PYC101: MATHEMATICAL METHODS, MECHANICS and ELECTRICAL CIRCUIT THEORY

(Under CBCS Ordinance from 2017 onwards)

PYC 101 SEM I Section I	**MATHEMATICAL METHODS, MECHANICS**	**Credit : 3—Theory 2 Practical 1**

Course Objectives

- To recall/memorise the Mathematical Methods in order to develop mathematical skills in solving numerical in Physics.
- Explain one dimensional motion and dependence of force on position, velocity and time
- Explain the two-dimensional motion like that of projectile motion.

Theory	**2 Credits**
• **Mathematical methods**	15 CH
Matrices and determinants, Linear equations System of linear equations, matrices and determinants.	2 CH
Elementary Vector Algebra Scalars and vectors, addition and subtraction of vectors, multiplication by a scalar, basis vectors and components, magnitude of a vector, unit vector, dot and cross product of vectors and their physical interpretation.	2 CH
Complex numbers Complex numbers, notation of complex number, complex planes, physical meaning of complex quantities, exponential, logarithmic and trigonometric functions, hyperbolic functions. De'Moivre's Theorem, Roots of unity.	2 CH
Limits and Continuity Definition, intervals and neighbourhoods, algebra of limits, limits of trigonometric functions, exponential limits. Concept of continuity, left and right-hand limits, graphical representation of continuity.	3CH
Differentiation Differentiation from first principles, derivative of polynomials, trigonometric, exponential, logarithmic functions and implicit functions. Rules of differentiation, Leibnitz theorem, higher order derivatives.	3CH
Integration Integration from first principles, integration as inverse of derivative, integration by inspection. Standard Integrals: (Algebraic, trigonometric, exponential logarithmic), integration by parts, substitution methods, reduction formulae).	3CH

Motion of a particle in one dimension Discussion of the general problem of one-dimensional motion. Dependence of force in general on position, velocity and time. Motion under a constant force with illustrations - Atwood's machine, free fall near the surface of the earth. Motion along a rough inclined plane. The equation of motion, momentum and energy conservation theorems. Motion under a force which depends on time-general approach to the solution. Illustration using force of the type $F = Fo \sin(\omega t + \varphi)$. Motion under a conservative force dependent on position, potential energy. Motion under damping force depending on velocity - general dependence of resistive force on velocity. Motion in a medium with resistive force proportional to first power of velocity. Body falling under gravity in a resistive medium near the surface of the earth.	10 CH
Motion in two dimensions : Equations of motion in plane polar coordinates. Momentum and energy theorems. Plane and vector angular momentum theorems. Projectile motion in a non-resistive and resistive medium, (resistive force proportional to the first power of velocity).	5 CH
Learning Outcome **Learner will be able to** • Build knowledge of mathematics to solve various numerical involved in Electricity, Electronic Circuit theory, Statistical Mechanics, Solid State Physics, Electromagnetic theory, Classical Mechanics, Quantum Mechanics, Thermodynamics. • Apply the equation of motion to one or two dimensions of the system in order to understand kinematics of the body under the various conditions of applied force.	
Text Books & References 1. K. F. Riley, M. P. Hobson and S. J. Bence, Mathematical methods for Physics and Engineering, Cambridge University Press (2006). 2. Robert Stainer and Philip Schmidt, Mathematics for Physics students, Schaum series, 2007. 3. K. R. Symon, Mechanics, Addison Wesley (1962). 4. R. G. Takawale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw-Hill (1997). 5. C. Kittel, W. D. Knight, M. A. Ruderman, A. C. Helmholtz and B. J. Moyer, Berkeley Physics Course, Volume I, Mechanics, McGraw-Hill (1973). 6. Eugene Hecht, College Physics, Schaum Outline Series, 2011. 7. P. V. Panat, Classical Mechanics, Narosa Publishing, (2013). 8. D. S. Mathur, Mechanics, S. Chand & Co. (1981). 9. Gupta, Kumar and Sharma, Classical	

Mechanics, Pragati Prakashan, Merut (2008).

Practical (any four) (1 credit)

Introduction to measurement techniques: Range and least count of instruments, measurements using various instruments and error analysis (Vernier callipers, micrometre screw gauge, travelling microscope, spherometer, spectrometer).

1. Graphical analysis of one-dimensional motion: Kinematics, plotting and interpretation of displacement, velocity and acceleration versus time graphs. Linear and nonlinear plots, determination of slopes and area under the curves for evaluation of physical quantities such as force, work and energy.

