held in a single session of 4 hours.

Distribution of Marks:

Experiment	50 marks
Viva- voce	30 marks
Lab Record	20 marks
Seminar	50 Marks
Total	150 marks

List of Experiments:

1. Study of Network theorems.
2. Study of Rectifiers and filter circuits.
3. Zener diode as voltage regulator.
4. Clipping and clamping circuits.
5. Experiments on FET and MOSFET characteristics and application as an amplifier.
6. Experiment on Uni-junction Transistor and its application.
7. Transistor I-V Characteristics.
8. Transistor Biasing and Stability.
9. Common Emitter Transistor Amplifier.
10. Frequency response of RC coupled Amplifier.
11. Push Pull amplifier.
12. To study the frequency variation in R-C phase shift, Oscillator, Colpitt Oscillator and Hartley Oscillator.
13. Differentiating and integrating circuits.
14. Astable, Mono-stable and Bi-stable Multi-vibrater.
15. Characteristics of Solar Cell.
16. Study of (i) Low pass filter (ii) High pass filter (iii) All pass filter (iv) Band pass filter (v) Band reject filter
17. Characteristics and applications of Silicon Controller Rectifier.
18. Study of a Regulated Power Supply.
19. To measure (a) phase difference, (b) deflection sensitivity and (c) frequency of an unknown ac signal using CRO.
20. Design and performance study of a constant current source.

CO No.	Course code (EP-805) : Engineering Physics Laboratory-II (Electronics)
	After successfully completing the course, student will be able to:
CO-1	Learn circuit fundamentals, making of electrical connections and to solve the complex electrical circuits.
CO-2	Understand the behaviour of electronic components and perform analysis for diodes, transistors based electronic devices.
CO-3	Gain practical knowledge of designing, assembling, and testing electronic circuits and devices as well as understanding the troubleshooting.
CO-4	Learn to present observations, results and analysis in suitable and presentable form.

Reference Books :

Semiconductor Devices - Physics and Technology by S.M .Sze ,Wiley (1985)

Introduction to Semiconductor Devices by M.S. Tyagi, John Wiley & Sons

Measurement, Instrumentation and Experimental Design in Physics and Engineering

by M.Sayer and A. Mansingh, Prentice Hall, India (2000)

Optical electronics by Ajoy Ghatak and K. Thygarajan, Cambridge Univ. Press.

Semiconductor Electronics by A.K.Sharma ,New Age International Publisher(1996)

Electronic fundamentals and applications (5th ed.) by J. D. Ryder

Integrated Electronics by J. Millman and C. C. Halkias

Network analysis by Van Valkenburg

Electronic devices and circuits by Y. N. Bapat

M. Sc. Engineering Physics
Semester-IX
Subject: Physics (Paper Code: EP-901)
Paper: Solid State Engineering Physics
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1. Nine Questions will be set in total
2. Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3. Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4. 20% numerical problems are to be set.
5. Use of scientific (non-programmable) calculator is allowed.

Unit I

Crystalline solids, lattice, the basis, lattice translation, vectors, direct lattice, two and three dimensional Bravais lattice, conventional units cells of FCC, BCC, Nacl, CsCl, Diamond and cubic ZnS, primitive lattice cell of FCC, BCC and HCP; closed packed structures: packing fraction of simple cubic, bcc, fcc, hcp and diamond structures.

Interaction of x-rays with matter, absorption of x-rays, X-ray diffraction & interpretation of Bragg's equation, Ewald's construction, reciprical lattice- reciprocal lattice to SC, BCC and FCC lattices, the X-ray diffraction, the Laue, powder and rotating crystal methods.

Unit-II

Vibration of one dimensional mono- and diatomic- chains, phonon momentum, density of normal modes in one and three dimensions, quantization of lattice vibrations, measurement of phonon dispersion using inelastic neutron scattering.

Point defects, line defects and planer (stacking) faults, Fundamental ideas of the role of dislocation in plastic deformation and crystal growth, the observation of imperfection in crystals, x-rays and electron microscopic techniques.

Unit III

Electron in periodic lattice, Bloch theorem Kronig-Penny model and band theory, classification of solids, effective mass, weak-binding method and its application to linear lattice, tight-binding method and its application to cubic bcc and fcc crystals, concepts of holes, Fermi surface : construction of Fermi surface in two- dimension, de Hass van alfen effect, cyclotron resonance, magneto-resistance.

Unit IV

Superconductivity, effect of magnetic field on superconductivity, Meissner effect, heat capacity, energy gap, micro-wave and infra-red properties, isotopic effect.

Thermodynamics of the superconductive transition, London equation, coherence length, BCS theory of superconductivity, Bose-Einstein condensation, Laser cooling, flux quantization in superconducting ring, duration of persistent currents, Type-I and type-II superconductors- vortex state, estimation of Hc1 and Hc2, Ginzburg-Landau theory, Josephon effect, superconductor tunneling- DC Josephson effect, AC Josephson effect and Macroscopic quantum interference, Applications of superconductivity.

CO No.	**Course code (EP-901) : Solid State Engineering Physics**
	After successfully completing the course, student will be able to:
CO-1	Have basic idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, and interpretation of Bragg's equation and also be able to explain the X-ray diffraction, the Laue, powder and rotating crystal methods.
CO-2	Understand dynamics of lattice vibration. The students will also be able to understand and explain the influence of imperfections in solids upon the different properties of solids.
CO-3	Explain motion of electron in periodic lattice of solids under different binding conditions, concept of energy band and effect of same on electrical properties.
CO-4	Understand the BCS theory of superconductivity and have basic idea about superconductors, their classifications and applications in diverse fields of science & technology.

Text and Reference Books :

Verma and Srivastava : Crystallography for Solid State Physics

Azaroff : Introduction to Solids

Omar : Elementary Solid State Physics

Aschroft & Mermin : Solid State Physics

Kittel : Solid State Physics

Chaikin and Lubensky : Principles of Condensed Matter Physics

H. M. Rosenberg : The solid State.

Rajnikant; Solid State Physics, Willey India, 2011.

M. Sc. Engineering Physics
Semester-IX
Subject: Physics (Paper Code: EP-902)
Paper: Electrodynamics and wave propagation Engineering
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

Time Varying Fields and Maxwell Equations

Faraday's Law of induction. displacement current. Maxwell equations. Scalar and vector potentials. Gauge transformation, Lorentz and Coulomb gauges, General Expression for the electromagnetic fields energy, conservation of energy, Poynting's Theorm. Conservation of momentum, time-Harmonic Fields.

Unit-II

Electromagnetic Wave Propagation

Wave equation, plane waves in free space and isotropic dielectrics, polarization, energy transmitted by a plane wave, waves in conducting media. Skin depth. Reflection and Refraction of EM waves at plane interface, Fresnel's amplitude relations. Propagation of electromagnetic wave through ionosphere; Reflection of electromagnetic waves by ionosphere.

Unit III

Waveguides and Resonant Cavities:

Field at the surface of and within a conductor, Cylindrical cavities and waveguides, Waveguides, modes in a rectangular waveguide, Energy flow and attenuation in waveguides, Perturbation of boundary conditions, Resonant cavities, Power losses in a cavity: Q of a cavity, Multimode propagation in optical fibers, Expansion in normal modes; Field generated by a localized source in a hollow metallic Guide.

Unit-IV

Electromagnetic radiations

Retarded potentials, Radiation from an oscillating dipole, Linear antenna, Lienard-Wiechert potentials, potentials for a charge in uniform motion-Lorentz formula, Fields of an accelerated charge, Radiation from an accelerated charged particle at low velocity, radiation when the velocity and acceleration of the particles are collinear, radiation from a charged particle moving in a circular orbit, Electric Quadrupole radiation.

CO No.	**Course code (EP-902) : Electrodynamics and wave propagation Engineering**
	After successfully completing the course, student will be able to:
CO-1	Use Maxwell equations in analysing the nature of electromagnetic field due to time varying charge and current distribution.
CO-2	Describe the nature of electromagnetic wave and its propagation through different media and interfaces involved in different situations.
CO-3	Analyze the basics of theory of transmission lines and waveguides.
CO-4	Simplify charged particle dynamics and radiation from localized time varying electromagnetic sources.

Text and Reference Books :

Classical Electrodynamics by J.D. Jackson

Introduction to Electrodynamics by D.J. Griffiths

Electromagnetic by B.B. Laud

Field and Wave Electromagnetics by D. K. Cheng

Classical Electricity and Magnetism by Panofsky and Phillips

Fundamentals of Electromagnetics by M.A. Wazed Miah

M. Sc. Engineering Physics
Semester-IX
Subject: Physics (Paper Code: EP 903)
Paper: Laser systems and Basics of Fiber optics Technology
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-.
1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit I

Laser: Laser characteristics, Spontaneous and Stimulated Emission, Absorption, population inversion, Laser pumping and pumping process: A two level system, a three level system, Optical pumping & pumping efficiency, Electrical pumping and pumping efficiency, Passive Optical Resonators, Rate Equations, Four-level Laser, Three-level Laser, Methods of Q-switching: Electro optical shutter, mechanical shutter.

Unit II

Laser systems: General description-Laser structure-excitation mechanism-Different laser systems- He-Ne laser, Argon-ion laser, Nitrogen laser, Carbon-dioxide laser, Nd:YAG; Nd:Glass, Pulsed-CW dye laser, Semiconductor Laser.

Applications of Lasers: Laser induced fusion, application in material procession (laser welding, hole drilling, laser cutting), lasers in Medicine & Military.

Holography Introduction, recording and reconstruction process, applications, holographic Interferometry, holographic memories.

Unit III

Fiber optics: Introduction; step index fiber, numerical aperture, pulse dispersion in step index fiber, graded index fibers, material dispersion, single mode fibers, fiber optics sensors; multimode and single mode fiber sensors.

Fiber materials and manufacture, glass fiber, plastic fiber, losses of fibers, bending losses, intrinsic fiber losses, scattering losses and absorption losses.

Unit IV

Optical Communication Systems: (Qualitative study only)

Modulation schemes, analog modulation, digital modulation, free space communication, fiber optical communication system, operating wave length, local area networks, integrated optics, slab and strip waveguides, devices, emitters (sources) and detectors (Qualitative idea only).

CO No.	**Course code (EP-903) : Laser systems and Basics of Fiber optics Technology**
	After successfully completing the course, student will be able to:
CO-1	Understand and explain the characteristics of lasers and basics concept like population inversion, laser pumping & pumping processes etc.
CO-2	Describe the basic principle, working and applications of most of the commercially available lasers.
CO-3	Have better understanding about the fibers & fiber optics technology.
CO-4	Have qualitative idea and basic understanding about the optical communication systems.

Text and Reference Books :

Optics-Azoy Ghatak, TMH Pub. Co.
Principles of Lasers by Svelto
Optical Electronics-Ajoy Ghatak and K. Thyagarajan, Cambridge Uty Press
Lasers and Non-linear Optics by B.B. Laud.
Lasers Theory and Applications- K. Thyagarajan and A.K. Ghatak
Optoelectronics an introduction- J. Wilson and J.F.W. Halkes , Printice hall of India.
High Power Lasers and Their Applications- Dr. M. Premasundern ,Law and commercial Publishers, New Delhi.

M. Sc. Engineering Physics
Semester-IX
Subject: Physics (Paper Code: EP 904A)
Paper: Advance Engineering Electronics-I
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

OPERATIONAL AMPLIFIERS

The basic Operational-Amplifier: Ideal Op-Amp, block diagram of Op. Amp, Practical Inverting & Noninverting Op-Amp; Differential amplifier: CMRR, circuit configuration, Emitter-coupled differential amplifier, Differential amplifier supplied with constant current, transfer characteristics of a differential amplifier; Off-set Error currents and voltages: Input bias current, Input offset current, input offset drift, input offset voltage, input offset voltage drift, output offset voltage, PSRR, Slew rate; Universal balancing techniques;

Inverting and non-inverting Op-Amp's basic applications: Sign changer or inverter, Scale changer, Phase changer, Adder or Summing operation, current to voltage & voltage to current signal conversion, differential dc amplifier, voltage follower, analog integrator & differentiator, Electronic analog computation, Logarithmic & antilogarithmic amplifier, Waveform generator-square wave generator (astable multivibrator), Pulse generator (monostable multivibrator) & Triangular wave generator.

Unit II

DIGITAL CIRCUITS

Binary numbers, Octal numbers, Hexadecimal numbers, Inter-conversions of numbers. Binary addition, subtraction, multiplication, division, Hexadecimal addition, subtraction , Octal addition, subtraction signed numbers, 1's complement arithmetic, 2's complement arithmetic,

Digital (Binary) operation of a system; Logic system: DC Positive and negative logic designations, Positive and negative pulse logic; The OR gate & The AND gate: Circuit in Diode logic (DL), Boolean expression, truth table, Boolean Identities; The NOT gate: Boolean expression, truth table, Boolean Identities, Transistor logic circuit; The NAND gate & The NOR gate: Diode Transistor logic circuit, Boolean expression, truth table, Boolean Identities; The Exclusive OR gate: Boolean notation, truth table and two logic block diagrams for XOR gate; DeMorgan's Laws & Boolean algebra.

Unit III

COMBINATIONAL DIGITAL SYSTEMS

Binary adders: Half adders, full adders, MSI adder, serial operation; Arithmetic functions; True/complement, Zero/one element, Binary subtraction, Digital comparator, parity checker/generator; Decoder: Binary-coded-decimal (BCD) system, BCD-to-decimal decoder, Demultiplexer: 4-to-16 line decoder, decoder/lamp driver, Multiplexer (Data selector): Applications- Parallel to serial conversion, sequential data selection; Encoders; Read Only Memory (ROM): Conversion of Binary to a Gray code & Gray to Binary conversion, ROM applications-Look-up table, sequence generator, seven segment visible display, combinational logic & character generator.

Unit IV

SEQUENTIAL DIGITAL SYSTEMS

A 1-BIT Memory: A sequential system, A 1-BIT storage cell, The clocked S-R Flip-Flop; Flip-Flops: The JK flip Flop- Logic symbol, truth table, preset and clear & race-around condition , Master slave JK flip-flop: T-type & D-type flip flops – Logic symbols and truth table; Shift-register and applications-serial to parallel converter, series in series out register, Parallel to serial converter, Parallel in Parallel out , Right shift, left shift register, digital delay line, sequence generators, shift-Register as ring counter, twisted-ring counter; Ripple (Asynchronous) counters: Ripple counter, Up-down counter, Divide by N counter; Synchronous counters: series carry, parallel carry, Applications of counters: Direct counting, Divide the frequency by N, measurement of frequency, time, distance & speed, wave form generator.

D/A and A/D Systems

Digital to analog converters: Weighted resistor type D/A converter, Ladder type D/A converter; Analog to Digital converter.

CO No.	Course code (EP-904A) : Advance Engineering Electronics-I
	After successfully completing the course, student will be able to:
CO-1	Realize the basics characteristics, circuit analysis and implementation of operational amplifier for various applications like addition, subtraction, differentiation, integration, Electronic analog computation, Logarithmic & antilogarithmic amplifier, Waveform generator-square wave generator, comparator, A/D & D/A convertor etc.
CO-2	Familiar with digital logic circuits Boolean expressions, De-Morgan’s Laws & Boolean algebra. The students will also be able to implement Boolean expression with basic gates and design circuits to achieve desired output.
CO-3	Understand and explain about the various Combinational digital systems like Half adders, full adders, BCD-to-decimal decoder, Demultiplexer, Multiplexer, Read Only Memory (ROM) etc. and also be able to appreciate the applications of these devices.
CO-4	Describe the working and applications of various Sequential Digital Systems like S-R Flip-Flop, The JK flip Flop, Master slave JK flip-flop, T-type & D-type flip flops, shift-Registers and counters etc.