2. Motion in resistive medium (Experimentation/Simulation).

3. Atwood’s machine.

4. Fly wheel: Determination of frictional couple and moment of inertia of a flywheel.

5. Projectile Motion (Experimentation/Simulation).

6. Bar pendulum

7. Conical Pendulum

8. Torsional Pendulum

PYC101: **ELECTRICAL CIRCUIT THEORY**

(Under CBCS Ordinance from 2017 onwards)

PYC 101 SEM I Section II	ELECTRICAL CIRCUIT THEORY	Credit : 3 —Theory 2 Practical 1

Course Objectives

- To explain fundamentals of circuit analysis ,Kirchoff's laws, Thevenin and Norton Theorem, superposition Theorem and Maxwells Cyclic current method.
- To introduce concept of self and mutual inductance and evaluation of self inductance of different conductors
- To explain how LR and CR circuits respond to DC transients.
- To explain response of LR and CR circuits to AC using J operator.
- To explain analysis of some AC circuits including bridges.

Theory **2 Credits**

Circuit Analysis [7] Concept of constant current and constant voltage source, Maxwell's cyclic current method for circuit analysis, Superposition theorem, Thevenin's theorem, Norton's theorem, maximum power transfer theorem (with proof) and their application to simple networks	7 CH
Inductance [4] Self Inductance, self inductance of two parallel wires carrying equal current in opposite directions, Principle of non-inductive resistance coils, self inductance of co-axial cables, mutual inductance, coefficient of coupling, inductance in series and parallel	4 CH
Response of circuits containing L, C and R to DC [6] Growth and decay of current in L-R circuit, Charging and discharging of capacitor in C-R circuit and in a series L-C-R circuit.	6CH
AC Circuits [7] AC applied to L-R and C-R circuits, Inductive and Capacitive reactance, impedance and admittance, The j operator and vector or phasor method applied to LR, CR and LCR circuits. Series and parallel resonance. Q factor and Bandwidth. Graphic representation of resonance (Variation of resistance, inductive reactance, capacitive reactance with frequency)	7CH
Mutually Coupled L-R circuits [3] AC applied to mutually coupled L-R circuits. Reflected impedance. Transformers, Effect of loading the secondary of a transformer	3CH
AC Bridges [3] General AC bridges, Maxwell's bridge, Maxwell's L/C bridge,De-Sauty's bridge. Wein's frequency bridge.	3CH

Learning Outcome

Learner will be able to

- Students learn to apply kirchoffs laws and network theorems for analysing electrical circuits
- Students learn to compute self and mutual inductance
- Students learn about AC and DC response for LR and CR and learn about design of oscillators and High Pass and Low Pass filters.
- Students learn about applications of Ac bridges for inductance and capacitance measurements.
- Students learn Principles of measurement in electrical circuits for lab work.

Text Books & References 1. J. Yarwood and J. H. Fewkes, Electricity and Magnetism. University Tutorial Press (1991). 2. D. N. Vasudeva, Fundamentals of Electricity and Magnetism, S. Chand and Company Ltd. New Delhi.(2012) 3. Brijlal and Subramaniam, Electicity and Magnetism, Ratan Prakashan, New Delhi. (1966). 4. Mahmood Nahvi, Joseph Edminister, Electrical Circuits, Schaum outline Series, (2002). 5. Thereja B.L. Text Book of Electrical Technology, S. Chand and Co Ltd. New Delhi (1990). 6. Sudhakar and Shammohan, Circuits and Networks Analysis and Synthesis, TMH, (2006).	
PYC101 SECTION 2: ELECTRICAL CIRCUIT THEORY Practical (any four) (1 credit) 1. Verification of Thevenin's Theorem. 2. Verification of Norton's theorem. 3. Response of LR and CR circuits to AC - phasor diagrams. 4. Step Response of CR circuit / LR Circuit. 5. De Sauty's Bridge and Maxwells L/C Bridge. 6. LCR Series and parallel resonance –Resonant frequency, Q value and Bandwidth. 7. Resistance of Mirror Galvanometer / Table Galvanometer by Shunting. 8. Figure of Merit of Mirror Galvanometer and Determination of Current and Voltage Sensitivity	

PYC102: Heat & Thermodynamics And Properties of Matter & Acoustics (Under CBCS Ordinance from 2017 onwards)

PYC 102 SEM II Section I	SECTION I: Heat & Thermodynamics	Credit: 3— Theory 2 Practical 1

Course Objectives

- To discuss the kinetic theory of gases, degrees of freedom, transport phenomenon.
- To discuss behaviour of real gas from ideal gas.
- To discuss three laws of thermodynamics