Text and Reference Books

Integrated Electronics by J. Millman and C.C.Halkias (Tata-McGraw Hill)
Fundamental of Electronics by J.D.Ryder (Prentice Hall Publication).
Linear Integrated Circuits by D.Roy Choudhury and Shail Jain (Wiley Eastern Ltd)

M. Sc. Engineering Physics
Semester-IX
Subject: Physics (Paper Code: EP 904B)
Paper: Radiation Physics-I
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

The Nucleus and Radioactivity

Atomic structure, Nuclear mass, Binding energy, binding energy curve and its interpretation, Isotopes, Isotones, Isobars, Nuclear size, Radioactivity, Modes of radioactive disintegration, Nature and properties of radioactive radiations, Radioactive decay, Half life time, Radioactive growth and decay, Radioactive equilibrium, Radioactive series, Radioactive branching, Radioactive dating, Artificial radioactivity, and Uses of radio-isotopes

Unit II

Other Sources of Radiations

X-rays: Characteristic X-rays, Bremsstrahlung (continuous) X-rays, X ray targets, and Clinical X ray beams; Cosmic rays: Discovery, Nature of a cosmic rays, soft and hard component, and Geometric effects on cosmic rays; Terrestrial radiations: Radon gas and Radioactive isotopes of lighter elements, Radiation quantities and units: Activity, KERMA, Exposure, Dose, Equivalent Dose, Effective Dose, Annual Limit on Intake (ALI), and Derived Air Concentration (DAC)

Unit III

Interaction of Radiation with Matter

Modes of interaction: ionization, excitation, elastic and inelastic scattering, Bremsstrahlung, Cerenkov radiation, concepts of specific ionization, mean free path; Interaction of Light Charged Particles with matter; Interaction of Heavy Charged Particles with matter; Interaction of Electromagnetic Radiations with matter: Photoelectric effect, Compton Scattering, and Pair production; Attenuation of Gamma Radiation: Linear and mass attenuation coefficient

Unit IV

Neutron Physics: Discovery of neutrons, Neutron sources, Neutron collimators, Properties of neutrons, Classification of neutrons according to energy, Neutron detectors: Slow neutron detectors (Boron trifluride proportional counter, Boron coated proportional counter, Helium-3 proportional counter, Fission counter, and Scintillation counters), Intermediate neutrons detectors, and Fast neutrons detectors, Neutron detection through slowing down of fast neutrons. Neutron monochromators, and nuclear fission

CO No.	**Course code (EP-904B) : Radiation Physics-I**
	After successfully completing the course, student will be able to:
CO-1	Explain radioactivity and uses of radio-isotopes.
CO-2	Understand and explain radiation quantities and units.
CO-3	Explain the interaction of radiation with matter
CO-4	Better Understanding about the Neutron Physics.

Text & Reference Books:

1. Nulcear and Particle Physics by S. L. Kakani and ShubhraKakani

2. Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005

3. Practical knowledge for Handling Radioactive Sources by Dr. Claus Grupen

4. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx

M. Sc. Engineering Physics
Semester-IX
Subject: Physics, Paper Code: EP-905(A)
Paper: Advance Engineering Electronics Laboratory
No. of Credits: 4

Max. Marks: 100
Time: 4 hrs

Special Note: -

1.Do any eight experiments from given list of experiments.
2.The Practical examination will be held in single session of 4 hours.

Distribution of Marks:

Experiment	50 marks
Viva- voce	30 marks
Lab Record	20 marks
Total	100 marks

List of Experiments

1. Linear characteristics of Operational amplifier.
2. Non-linear characteristics of Operational amplifier.
3. To study the use of operational amplifier for different mathematical operations.
4. Differential Amplifier.
5. Active filters using Operational amplifier.
6. Differentiating and integrating circuits using OP-AMP.
7. To study Schmitt Trigger using transistor and OP-AMP.
8. To study SR and JK flip flop circuits using logic gates.
9. Study of Ripple Counters.
10. To study 4 bit Shift Register.
11. Sample and Hold circuit.
12. A/D and D/A conversion.
13. BCD to Seven segment display.
14. Basic Logic Gates, TTL, NAND and NOR.
15. Working of Half & Full Adders.
16. Working of Half & Full Subtractors.
17. To study the digital comparator, 3 to 8 line Decoder and tri-state digital O/P circuits.
18. To study analog voltage comparator circuit.
19. Pulse position/Pulse width Modulation.
20. Study of Frequency Modulation and Demodulation.
21. Study of Pulse Amplitude Modulations & Demodulation.

CO No.	Course code (EP-905A) : Advance Engineering Electronics Laboratory
	After successfully completing the course, student will be able to:
CO-1	Perform experiments to realize the applications of different analog and digital devices like Operational amplifier, basic logic gates, Flip-flops, shift register, counters, A/D & D/A convertors, Half & Full adders/Subtractors, digital and analog voltage comparators etc.
CO-2	Gain practical knowledge of Modulation and Demodulation process.
CO-3	Have in-depth knowledge about the electronic circuit fundamentals, making of electrical connections and to solve the complex electrical circuit networks.
CO-4	Learn to present observations, results and analysis in suitable and presentable form.

Reference Books:

Integrated Electronics by J. Millman and C.C.Halkias (Tata-McGraw Hill)
Fundamental of Electronics by J.D.Ryder (Prentice Hall Publication).
Linear Integrated Circuits by D.Roy Choudhury and Shail Jain (Wiley Eastern Ltd)

M. Sc. Engineering Physics
Semester-IX
Subject: Physics, Paper Code: EP-905(B)
Paper: Radiation Physics Laboratory
No. of Credits: 4

Max. Marks: 100
Time: 4 hrs

Special Note: -

1.Do any eight experiments from given list of experiments.
2.The Practical examination will be held in single session of 4 hours.

Distribution of Marks:

Experiment	50 marks
Viva- voce	30 marks
Lab Record	20 marks
Total	150 marks

List of Experiments

1. Investigation of the plateau and optimal operating voltage of a Geiger-Muller counter.
2. Investigation of statistical nature of counting rate.
3. To determine the resolving time of a GM counter.
4. Absorption of gamma-rays in material media at different energies.
5. To investigate the relationship between absorber materials (atomic number), absorption thickness and backscattering.
6. To verify the inverse square relationship between the distance and intensity of radiation.
7. To investigate the attenuation of radiation via the absorption of beta particles.
8. To determine the maximum energy of decay of a beta particle.
9. Measurement of range of α particle range in air using a spark counter.
10. Determination of detection efficiency of a Nal (TI) scintillation spectrometer.
11. Investigation of energy response and calibration of a Nal (TI) scintillation spectrometer based on Gamma-rays spectroscopy.
12. Study of the attenuation coefficients of the γ rays for Al, Fe and Pb using NaI scintillation counter.
13. Measurement of γ ray energy of Cs-137 source using a NaI Scintillation detector.
14. Gamma-rays spectroscopy using a single crystal HPGe detector : a) energy response, b) energy resolution and c) detection efficiency determination.
15. Proportional counter, its energy response and low energy X-ray measurements.

CO No.	Course code (EP-905B) : Radiation Physics Laboratory **After successfully completing the course, student will be able to:**
CO-1	Have hands on experience on GM counter, Spark Counter, Scintillation counter
CO-2	Measure range of alpha, beta particles, attenuation coefficient.
CO-3	Familiar with different techniques of detection of nuclear radiations.
CO-4	Appreciate the interaction of nuclear radiation with mater.

Reference Books:

Measurement, Instrumentation and Experimental Design in Physics and Engineering, M. Sayer and A. Mansingh (Prentice Hall India, 2010).

Radiation Detection and Measurement, G. F. Knoll (John Wiley & Sons, Inc. 3rd Ed.,2000)

Physics & Engineering of Radiation Detection, S. N. Ahmed (Academic Press 2007)

Techniques for Nuclear and Particle Physics Experiments, W.R. Leo (Springer- Verlag 1987)

Practical knowledge for Handling Radioactive Sources by Claus Grupen. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx.

M. Sc. Engineering Physics
Semester-X
Subject: Physics (Paper Code: EP 1001)
Paper: Materials Science Engineering
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total

2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.

3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

UNIT – I

CERAMICS AND COMPOSITES

Introduction, Structure of Ceramics, Production of ceramics other than glass and cement: Raw materials, forming process, post forming process; production of glass: melting of glass, glass forming and annealing; mechanical properties of ceramics; wear and erosion resistance; thermal shock; A commercial ceramic system: silica-alumina system; Technical ceramics: Zirconia and sialons; Cement and concrete; Composites; Mechanical properties of Continuous fiber composites: strength, Young's modulus; Mechanical properties of Discontinuous fiber composites; anisotropy; toughness; comparison of polymer, metal and ceramic matrix composites; some commercial composites: carbon-carbon and zirconia-toughened alumina, alumina reinforced aluminum alloys, polymer matrix composites.

Unit- II

Polymeric material

Introduction, molecular structure: Monomers and polymers, molecular weight, branching, tacticity and copolymers; Mechanics of flexible polymer chains: chain conformations, entanglements; Thermoplastic melts: viscosity, processing of thermoplastics; Amorphous polymers: The rubbery state, glass transition, time dependence; Crystallinity and orientation: Lamellae and spherulites, orientation; Thermosets and elastomers: thermosets, elastomers, thermoplastic elastomers; Mechanical properties: Stress-strain behaviour, crep recovery and stress relaxation, time-temperature correspondence, viscoelastic models, crack and craze growth, impact and fatigue; Physical and chemical properties: optical properties, electrical conductivity, density, diffusion, absorption and corrosion, degradation, oxidation and ageing; Speciality polymers: High – performance polymers, Liquid crystal polymers and functional polymers.

Unit – III

Nanomaterials; Introduction to Nanomaterials, Advances in Nanomaterials, Classification of Nanomaterials ; Zero, one , two and three dimensional nanostructures.

Different methods of preparation of Nanomaterials, Top down and Bottom up: Mechanical grinding, Wet Chemical Synthesis of Nanomaterials; Sol-gel process, Properties of Nanomaterials**:** Optical properties, Electrical properties, Mechanical properties, Magnetic properties, Selected Application of Nanomaterials, Disadvantages of Nanomaterials.

Unit – IV

Magnetic Materials

Classification of magnetism - Concept of magnetic domain structure - Soft magnetic materials: iron and iron based materials, permalloys, Ni_Zn and Mn_Zn ferrites - Microwave ferrites and garnets - Amorphous magnets (metglasses) - Hard magnetic materials: High carbon steel, AINiCo alloys - Structure and magnetic properties of Barium ferrites, Sm-co and Nd2Fe4B magnets - Rare earth element magnets - Effects of 3d transition elements – Applications of hard Vs Soft magnets.

CO No.	**Course code (EP-1001) : Materials Science Engineering** **After successfully completing the course, student will be able to:**
CO-1	Explain the types, structures, mechanical properties and different applications of ceramic and composite materials.
CO-2	Knowledge about the different types of polymers, their important properties and their applications in different scientific and technological fields.
CO-3	Have basic understanding about the classification, synthesis methods, important properties and applications of Nanomaterials.
CO-4	Explain the classification and applications of magnetic materials.

Text and Reference Books:

1. J.C. Anderson, KD. Leaver, R.D. Rawlings and J.M. Alexander, Materials Science, 4th Edition (ChapmanHall, London, 1990).

2. V. Raghavan, Materials Science and Engineering, 3rd Ed. (Prentice-Hall India, New Delhi, 1993). (For units 2, 3 & 5).47

3. C.M. Srivastava and C. Srinivasan Science of Engineering Materials, Wiley-Eastern Ltd., New Delhi, 1987). (For units 1, 2 & 5).

4. G.K. Narula, K.S. Narula and V.K. Gupta, Materials Science (Tata McGraw-Hill, 1988).

5. Z.D. Jaberezki, The Nature and Properties of Engineering Materials, (Wiley Eastern).

6. E.P. Wohlfarth, Ferromagnetic materials, Vols. 1, 2 & 3 (North rolland, 1980).

7. H. Ibach and H. Luth, Solid State Physics – An Introduction to Principles of Material Science, 2nd Ed. (2001).

8. R.K. Gupta (Editor), Physics of Particles, Nuclei and Materials - Recent Trends (New Horizons of Physics Series, Narosa, New Delhi, 2002).

M. Sc. Engineering Physics
Semester-X
Subject: Physics (Paper Code: EP 1002)
Paper: Modern Characterization techniques
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs.

Note:-

1 Nine Questions will be set in total

2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.

3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit I

Electron Microscopy: introduction, Electron optics; Principle, instrumentation, methodology and applications of Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM) and Atomic Force Microscope (AFM).

Rutherford backscattering spectrometry (RBS): Principle, kinematics, instrumentation, depth profile and applications.

Elastic recoil detection analysis (ERDA): Principle, instrumentation, methodology and applications.

Unit - II

Auger Electron spectroscopy (AES): Principle, instrumentation, methodology and applications of AES in composition analysis and depth profiling;

X-ray photoelectron spectroscopy (XPS): principle, instrumentation, methodology and applications

Secondary ion mass spectroscopy (SIMS): Principle, instrumentation, working and application. Glancing angle X-ray diffraction: Basic concept, Instrumentation and structural analysis applications.

Unit - III

NMR: The principle of NMR, NMR spectrometer, Relaxation mechanisms, chemical shift; spin-spin coupling, applications of NMR spectroscopy.

ESR: ESR spectrometer, substances which can be studied by ESR, Resonance condition. Description of ESR by Precession, Relaxation mechanisms, Features of ESR spectra (a) Fine structure (b) hyperfine structure and applications of ESR.

Unit - IV

UV-Visible Spectroscopy: Introduction, instrumentation and applications.

Thermal analysis tools: TGA, DTA /DSC- Basic principle, instrumentation and applications.

FTIR spectroscopy: Basic concept, instrumentation, different mode of operation and applications.

Raman spectroscopy: introduction: Basic concept, instrumentation and applications.

CO No.	Course code (EP-1002) : Modern Characterization techniques After successfully completing the course, student will be able to:
CO-1	Explain the basic principle, working and applications of SEM, TEM, AFM, RBS & ERDA techniques in characterization of different materials.
CO-2	Describe the principle, working instrumentation and importance of AES, XPS and SIMS techniques in materials characterization.
CO-3	Have basic understanding about the Electron spin resonance and nuclear spin resonance spectroscopic techniques.
CO-4	Describe the working principle, instrumentation and applications of thermogravimetric analysis, UV-vis, Raman and FTIR spectroscopic techniques

References Books

1. Electron spectroscopy: theory, techniques and applications- C.R. Brundee and A.D. Baker Eds. Academic Press.

2. Fundamentals of surface and thin film analysis- L.C. Feldman and J.W. Mayer, North Holland.

3. Atomic and Nuclear Analytical Methods, H.R. Verma, Springer Berlin Heidelberg, New York.

4. Fundamentals of solid state engineering by Manijeh Razeghi, Springer.

5. Infrared and Raman Spectroscopy Edited by Bernhard Schrader, VCH Publishers. Inc., New York.

6. Modern Spectroscopy-J. Michael Hollas, Wiley publisher.

7. Thermal characterization of polymeric materials-E.A. Turi, Elsevier publisher.

8. Polymer characterization. Physical techniques- D. Campbell and J.R. White, Chapman and Hall.

M. Sc. Engineering Physics
Semester-X
Subject: Physics (Paper Code: EP 1003)
Paper: Modern Medical imaging systems
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs.

Note:-

1 Nine Questions will be set in total

2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.

3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit I

X-ray Machine and digital Radiography: Basis of diagnostic radiology, Nature of X-rays, Properties of X-rays, units of X-radiation, Production of X-rays; stationary anode tube, collimators and grids, exposure timing systems, automated exposure control, Visualization of X-rays Machine; X-ray films, fluorescent screens, x-ray image intensifier television system.