Theory **2 Credits**	
Kinetic theory of gases Three states of matter, concept of ideal gas, postulates of Kinetic Theory of gases, expression of pressure of a gas, relation between rms velocity and temperature, Average kinetic energy of a gas molecule, heat and temperature, kinetic interpretation of temperature, Degrees of freedom, Law of equipartition of energy and its application to specific heats of gases. Brownian motion and its features, Einstein's equation, Determination of Avogadro's number. Mean free path and derivation to calculate MFP, Transport phenomena, transport of momentum (viscosity).	8 CH
Behavior of real gases Deviation from perfect gas behavior, Discussion of results of Andrew's experiments on CO2 and Amagat's experiment, critical constants, Van der Wall's equation of state, expression of Wan der Wall's constants, Reduced equation of state, Law of corresponding state, relation between Boyle temperature and critical temperature, critical coefficient.	7CH
Zeroth and First Law of Thermodynamics Basic concepts of thermodynamics: Thermodynamic system, Thermodynamic variables, Thermodynamic equilibrium, and Thermodynamic processes, Zeroth law of thermodynamics and concept of temperature, Internal energy and First law of thermodynamics, Relation between pressure, volume and temperature in adiabatic process, Work done in isothermal and adiabatic processes, Path dependence of heat and work.	4CH
Second Law of Thermodynamics Process-reversible and irreversible, condition of reversibility, Second law of thermodynamics, Carnot's cycle, efficiency of Carnot's cycle, reversibility of Carnot's cycle, Carnot's theorem, coefficient of performance of a refrigerator, Thermodynamic scale of temperature, its identity with perfect gas scale, Clapeyron latent heat equation and its applications.	7CH
Entropy Entropy as a Thermodynamic variable, Entropy change in reversible and irreversible processes, Temperature–Entropy diagram of Carnot's Cycle, Entropy of a perfect gas, Physical significance of Entropy: Entropy and Unavailable Energy, Entropy and molecular disorder, Entropy and Second Law of Thermodynamics. Impossibility of attaining Absolute Zero (Third law of Thermodynamics).	4CH

Learning Outcome

Learner will be able to

- Explain motion of gas particles on the basis of kinetic theory of gases, identify various degrees of freedom associated with different types of molecules.
- Apply laws of thermodynamics to real system

Text Books & Reference Books:

1. Treatise on heat, M. N. Saha and B. N. Shrivastava, The Indian Press (1965).
2. Thermal Physics, S.C . Garg, R.M. Bansal and C. K. Ghosh, TMH (1993).
3. Thermodynamics J.K. Roberts and A.R Miller , E.L.B.S. (1960).
4. Text Book of Heat, G.R. Noakes, Mcmilan& Co(1960).
5. Thermodynamics, William C .Reynolds (1968).
6. Heat and Thermodynamics M.W. Zemansky and R.H. Ditman, McGraw Hill (1997).
7. Heat, Thermodynamics and Statistical Physics, BrijLal, N. Subrahmanyam and P. S. Hemne, S. Chand.

Practical (any four) (1 credit)

1. Determination of Stefan's constant.
2. Resistance Thermometry (Cu wire and Pt 100).
3. Thermistor- NTC /PTC.
4. Study of thermocouples for temperature measurement.
5. Constant volume air thermometer.
6. Constant pressure air thermometer.
7. Calibration of Si diode as a temperature sensor.
8. Measurement of thermal conductivity of good conductors- by any method

PYC102: PROPERTIES OF MATTER AND ACOUSTICS
(Under CBCS Ordinance from 2017 onwards)

<table>
<tr><td>PYC 102 Section II</td><td>SECTION I: PROPERTIES OF MATTER AND ACOUSTICS</td><td>Credit: 3— Theory 2
Practical 1</td></tr>
<tr><td colspan="3">Course Objectives
To explain concept of M I and its computation.
To explain concept of elasticity and computation of elastic constants, torsional pendulum and bending of beams
To explain surface tension, angle of contact and capillarity
To explain viscocity and computation of co-efficient of viscocity.
To explain significance of Newton’s formula for velocity of sound and vibrations of stressed strings and superposition of SHM.
To explain Doppler effect, production of ultrasonic waves and their application.
To explain role of reverberation in acoustic design of auditorium</td></tr>
<tr><td colspan="3">Theory 2 Credits</td></tr>
<tr><td colspan="2">Elasticity: [10] Brief review of moment of Inertia. Modulii of elasticity, Strain energy, equivalence of shear to compression and extension at right angles to each other, Poisson's ratio and its limiting values, Relationship between the elastic constants. Torsion in a string-couple per unit twist, Torsional Pendulum. Bending of beams-bending moment, flexural rigidity. Cantilever (rectangular bar). Depression of a beam supported at the ends and loaded at the center. Theory of Loaded pillars, Critical load for pillars</td><td>10 CH</td></tr>
<tr><td colspan="2">Surface Tension: [4] Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Pressure difference across curved surfaces. Angle of contact. Capillarity, experimental determination of surface tension and angle of contact.</td><td>4CH</td></tr>
<tr><td colspan="2">Flow of liquids and Viscosity: [3] Streamline flow, Turbulent flow, Critical velocity. Coefficient of viscosity, Poiseuille's formula for flow of liquid through a capillary tube. Viscosity of gases – Mayer’s formula.</td><td>3CH</td></tr>
<tr><td colspan="2">Acoustics: [10] Differential equation for harmonic oscillator, Velocity of longitudinal waves in fluids. Newton's formula for velocity of sound, vibrations in stretched strings. (transverse and longitudinal modes). Vibration in rods. Superposition of two simple harmonic motions, standing waves and beats, Helmholtz resonator.
Doppler effect. Intensity level - Bel and Decibel. Production and detection of Ultrasonic waves and its applications</td><td>10CH</td></tr>
<tr><td colspan="2">Reverberation of sound [3] Reverberation of Sound, Reverberation time, Absorption coefficient, Sabine’s formula for reverberation time, Acoustic requirements of an auditorium.</td><td>3CH</td></tr>
<tr><td colspan="2">Learning Outcome