X-ray computed tomography: Basic principle, Contrast Scale, System components- scanning system, processing system, viewing system; Patient dose in CT Scanners.

Unit-II

Ultrasonic imaging systems: Diagnostic ultrasound, Physics of ultrasonic waves-Characteristic impedance, wavelength and frequency, velocity of propagation, absorption of ultrasonic energy, beam width, resolution, generation and detection ultrasound; Medical ultrasound; Basic pulse echo apparatus; A scan- applications; B scanner- types of scan, imaging instrumentation; Biological effects of ultrasound.

Unit – III

Nuclear Magnetic imaging systems: Radio-isotopes in medical diagnosis; Physics of radioactivity: time decay of radioactive isotopes, units of radioactivity, types and properties of particles emitted in radioactive decay; The gamma camera-basic idea and it’s electronics; emission computed tomography (ECT); Single-Photon-Emission computed tomography (SPECT); Position Emission tomography (PET scanner).

Unit – IV

Magnetic imaging system: Principles of NMR imaging system, Free induction decay (FID), Fourier Transformation of FID, The Bloch equation; Image reconstruction technique- Sequential point method, sequential line method, sequential plane method; Discrimination based on relaxation rates-saturation recovery, inversion recovery, spin-eco-imaging technique; Types of imaging sequences; Basic NMR components; Biological effects of NMR imaging system; Advantages of NMR imaging systems.

CO No.	**Course code (EP-1003) : Modern Medical Imaging Systems** **After successfully completing the course, student will be able to:**
CO-1	Understand the working of X-ray Machine and basics of diagnostic radiology.
CO-2	Understand the basic Physics involved, instrumentation and biological effects of Ultrasonic imaging systems.
CO-3	Have basic understanding about advanced medical diagnosis systems like Emission Computed Tomography (ECT); Single-Photon-Emission Computed Tomography (SPECT) and Position Emission Tomography (PET scanner).
CO-4	Describe the working principle, basic components, biological effects and advantages of NMR imaging system

Text and Reference Books:

1. Medical Instrumentation by John. G. Webster –John Wiley
2. Principles of Applied Biomedical Instrumentation by Goddes & Baker – John Wiley
3. Biomedical Instrumentation & Measurement by Carr & Brown-Pearson
4. Biomedical Instrument by Cromwell-Prentice Hall of India, New Delhi
5. Hand book of Medical instruments by R.S. Khandpur –TMH, New Delhi
6. Medical Electronics and Instrumentation by Sanjay Guha – University Publication
7. Introduction to Biomedical electronics by Edwand J. Bukstein –sane and Co. Inc. USA

M. Sc. Engineering Physics
Semester-X
Subject: Physics (Paper Code: EP 1004A)
Paper: Advance Engineering Electronics-II
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total
2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.
3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.
4 20% numerical problems are to be set.
5 Use of scientific (non-programmable) calculator is allowed.

Unit I

Amplifier models, feedback and biasing

Two port network analysis: active circuit models, gain in decibels, equivalent circuit for BJT, the transconductance model for BJT, analysis of CE, CB, and CC amplifiers; An amplifier with feedback, effect of negative feedback on gain and its stability, distortions, input and output impedances of amplifiers, Analysis of amplifiers with voltage series, voltage shunt, current series and current shunt negative feedbacks; Location of quiescent (Q) point, biasing circuits for amplifiers: fixed bias, emitter feedback bias & voltage feedback bias, bias sources for integrated circuits, Circuits for stabilization of Q-Point.

Unit II

Frequency response of amplifiers

Introduction, the amplifier pass band, mid-range response of CE cascade, the high frequency equivalent circuit (Miller effect), the high frequencies response, the frequency response of RC and transformer coupled CE amplifiers, gain-frequency plots of amplifier response, bandwidth of cascaded amplifiers, bandwidth criterion for the transistor, the gain-bandwidth product, composite amplifier designs, bootstrapping in amplifiers, noise in amplifiers, noise figure.

Unit III

Power amplifiers

Power amplifiers: class A large signal amplifiers, second and higher order harmonic distortions, the transformer coupled power amplifier, impedance matching, efficiency, push-pull amplifiers, class-B amplifiers, complementary stages, cross over distortions, class-AB operation, heat sinks, derating curve

Unit IV

Fundamentals Modulation and Demodulation

Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated class C amplifier, Efficiency modulation, frequency conversion, SSB system, Balanced modulation, filtering the signal for SSB, phase shift method, product detector, Pulse modulation: PAM, PTM, PWM, PPM, PCM (in brief), Digital transmission and demodulation.

CO No.	**Course code (EP-1004A) : Advance Engineering Electronics-II** **After successfully completing the course, student will be able to:**
CO-1	Understand and explain the role of different biasing and feedback methods in BJT amplifiers.
CO-2	Understanding of frequency response of amplifiers and be able to apply this knowledge to the study of frequency response of amplifier in Laboratory.
CO-3	Describe the working of different types of Power Amplifiers and be able to perform experiments in laboratory related to power amplifiers.
CO-4	Understand and explain the fundamentals of Modulation and Demodulation.

Text and Reference Books

Integrated Electronics by J. Millman and C.C.Halkias (Tata-McGraw Hill)
Fundamental of Electronics by J.D.Ryder (Prentice Hall Publication).
Linear Integrated Circuits by D.Roy Choudhury and Shail Jain (Wiley Eastern Ltd)
Electronic devices and circuits by Y. N. Bapat
Pulse, digital and switching waveforms by J. Millman and H. Taub

M. Sc. Engineering Physics
Semester-X
Subject: Physics (Paper Code: EP 1004B)
Paper: Radiation Physics-II
No. of Credits: 4

Max. Marks: 100
Theory: 80
Internal Assessment: 20
Time: 3 hrs

Note:-

1 Nine Questions will be set in total

2 Question number 1 will be compulsory and will be based on the conceptual aspects of entire syllabus. This question may have five parts and the answer should be in brief but not in Yes/ No.

3 Four more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

4 20% numerical problems are to be set.

5 Use of scientific (non-programmable) calculator is allowed.

Unit I

Principles of radiation detection

Gas filled radiation detectors: ionization chambers, proportion counters, GM counters, and Spark counter. Scintillation (organic/inorganic) counter; Solid State Detector: Crystal detector, Semiconductor Detectors (Junction type detector, Lithium drift Germanium detector, and HPGe), Thermo – Luminescent Dosimeters (TLD), Chemical detectors (Photographic Emulsions Films), Radiation Monitoring Instruments and Calibration check of radiation monitoring equipment.

Unit II

Biological Effects of Ionizing Radiation

Introduction, Cell Biology: Structure and function of living cell, cell division-mitosis, meiosis and differentiation, central dogma of molecular biology, genetic codes-DNA, RNA and Proteins; Effect of Radiation on Cell: inhibition of cell division, chromosome aberrations, genes mutation, and cell death; Biological effects of Radiation on Human: Somatic Effects (Early effect) and Stochastic effect (Late effect).

Unit III

Principles of Radiological Protection

Justification of Practice, Optimization of Practice, and Dose Limitations; Internal Exposure, Dose Limit for (i) Radiation Workers (ii) Public, Occupational Exposure of Women, Apprentices and Students. Production of Radioisotopes and Labeled Compounds: Introduction, Separation of Isotopes, Production of labeled compounds, Specific Activity of labeled compounds, Storage, Quality, and Purity of Radio-labeled compounds.

Unit IV

Radiation Hazard: Internal Hazards and External Hazards; Evaluation and Control of Radiation Hazard, Radiation Shield, Monitoring of External Radiation, Control of Internal Hazard: (i) Containment of Source (ii) Control of Environment (iii) Contamination (iv) Air Contamination Monitoring (v) Personal Contamination Monitoring (vi) Decontamination Procedures; Radiation Emergency and Preparedness.