Learner will be able to
Students learn role of elastic constant in design of structures and solve problems.
Students learn to use Newton’s formula for computation of sound velocity in media.
Students learn about Physics of string based musical instruments and solve problems.
Students learn to apply Doppler principal and solve practical problems.
Students learn acoustic design of auditorium and use Sabine’s formula to optimize reverberation.</td><td></td></tr>
</table>

- Students learn about measurements for laboratory work

Text Books and References

1. Elements of Properties of Matter, by D. S. Mathur, S. Chand and Sons, (2013).
2. Lectures in elementary fluid dynamics, by J. M. McDonough (Lecture Notes available on Net, free download).
3. Fluid Mechanics by R K Bansal, Firewall Media, (2005).
4. Fluid Mechanics by Merle Potter, David Wiggert, Schaum Outline Series, (2008).
5. Continuum Mechanics by George Mase, Schaum Outline Series. (1969).
6. Text book of Sound by Khanna and Bedi, Atma Ram, New Delhi, 1969.

Practical (any four) (1 credit)

1 **SECTION 2: PROPERTIES OF MATTER AND ACOUSTICS Practical (any four) (1 credit)**

1. Bending of beams-single cantilever: determination of Young's modulus.
2. Bending of beams-double cantilever: determination of Young's modulus.
3. Young's modulus by transverse vibrations of rods /strips.
4. Capillarity: determination of Surface tension.
5. Viscosity of a liquid by Poiseuilles method.
6. Verification of Bernoulli's theorem.
7. To measure the velocity of flow using Pitot tube.
8. To determine the viscosity of fluid by viscometer.
9. Frequency of AC cycle using amplitude resonance
10. Kundt's tube experiment

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PYG 101 BASIC PHYSICS

PYG-101 (GE Sem I)	BASIC PHYSICS	Credit: 4 (Theory: 4)
Course Objectives: 1. To acquire knowledge of the various units and how is the measurement of physical quantities carried out. 2. To understand the concepts of Elasticity, Fluid statics and Fluid dynamics, Doppler Effect, Acoustics, Transducers and Rectifiers. 3. To correlate the gained knowledge in their daily life situations.		

THEORY:	
MEASUREMENT OF PHYSICAL QUANTITIES, STANDARDS AND UNITS: Length: radius of proton to size to astronomical distances. Mass: atomic mass unit to mass of earth. Time: time for fast elementary particle to pass through nucleus to age of earth. Units in electricity: volts, Amperes, ohms. Units of Temperature: Celsius scale, Kelvin scale. International systems and units: Units used to measure physical quantities and their inter-conversion.	5H
PROPERTIES OF MATTER: Elasticity: Hook's law, modulii of elasticity. Surface tension: Brief review of molecular theory of surface tension. Relation between surface tension and surface energy. Pressure difference across curved surfaces. Angle of contact. Capillarity. Application of the phenomenon to life sciences. Fluid Statics and fluid dynamics**:** Pascal's Principle, Measurement of pressure. Various units of pressure and their inter-conversion, Concept of pressure energy. Bernoulli's theorem and its applications- Venturi meter and Pitot's tube. Viscosity, Viscosity estimation by Oswald's viscometer. Relevance to life sciences.	12H
ACOUSTICS: Loudness, units of intensity and loudness, Weber Fechner law and sound absorbers. Production and detection of Ultrasonic waves and its applications. Doppler effect. Calculation of apparent frequency, (Normal incidence only), application to life sciences. Acoustics of Building: Growth and decay of intensity, Reverberation of Sound, Reverberation time, Absorption coefficient, Sabine's formula for reverberation time (discussions only), Acoustic requirements of a good auditorium.	12H
BASICS OF ELECTROSTATICS AND ELECTRICITY: Electric charge. Coulomb's law. Applications of electrostatics in life sciences. Basics of electricity: Current, voltage and resistance and their units, Ohm's law, Conductor, Semiconductor and Insulator. Transducers: characteristics, classification of transducers-electrical, mechanical, optical. Applications in chemical and biological instruments.	10H
MAGNETISM: The magnetic field, The definition of B, magnetic dipoles, Units of magnetism, Electromagnetic induction, Faraday's law, Lenz's law.	5H
BASIC ELECTRONICS: Voltage and current sources, Inductance coils, capacitors and transformers. Rectifiers and voltage regulators: Volt-ampere characteristics of Junction	16H

diode, Half-wave, Full-wave and Bridge rectifiers using Junction diodes, Percentage regulation, Ripple factor and Rectification efficiency. ripple filters, Zener diode characteristics and its use as a simple voltage regulator. Thermistor characteristics and its use in A.C. voltage regulation. Junction Transistor and its characteristics in CE mode, Current gain, Voltage gain, Light Emitting Diodes, Photodiodes and Phototransistors.

LEARNING OURCOME:

1. The student is expected to acquire the basic understanding of the Measurements, Elasticity, fluid mechanics, Acoustics, transducers and Rectifiers.
2. The student will be able to use the concepts learnt, in laboratory while dealing with the instruments and in their practical life.

BOOKS:

1. Haliday, Resnik and Walker, Fundamentals of Physics, 10e, John Wiley and Sons.

2. Elements of Properties of Matter, by D. S. Mathur, S. Chand and Sons, (2013).

3. Text book of Sound by D.R. Khanna and R.S. Bedi, Delhi: Atma Ram, 1962.

4. H.S. Kalsi, Electronic Instrumentation, Tata McGraw Hill Publication.

5. A course in Electrical and Electronic Measurements and Instrumentation by A.K. Sawhney, Dhanpat Rai & Sons,

6. V. K. Metha, Principles of Electronics, S. Chand & Company (2009).

7. A. P. Malvino, Electronic Principles –TMH 5th edition

PYG 102 OPTICS AND INSTRUMENTATION

PYG-102 (GE-SEM II)	**OPTICS AND INSTRUMENTATION**	**Credit: 4 (Theory: 4)**

Course Objectives:

- To acquire knowledge about optics, lasers, X-rays and about the various instruments used in optics and in medical imaging.
- To understand the various concepts used in optics, lasers, X-rays and medical imaging.
- To apply the knowledge in practical situations.

THEORY:	
IMAGE FORMATION: Luminous intensity and its units, reflection, refraction. Introduction to lenses, optical properties of lenses, thin lenses & thick lenses, cardinal points of an optical system. Aberrations: Spherical & chromatic aberrations in lenses (only conceptual), methods of minimizing spherical & chromatic aberrations. Eyepieces: Kellner's, Ramsden And Huygens eyepiece. Construction and image formation with optical ray diagrams.	8H
INTERFERENCE: Interference by division of wave front & division of amplitude. One example of each kind.	3H
DIFFRACTION: Concept of diffraction, Fresnel and Fraunhoffer class of diffraction. Concept of Fraunhoffer diffraction at single slit. Application of Fraunhoffer diffraction to resolving power of optical instruments, Raleygh's criterian for resolution, resolving power of telescope and microscope.	5H
POLARIZATION: Concept of polarization, plane of polarization, polarization by reflection, Brewster's law, polarization by refraction, double refraction. Nicol prism, simple Polarimeter.	5H
LASERS: Stimulated and spontaneous emission, population inversion, Lasers, properties of Lasers, different kinds of Lasers, applications of Lasers in Medicine and Science. Optical fibers: Basic principle and applications.	7H
X-RAYS: Coolidge tube generator, continuous X-ray spectra and its dependence on voltage, Duane and Hunt's law, wave nature of X-rays – Laue's pattern, diffraction of X-rays by crystal, Bragg's law, Bragg single crystal spectrometer, analysis of crystal structure - simple cubic crystal.	5H
LCD AND LED DISPLAYS: Types of liquid crystals, principle of liquid crystal displays, applications, LED's, LED displays and their advantages.	5H
INSTRUMENTATION: Simple microscope, compound microscope, phase cantrast microscope, electron microscope, XRD, UV and IR spectroscopy.	7H
MEDICAL IMAGING PHYSICS: Magnetic field, diamagnetism, paramagnetism and ferromagnetism, X-ray	12H

diagnostics and imaging, Physics of nuclear magnetic resonance (NMR) – NMR imaging – MRI Radiological imaging –Radiography –X-ray film – fluoroscopy – computed tomography scanner – principle function – display – generations – mammography. Ultrasound imaging – magnetic resonance imaging.	
DEMONSTRATION: (Any Four) 1. Luxmeter/Photometer. 2. Construction and image formation of Ramsden /Huygens eyepiece. 3. Interference patters using Fresnel's biprism, Lloyds mirror in Physics Laboratory. 4. Fresnel and Fraunhoffer class of Diffraction, Resolving power of telescope and microscope in Physics Laboratory 5. Polarization using Polaroid, Double refraction. Nicol prism, simple polarimeter in Physics Laboratory 6. Some properties of lasers in class 7. Analysis of x-ray diffraction data for crystal structure determination	4H
LEARNING OURCOME: **1.** The student is expected to acquire the basic understanding of optics and instruments used in optics and medical imaging. **2.** One should be able to use the concepts learnt, in laboratory and in their practical life while dealing with the instruments.	
BOOKS: 1. N Subrahmayam and N.Brijlal, Text Book of Optics, S. Chand & Company Ltd,(1991). 2. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1985). 3. Banwell, Fundamentals of Molecular Spectroscopy, TMH (2012). 4. K. Thyagrajan and A. Ghatak Laser: Theory and Applications, McMillan (2009). 5. R. S. Khandpur, Handbook of Biomedical Instrumentation, Second Edition. Front Cover. Tata Mcgraw-hill Pub, 1992 Medical Physics, J.R. Cameron and J.G.Skofronick, Wiley (1978).	