CO No.	**Course code (EP-1004B) : Radiation Physics-II**
	After successfully completing the course, student will be able to:
CO-1	Understand and explain the working of radiation detectors.
CO-2	Have better understanding of biological effects of radiation.
CO-3	Have knowledge about the principles of Radiological Protection
CO-4	Have awareness about the radiation hazard's types, their control and radiation emergency and preparedness.

Text and Reference Books

Radiation Oncology Physics: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2005.

Practical knowledge for Handling Radioactive Sources by Claus Grupen. Introduction to Radiological Physics and Radiation Dosimetry by Frank Herbert Attlx.

Radiation Biology: a handbook for teachers and students; International Atomic Energy Agency Vienna, 2010.

M. Sc. Engineering Physics
Semester-IX
Subject: Physics, Paper Code: EP-1005 (A)
Paper: Advance Engineering Physics Laboratory
No. of Credits: 4

Max. Marks: 150
Time: 4 hrs

Special Note: -

4.Do any eight experiments from the given list of experiments.
5.Each student will deliver one seminar of about 40minutes duration to be conducted once a week during the laboratory hrs.
6.The Practical examination will be held in single session of 4 hours.

Distribution of Marks:

Experiment	50 marks
Viva- voce	30 marks
Seminar	50 Marks
Lab Record	20 marks
Total	150 marks

List of Experiments

1. To determine magneto resistance of a Bismuth crystal as a function of magnetic field.
2. To study hysteresis in the electrical polarization of a TGS crystal and measure the Curie temperature.
3. To determine the band gap of Si material.
4. To study dielectric properties of liquids & Solids.
5. To study Hall Effect and to determine Hall coefficient.
6. To study of dielectric constant as a function of temperature and determine the Curie temperature.
7. To determine the Dielectric Constant of different solid samples.
8. Study of lead tin phase diagram.
9. To determine the capacitance of a parallel plate Capacitor using Capacitance and permittivity kit.
10. Determine the Curie temperature of a given ferroelectric material.
11. To study the piezoelectric properties of a given material.
12. Study of ferroelectricity using standard P-E loop measurement.
13. Measurement of Magneto-resistance of Semiconductors.
14. Measurement and analysis of FTIR/Raman spectrum of a given material.
15. Measurement and analysis of UV-visible spectrum of a given material.
16. Measurement and analysis of TG-DTG thermogram of a given material.
17. DSC/DTA analysis of a given material.
18. Lattice parameter and Miller Indices using XRD.
19. Determination of particle size and lattice strain using XRD.
20. SEM/TEM/AFM analysis of a given material.

CO No.	Course code (EP-1005A) : Advance Engineering Physics Laboratory
	After successfully completing the course, student will be able to:
CO-1	Perform experiments to determine resistance & band gap of semiconductor materials and to study the piezoelectric & ferroelectric properties of ferroelectric materials.
CO-2	Familiar with the material characterization techniques like TGA/DTA, SEM/TEM/AFM, FTIR, Raman and UV-visible spectroscopy.
CO-3	Adopt the skills related to research, education, and industry.
CO-4	Learn to present observations, results and analysis in suitable and presentable form.

Reference Books:

Solid State Physics by A. J. Dekker (Macmillan)

Introduction to Condensed Matter Physics By K.C. Barua (Narosa)

Principle of Electronic Materials and Devices by S. O. Kasap (Tata McGraw Hill)

Electronic Properties of Materials by Rolf E. Hummel (Springer)

Solid State Physics by Ashcroft &Mermin (Cengage Learning).

Introduction to Solid State Physics by Charles Kittel (Wiley).

Electron spectroscopy: theory, techniques and applications- C.R. Brundee and A.D. Baker Eds. Academic Press.

Infrared and Raman Spectroscopy Edited by Bernhard Schrader, VCH Publishers. Inc., New York.

Modern Spectroscopy-J. Michael Hollas, Wiley publisher.

Polymer characterization. Physical techniques- D. Campbell and J.R. White, Chapman and Hall.

M. Sc. Engineering Physics
Semester-X
Subject: Physics (Paper Code: EP – 1005B)
Paper: Project Work-Dissertation
No. of Credits: 2

Max. Marks: 150
Project: 100
Viva-Voce: 50

In the project, the student will explore new developments from books and journals, collecting literature / data and write a dissertation based on his / her work and studies. The project can also be based on experimental work.

CO No.	**Course code (EP-1005B) : Project Work-Dissertation**
	After successfully completing the course, student will be able to:
CO-1	Have adventures into preliminary research field both in theory and experiment.
CO-2	Learn about the synthesis methods of smart materials and their characterization using modern techniques like TGA/DTA, SEM/TEM/AFM, FTIR, Raman, UV-visible spectroscopy etc.
CO-3	Explore new developments by collecting literature/data from books and journals and be able to adopt the skills related to research, education, and industry.
CO-4	Learn to present observations, results and analysis in suitable and presentable form.

Open Elective-I
Subject: Physics (Paper Code: OE-EP806)
Paper: Weather Forecasting
No. of Credits: 2

Max. Marks: 50
Theory: 35
Internal Assessment: 15
Time: 1:30 hrs

Note:-

1 Five Questions will be set in total

2 Question number 1 will be compulsory and of 7marks; it will be based on the conceptual aspects of entire syllabus. This question may have 3-5 parts and the answer should be in brief but not in Yes/ No.

3 Two more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit I

Introduction to atmosphere

Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones and anticyclones: its characteristics.

Measuring the weather

Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

Unit II

Climate and Climate Change

Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

Basics of weather forecasting

Weather forecasting: analysis and its historical background; need of measuring weather; types of weather forecasting; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

CO No.	**Course code (OE-EP806) : Weather Forecasting** **After successfully completing the course, student will be able to:**
CO-1	Acquire basic knowledge of the elements of the atmosphere, its composition at various heights, variation of pressure and temperature with height.
CO-2	Learn basic techniques to measure temperature and its relation with cyclones and anti-cyclones.
CO-3	Acquire knowledge of simple techniques to measure wind speed and its directions, humidity & rainfall.
CO-4	Have awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques and appreciate the role of physics in understanding the concepts related to weather forecasting.

Reference Books:

Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books

The weather Observers Hand book, Stephen Burt, 2012, Cambridge University Press.

Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.

Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers, Nagpur.

Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.

Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

Open Elective-II
Subject: Physics (Paper Code: OE-EP906)
Paper: Medical Physics
No. of Credits: 2

Max. Marks: 50
Theory: 35
Internal Assessment: 15
Time: 1:30 hrs

Note:-

1 Five Questions will be set in total
2 Question number 1 will be compulsory and of 7marks; it will be based on the conceptual aspects of entire syllabus. This question may have 3-5 parts and the answer should be in brief but not in Yes/ No.
3 Two more questions are to be attempted, selecting one question out of two questions set from each unit. Each question may contain two or more parts. All questions will carry equal marks.

Unit I

Physics of the Body-I

Mechanics of the body: Skeleton, forces, and body stability. The Physics of Locomotors Systems: joints & movements, Stability & Equilibrium. Energy household of the body: Energy balance in the body, Energy consumption of the body, Heat losses of the body, Thermal Regulation. Pressure system of body: Physics of breathing, Physics of cardiovascular system.

Physics of the Body-II

Acoustics of the body: Nature and characteristics of sound, Production of speech, Physics of the ear, Diagnostics with sound and ultrasound. Optical system of the body: Physics of the eye. Electrical system of the body: Physics of the nervous system, Electrical signals and information transfer.

Unit II

Medical Imaging Physics

Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, Computed tomography scanner- principle & function, display, generations, mammography. Thyroid uptake system and Gamma camera (Only Principle, function and display).

Diagnostic nuclear medicine

Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography.

Medical Instrumentation

Basic Ideas of Endoscope and Cautery, Sleep Apnea and Cpap Machines, Ventilator and its modes.