PYC 103 WAVES AND OSCILLATIONS (Under CBCS Ordinance(from 2018 onwards)

<table>
<tr><td>PYC 103 SEM III
Section I</td><td>Waves & Oscillations</td><td colspan="2">Credit : 3(Theory 2 ;
Practical 1)</td></tr>
<tr><td colspan="4">Course Objectives: This course will provide students with :
1. Understanding of the concepts of free oscillations, superposition of oscillations and damped oscillations
2. Knowledge of setting the equations of motion for free, damped and forced damped oscillations
3. Correlation of these concepts to real life examples.
4. Knowledge to design the experiments which will demonstrate the free and damped oscillations.</td></tr>
<tr><td colspan="4">Theory</td></tr>
<tr><td colspan="3">Waves and Oscillations:
Periodic oscillations and potential well, differential equation for harmonic oscillator and its solutions (case of harmonic oscillations), kinetic and potential energy. Examples of simple harmonic oscillations: spring and mass system, simple and compound pendulum, Helmholtz resonator, bifilar oscillations.</td><td>10H</td></tr>
<tr><td colspan="3">Superposition of Waves:
Wave equation and solutions, Superposition of two simple harmonic motions of the same frequency along the same line, interference, superposition of two mutually perpendicular simple harmonic vibrations of the same frequency, Lissajous figures, case of different frequencies.</td><td>8H</td></tr>
<tr><td colspan="3">Oscillatory Motion in a Resistive Medium:
Damped harmonic oscillator, Damped forced harmonic oscillator. Displacement and velocity Resonance, Sharpness of resonance, Phase relationships, Energy consideration in a forced harmonic oscillator. Harmonic oscillator with an arbitrary applied force.</td><td>12H</td></tr>
<tr><td colspan="3">PRACTICAL(any four)(1 credit):
1. Bifilar oscillations Determination of η using Flat spiral spring.
2. Determination of η using Flat spiral spring.
3. Determination of Y using Flat spiral spring.
4. Y by vibrations of cantilever.
5. Superposition of two mutually perpendicular simple harmonic oscillations -Lissajous figures using CRO.
6. Helmholtz resonator.
7. Simulation of Waves
8. Resonance pendulum –study of amplitude resonance and determination of ‘g’
9. Double pendulum</td><td></td></tr>
<tr><td colspan="3">Learning Outcome: At the end of the course learners will be able to:
1. Understand the concepts of free oscillations, superposition of oscillations and damped oscillations
2. Set the equations of motion for free, damped and forced damped oscillations and find solutions of these equations.
3. Understand superposition of two mutually perpendicular simple harmonic vibrations of the same frequency</td><td></td></tr>
</table>

4. Demonstrate the formation of Lissajous figures 5. Correlate these concepts to real life examples. 6. Solve the numerical problems related to oscillations 7. Students will be able to design the experiments which will demonstrate the free and damped oscillations.	
References: 1.Takawale R. G. and Puranik P S. Introduction to Classical Mechanics, TMH, 1997 2. D. R. Khanna and R.S. Bedi, Text book of Sound,Atma Ram, New Delhi (1994). 3. N. K. Bajaj, Physics of Waves and Oscillations, TMH, 2006. 4. A P French, Waves and Oscillations, CBS Publishers, 2003 5. H. J. Pain, Physics of Vibrations and waves, 6th Ed, Wiley, India, 2005 6. Brijlal and Subrahmanyam, Waves and Oscillations and Accoustics, S Chand & Co Ltd.(2009) 7. D. Chattopadhyay and P.C. Rakshit, Waves and Oscillations, Books and Allied Pvt Ltd (2009) 8. M Ghosh and B Bhattacharya, Oscillations and Accoustics, S Chand & Co Ltd. (1976). 9. S.P.Puri, Text book of Vibrations and Waves, Macmillan India ltd, 2nd edition, 2004	

PYC 103 ELECTRONICS (Under CBCS Ordinance (from 2018 onwards)

PYC 103 SEM III Section II	**Electronics**	**Credit : 3(Theory 2 ; Practical 1)**

Course Objectives: This course will provide students with :

1. Basic knowledge of working of common devices such as Junction diode, Zener diode, Thermister, Transistor and Operational Amplifier.
2. Acquire them with basic knowledge of identifying these devices in various circuitries.
3. Use them in various applications such as Rectifier circuits, Voltage regulatory circuits (dc and ac), Temperature controller circuits, Biasing circuits and basic circuits such as Adder, Subtractor, and Inverting and Non-inverting amplifier.

Theory

Rectifiers and Regulators: Volt-ampere characteristics of Junction diode, Half wave, Full wave and Bridge rectifiers using Junction diodes without and with capacitive filters. Percentage regulation, Ripple factor and Rectification efficiency. Zener diode characteristics and its use as a simple voltage regulator. Thermistor characteristics and its use in A.C. voltage regulation.	6H
Transistors: Basic configurations of transistors, Transistor characteristic in CE and CB mode, Current gains α and β and their inter-relation, Leakage current in transistors.	3H
Basic Amplifier Characteristics: Current gain, Voltage gain, Power gain, Input resistance, Output resistance, Conversion efficiency, Classes of amplifier operations, Decibel, Frequency response, Amplifier bandwidth.	3H
C-E amplifier: Class A: Graphical analysis, Effect of adding A.C. load, Input and Output resistance, Conversion efficiency, Phase relationship between input and output.	4H
Transistor Biasing: Bias stability, Stability factor, Different methods of biasing, Biasing compensation.	4H
Feedback: Positive and negative feedback, Voltage and current feedback, series and shunt feedback. Effect on negative feedback on gain, frequency response, input and output resistance and distortion. **Positive feedback,** Barkhausen criterion for oscillations, Phase shift oscillator, Wein bridge oscillator, LC tank circuit, Hartley oscillator and Colpitts oscillator.	5H
Linear IC's and Operation Amplifiers: The Differential Amplifier, OP-Amp characteristics, Input and Output impedance, Input bias and offset currents, Input and output offset voltages. Differential and Common mode gains, CMRR, Slew rate, OP-Amp as inverting , Non Inverting amplifier and Difference amplifier.	5H

PRACTICAL(any four)(1 credit):

1. Half wave & Full wave rectifier using junction diode: Load regulation characteristics.
2. Bridge rectifier with capacitor filter: Ripple factor using CRO.
3. Zener diode regulation.
4. Colpitts/Hartley Oscillator.
5. Wein's Bridge/Phase Shift Oscillator.
6. Transistor characteristics: Input and Ouput(CE Mode)
7. C.E. Amplifier: Frequency response with and without negative feedback,

calculation of Gain Bandwidth product. 8. C.E. Amplifier: Determination of Input and Output Impedance, variation of Gain with load. 9. Op-Amp: Inverting and Non-Inverting amplifier. 10. Op-Amp: Differential amplifier & adder/subtractor	
Learning Outcome: At the end of the course, students will be able to: 1. To gain knowledge of basic devices such as Diodes, Transistors, Thermister and Operational amplifier. 2. Apply them to various circuits. 3. Understand the effect of temperature on devices such as transistors. 4. Improvise effective methods for performance of these devices under various conditions. 5. Apply them to solve various circuit problems. 6. Understand the use of Operational amplifiers in Inverting and Non-Inverting amplifiers, adder and subtractor circuits.	
References: 1. A.P. Malvino: Electronic Principles – TMH 5th edition(1996). 2. Allen Mottershead: Electronic Devices and Circuits- An Introduction – 3rd edition PHI(1997). 3. Millman and Halkias, Integrated Electronics – TMH(1972). 4. Bhargava, Kulshrestha and Gupta – Basic Electronics and Linear Circuits, TMH(1984). 5. Ramakant Gayakwad: Op-Amp and Linear Integrated Circuits, PHI(2002).	

PYS 101 NETWORK ANALYSIS

SEM III PYS-101(SEC)	**NETWORK ANALYSIS**	**Credit: 4 (Theory: 3, Practical: 1)**
Course Objectives: 1. To acquire knowledge about various ways of solving complex network circuits. 2. To understand the various concepts of Power and Power Factor, coupled circuits, and resonance.		
THEORY:		

REVIEW OF BASIC CONCEPTS: Voltage, Current, Power and Energy, Constant voltage and constant current source, The sine wave, RMS value and average value of a sine wave, The Resistance, Inductance and Capacitance, Kirchhoff's Voltage Law, Kirchhoff's Current Law, Principle of non-inductive resistance coils, Mutual inductance, Coefficient of coupling. Self-Inductance of co-axial cables, Inductance in series and parallel. Capacitances in series and parallel.	5H
CIRCUIT ANALYSIS AND NETWORK THEOREMS: Mesh analysis, Super Mesh analysis, Nodal analysis, Super Node analysis, Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power transfer Theorem, Impedance matching.	10H
RESPONSE OF RL, RC and RLC circuits to DC and AC: Transient Response of RL, RC and RLC circuits. Sinusoidal response of RL, RC, RLC circuits, Impedance diagram, Phase angle, series and parallel complex impedance circuits.	11H
POWER AND POWER FACTOR: Instantaneous power, Average power, Apparent power and Power factor, Reactive power, Power triangle.	3H
COUPLED CIRCUITS: AC applied to mutually coupled L-R circuits. Reflected impedance, Transformers, Effect of loading the secondary of a transformer, Ideal transformer.	3H
RESONANCE: Series resonance, quality factor (Q) and its effect on Bandwidth, parallel resonance, Q factor of parallel resonance.	3H
TWO-PORT NETWORK: Two-port networks, open circuit impedance (Z) parameters, Short circuit admittance (Y) parameter, Hybrid (h) parameter, Interrelationship of different parameters, T & II networks, Lattice networks.	7H
AC BRIDGES: Simple microscope, compound microscope, phase cantrast microscope, electron microscope, XRD, UV and IR spectroscopy.	3H
Practical: Minimum of 4 experiments. 1. Design of 1 mH inductor. 2. Study of High pass, Low Pass filters using passive components.	