CO No.	Course code (OE-EP906) : Medical Physics
	After successfully completing the course, student will be able to:
CO-1	Learn about the human body, its anatomy, physiology and biophysics, the Physics of the senses, exploring its performance as a physical machine.
CO-2	Gain knowledge with reference to working of various diagnostic tools, medical imaging techniques.
CO-3	Acquire a broad and fundamental understanding of Physics while developing particular expertise in medical applications.
CO-4	Appreciate the applications of Physics to clinical medicine.

Reference Books:

Medical Physics, J.R. Cameron and J.G. Skofronick, Wiley (1978)

Basic Radiological Physics Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003).

Christensen’s Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990).

Physics of Radiation Therapy: F M Khan - Williams and Wilkins, Third edition (2003).

Physics of the human body, Irving P. Herman, Springer (2007).

The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002).

Handbook of Physics in Diagnostic Imaging: R.S. Livingstone: B.I. Publication Pvt Ltd.

The Physics of Radiology-H E Johns and Cunningham.

Hand book of Medical instruments by R.S. Khandpur –TMH, New Delhi.

KURUKSHETRA UNIVERSITY KURUKSHETRA

POs & PSOs
(7^{th} to 10^{th} semester)

for

Five Years Integrated
M. Sc. Engineering Physics (3 Years BSc+2Years M.Sc.)
Under CBCS-LOCF
(Effective from the Academic Session 2023-24)

Department of Physics
INSTITUTE OF INTEGRATED & HONORS STUDIES
Kurukshetra University
Kurukshetra - 136 119
Haryana (INDIA)

Program Outcomes (PO) for Post Graduate Programmes (M.Sc. Engineering Physics-7th to 10th semesters), Institute of Integrated & Honors Studies, KUK:

PO1	Knowledge	Capable of demonstrating comprehensive disciplinary knowledge gained during course of study
PO2	Research Aptitude	Capability to ask relevant/appropriate questions for identifying, formulating and analyzing the research problems and to draw conclusion from the analysis
PO3	Communication	Ability to communicate effectively on general and scientific topics with the scientific community and with society at large
PO4	Problem Solving	Capability of applying knowledge to solve scientific and other problems
PO5	Individual and Team Work	Capable to learn and work effectively as an individual, and as a member or leader in diverse teams, in multidisciplinary settings.
PO6	Investigation of Problems	Ability of critical thinking, analytical reasoning and research based knowledge including design of experiments, analysis and interpretation of data to provide conclusions
PO7	Modern Tool usage	Ability to use and learn techniques, skills and modern tools for scientific practices
PO8	Science and Society	Ability to apply reasoning to assess the different issues related to society and the consequent responsibilities relevant to the professional scientific practices
PO9	Life-Long Learning	Aptitude to apply knowledge and skills that are necessary for participating in learning activities throughout life
PO10	Ethics	Capability to identify and apply ethical issues related to one's work, avoid unethical behaviour such as fabrication of data, committing plagiarism and unbiased truthful actions in all aspects of work
PO11	Project Management	Ability to demonstrate knowledge and understanding of the scientific principles and apply these to manage projects

Programme Specific Outcomes (PSOs)

After successful completion of M. Sc. Engineering Physics programme, the students will

PSO1: Able to develop skills of critical thinking, hypothesis building and applying the scientific method of physics and engineering concepts, theoretical models and laboratory experiments to appreciate how diverse phenomena observed in nature follow from a small set of fundamental laws through logical and mathematical reasoning.

PSO2: Be capable of applying the core physical laws to understand the basic concepts, latest progress in the fields of Science & Technology.

PSO3: Gain hands-on skills for carrying out basic experiments as well as be able to grasp the understanding of basics principle and instrumentation of advance tools (The ornaments of present day science and technology) through the study of subjects like Engineering Electronics, Lasers and fiber optics technology, Modern Characterization techniques, Modern Medical Imaging systems, Materials Science engineering, Project work for synthesis, design and characterization of advance and smart materials etc.

PSO4: Develop problem solving skill for identifying and formulating problems independently and creatively employing the theoretical and/or experimental methods that he has acquired during the course

PSO5: Have a new perspective to look at everything from 'Physics' point of view that enabling them to work environment at industrial scale as well as at research level so that the students can successfully compete for current employment opportunities.

PSO6: Have awareness of the impact of Physics & Engineering in social, economical and environmental issues.

Mapping of CO with PO's and PSO's
Semester-VII

Course code EP-701																	
Course outcomes	PO1- Knowledge	PO2- Research Aptitude	PO3- Communication	PO4- Problem Solving	PO5- Individual and Team Work	PO6- Investigation of Problems	PO7- Modern Tool usage	PO8- Science and Society	PO9- Life-Long Learning	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	2	3	2	2	2	-	2	3	3	2	3	3	2
CO2	3	3	3	3	2	3	2	2	2	-	2	3	3	2	2	3	2
CO3	3	3	3	3	2	3	2	2	2	-	2	3	3	2	3	2	2
CO4	3	3	3	3	2	3	2	2	2	-	2	3	3	2	2	2	2
Average	3	3	3	3	2	3	2	2	2	-	2	3	3	2	2.50	2.50	2
Note: S-Strong, M-Medium, W-Weak																	

Course code EP-702																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	3	2	3	3	-	2	3	3	2	3	3	2
CO2	3	3	3	3	2	3	2	2	2	-	2	3	2	2	3	2	2
CO3	3	3	3	3	2	3	2	3	3	-	2	3	3	2	3	3	2
CO4	3	3	3	3	2	3	2	2	2	-	2	3	2	2	3	2	2
Average	3	3	3	3	2	3	2	2.50	2.50	-	2	3	2.50	2	3	2.50	2

Course code EP-703																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	3	2	3	2	-	2	3	3	2	3	3	2
CO2	3	3	3	3	2	3	2	3	2	-	2	3	3	2	3	2	2
CO3	3	3	3	3	2	3	2	3	2	-	2	3	3	2	3	3	2
CO4	3	3	3	3	2	3	2		2	-	2	3	3	2	3	2	2
Average	3	3	3	3	2	3	2	3	2	-	2	3	3	2	3	2.50	2

Course code EP-704																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	3	2
CO2	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	2	2
CO3	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	3	2
CO4	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	2	2
Average	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	2.50	2

Course code EP-705																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	3	2
CO2	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	2	2
CO3	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	3	2
CO4	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	2	2
Average	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	2.50	2

Mapping of CO with PO's and PSO's
Semester-VII

Course code EP-801																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	2	3	3	2	3	-	3	3	3	2	3	3	2
CO2	3	3	3	2	3	2	3	2	3	-	3	3	3	2	3	2	2
CO3	3	3	3	2	2	3	3	2	3	-	3	3	3	2	3	3	2
CO4	3	3	3	2	3	2	3	2	3	-	3	3	3	2	3	2	2
Average	3	3	3	2	2.50	2.50	3	2	3	-	3	3	3	2	3	2.50	2

Course code EP-802																	
Course outcomes	**PO1-** Knowledge	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	3	2	2	3	-	2	3	3	2	3	3	2
CO2	3	3	3	3	2	2	2	2	3	-	2	3	3	2	3	2	2
CO3	3	3	3	3	2	3	2	2	3	-	2	3	3	2	3	3	2
CO4	3	3	3	3	2	2	2	2	3	-	2	3	3	2	3	2	2
Average	3	3	3	3	2	2.50	2	2	3	-	2	3	3	2	3	2.50	2

Course code EP-803																	
Course outcomes	**PO1-** Knowledge	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	2	2	2	2	3	-	2	3	3	2	3	2	2
CO2	3	3	3	2	2	2	2	2	3	-	2	3	3	2	3	2	2
CO3	3	3	3	2	2	2	2	2	3	-	2	3	3	2	3	2	2
CO4	3	3	3	2	2	2	2	2	3	-	2	3	3	2	3	2	2
Average	3	3	3	2	2	2	2	2	3	-	2	3	3	2	3	2	2

Course code EP-804																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	2	3	2	3	-	2	3	3	2	3	2	2
CO2	3	3	3	3	2	2	3	2	3	-	2	3	3	2	3	2	2
CO3	3	3	3	3	2	2	3	2	3	-	2	3	3	2	3	2	2
CO4	3	3	3	3	2	2	3	2	3	-	2	3	3	2	3	2	2
Average	3	3	3	3	2	2	3	2	3	-	2	3	3	2	3	2	2

Course code EP-805																	
Course outcomes	PO1- Knowledge	PO2- Research Aptitude	PO3- Communication	PO4- Problem Solving	PO5- Individual and Team Work	PO6- Investigation of Problems	PO7- Modern Tool usage	PO8- Science and Society	PO9- Life-Long Learning	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	3	2
CO2	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	3	2
CO4	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	2	2
Average	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	2.50	2

Course code EP-901																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	3	3	2	2	3	-	2	3	3	2	3	2	2
CO2	3	3	3	2	3	3	2	2	3	-	2	3	3	2	3	2	2
CO3	3	3	3	2	3	3	2	2	3	-	2	3	3	2	3	2	2
CO4	3	3	3	2	3	3	2	2	3	-	2	3	3	2	3	2	2
Average	3	3	3	2	3	3	2	2	3	-	2	3	3	2	3	2	2

Course code EP-902																	
Course outcomes	**PO1-** Knowledge	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	2	3	2	2	2	-	2	3	3	2	3	2	2
CO2	3	3	3	2	2	3	2	2	2	-	2	3	3	2	3	2	2
CO3	3	3	3	2	2	3	2	2	2	-	2	3	3	2	3	2	2
CO4	3	3	3	2	2	3	2	2	2	-	2	3	3	2	3	2	2
Average	3	3	3	2	2	3	2	2	2	-	2	3	3	2	3	2	2

Course code EP-903																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	3	3	3	3	-	2	3	3	2	3	2	2
CO2	3	3	3	3	2	3	3	3	3	-	2	3	3	2	3	2	2
CO3	3	3	3	3	2	3	3	3	3	-	2	3	3	2	3	2	2
CO4	3	3	3	3	2	3	3	3	3	-	2	3	3	2	3	2	2
Average	3	3	3	3	2	3	3	3	3	-	2	3	3	2	3	2	2

Course code EP-904A																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO2	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO3	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO4	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
Average	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2

Course code EP-904B																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	2	3	2	3	3	-	2	3	2	2	3	2	2
CO2	3	3	3	2	2	3	2	3	3	-	2	3	2	2	3	2	2
CO3	3	3	3	2	2	3	2	3	3	-	2	3	2	2	3	2	2
CO4	3	3	3	2	2	3	2	3	3	-	2	3	2	2	3	2	2
Average	3	3	3	2	2	3	2	3	3	-	2	3	2	2	3	2	2

Course code EP-905A																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	3	2
CO2	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	2	2
CO3	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	3	2
CO4	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	2	2
Average	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	2.50	2

Course code EP-905B																	
Course outcomes	**PO1-** Knowledge	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	3	2
CO2	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
CO3	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	3	2
CO4	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
Average	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2.50	2

Course code EP-1001																	
Course outcomes	**PO1-** Knowledge	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	2	3	3	2	3	-	3	3	3	2	3	3	2
CO2	3	3	3	2	2	3	3	2	3	-	3	3	3	2	3	2	2
CO3	3	3	3	2	2	3	3	2	3	-	3	3	3	2	3	3	2
CO4	3	3	3	2	2	3	3	2	3	-	3	3	3	2	3	2	2
Average	3	3	3	2	2	3	3	2	3	-	3	3	3	2	3	2.50	2

Course code EP-1002																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	3	3	3	3	-	3	3	3	3	3	2	2
CO2	3	3	3	3	2	3	3	3	3	-	3	3	3	3	3	2	2
CO3	3	3	3	3	2	3	3	3	3	-	3	3	3	3	3	2	2
CO4	3	3	3	3	2	3	3	3	3	-	3	3	3	3	3	2	2
Average	3	3	3	3	2	3	3	3	3	-	3	3	3	3	3	2	2

Course code EP-1003																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO2	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO3	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO4	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
Average	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2

Course code EP-1004A																	
Course outcomes	**PO1-** Knowledge	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO2	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO3	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
CO4	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
Average	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2

Course code EP-1004B																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	2	3	2	3	3	-	2	3	3	2	3	2	2
CO2	3	3	3	2	2	3	2	3	3	-	2	3	3	2	3	2	2
CO3	3	3	3	2	2	3	2	3	3	-	2	3	3	2	3	2	2
CO4	3	3	3	2	2	3	2	3	3	-	2	3	3	2	3	2	2
Average	3	3	3	2	2	3	2	3	3	-	2	3	3	2	3	2	2

Course code EP-1005A																	
Course outcomes	PO1- Knowledge	PO2- Research Aptitude	PO3- Communication	PO4- Problem Solving	PO5- Individual and Team Work	PO6- Investigation of Problems	PO7- Modern Tool usage	PO8- Science and Society	PO9- Life-Long Learning	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
CO1	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	3	2
CO2	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
CO3	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	3	2
CO4	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
Average	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2.50	2

Course code EP-1005B																	
Course outcomes	**PO1- Knowledge**	**PO2- Research Aptitude**	**PO3- Communication**	**PO4- Problem Solving**	**PO5- Individual and Team Work**	**PO6- Investigation of Problems**	**PO7- Modern Tool usage**	**PO8- Science and Society**	**PO9- Life-Long Learning**	**PO10- Ethics**	**PO11- Project Management**	**PSO1**	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**
CO1	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
CO2	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
CO3	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
CO4	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
Average	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2

Mapping of CO's with PO's &PSO's for five yrs. Integrated MSc. Engineering Physics (7th to 10th semesters)

Course code	PO1- Knowledge	PO2- Research Aptitude	PO3- Communication	PO4- Problem Solving	PO5- Individual and Team Work	PO6- Investigation of Problems	PO7- Modern Tool usage	PO8- Science and Society	PO9- Life-Long Learning	PO10- Ethics	PO11- Project Management	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6
EP-701	3	3	3	3	2	3	2	2	2	-	2	3	3	2	2.50	2.50	2
EP-702	3	3	3	3	2	3	2	2.50	2.50	-	2	3	2.50	2	3	2.50	2
EP-703	3	3	3	3	2	3	2	3	2	-	2	3	3	2	3	2.50	2
EP-704	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	2.50	2
EP-705	3	3	3	3	3	3	3	2	3	-	3	3	3	2	3	2.50	2
EP-801	3	3	3	2	2.50	2.50	3	2	3	-	3	3	3	2	3	2.50	2
EP-802	3	3	3	3	2	2.50	2	2	3	-	2	3	3	2	3	2.50	2
EP-803	3	3	3	2	2	2	2	2	3	-	2	3	3	2	3	2	2
EP-804	3	3	3	3	2	2	3	2	3	-	2	3	3	2	3	2	2
EP-805	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	2.50	2
EP-901	3	3	3	2	3	3	2	2	3	-	2	3	3	2	3	2	2
EP-902	3	3	3	2	2	3	2	2	2	-	2	3	3	2	3	2	2
EP-903	3	3	3	3	2	3	3	3	3	-	2	3	3	2	3	2	2

EP-904A	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
EP-904B	3	3	3	2	2	3	2	3	3	-	2	3	2	2	3	2	2
EP-905A	3	3	3	3	3	3	3	2	3	-	3	3	3	3	3	2.50	2
EP905B	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2.50	2
EP-1001	3	3	3	2	2	3	3	2	3	-	3	3	3	2	3	2.50	2
EP-1002	3	3	3	3	2	3	3	3	3	-	3	3	3	3	3	2	2
EP-1003A	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
EP-1004A	3	3	3	3	2	3	3	3	3	-	2	3	3	3	3	2	2
EP-1004B	3	3	3	2	2	3	2	3	3	-	2	3	3	2	3	2	2
EP-1005A	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2.50	2
EP1005B	3	3	3	2	3	3	3	2	3	-	3	3	3	3	3	2	2
Note: S-Strong, M-Medium, W-Weak																	