3. Band pass and Band stop filters using passive components. 4. Study of passive integrator and differentiator. 5. Thevenin's Theorem and Norton's Theorem. 6. Verification of Superposition Theorem. 7. Impedance Matching. 8. Response of LR, circuit to DC and AC. 9. Response of CR circuit to DC and AC.	

LEARNING OURCOME:

- The student is expected to acquire the basic understanding of how to solve network circuit problems.
- Student will able to use the knowledge in laboratory and in their practical life while dealing with the network circuits.

BOOKS:

1. Sudhakar and Shammohan, Circuits and Networks Analysis and Synthesis, TMH, (2006).
2. J. Yarwood and J. H. Fewkes, Electricity and Magnetism. University Tutorial Press (1991).
3. D. N. Vasudeva,Fundamentals of Electricity and Magnetism.S. Chand and Company Ltd. New Delhi.(2012).
4. Brijlal and Subramaniam, Electicity and Magnetism, Ratan Prakashan, New Delhi. (1966).
5. Thereja B.L. Text Book of Electrical Technology, S. Chand and Co Ltd. New Delhi (1990).
6. Mahmood Nahvi, Joseph Edminister, Electrical Circuits, Schaum outline Series, (2002).

PYC 104 OPTICS (Under CBCS Ordinance(2018 onwards)

<table>
<tr><th>PYC 104 SEM IV
Section I</th><th>Optics</th><th>Credit : 3(Theory 2 ; Practical 1</th></tr>
<tr><td colspan="3">Course Objectives: This course will provide students with :
1. An understanding of optical phenomena based on the wave and particle description of light.
2. Understanding of the principles that outline the phenomena of Interference, diffraction and polarization.
3. Apply these phenomena in the determination of various parameters associated with light such as wavelength, resolving power of systems and thickness of thin films.</td></tr>
<tr><td colspan="3">Theory</td></tr>
<tr><td colspan="2">Interference: Introduction: Interference by division of wavefront & division of amplitude. Fresnel’s biprism and Lloyd’s mirror.
Formation of colors in thin films – reflected system. Transmitted system, wedge shaped film, Newton’s Rings and its application to determine refractive index of liquids (Normal Incidence only).
Interfeometry:- Michelson interferometer – its principle, working and its application to determine wavelength and difference between two wavelengths. Fabri Perot Interferometer.</td><td>9H</td></tr>
<tr><td colspan="2">Diffraction: Concept of Diffraction. Fresnel and Fraunhoffer Diffraction. Division of cylindrical wavefront into half period strips, Fresnel’s diffraction at straight edge and cylindrical wire. Fraunhoffer diffraction at single, double and N slits. Diffraction grating, width of principal maxima of plane diffraction grating. Resolving power of optical instruments – Rayleigh’s criterion, Resolving power of telescope, Prism and grating.</td><td>12H</td></tr>
<tr><td colspan="2">Polarization: Concept of polarization. Plane of polarization, Polarization by reflection, Brewster’’s law, Polarization by refraction, double refraction, uniaxial and biaxial crystals, positive and negative crystals, Nicol’s prism, Circularly and Elliptically polarized light – theory and analysis, Polariod, Retardation plates – Quarter wave plate and Half wave plate, Optical activity, specific rotation, simple polarimeter, Laurent’s half shade polarimeter.</td><td>9H</td></tr>
<tr><td colspan="2">PRACTICAL(any four)(1 credit):
1. Spectrometer: Determination of dispersive power of prism.
2. Cardinal points of two lenses.
3. Wedge shaped film – determination of wavelength.
4. Fresnel Biprism.
5. Newton’s rings: determination of radius of curvature of lens.
6. Single Slit Diffraction using Na source.
7. Diffraction Grating.
8. Resolving Power of telescope using wire method.
9. Verification of Brewster’s law.</td><td></td></tr>
<tr><td colspan="2">Learning Outcome: At the end of the course, students will be able to:
• Understand the image formation by lenses and draw the cardinal points for a system of lenses.
• Apply the principles of light to various phenomena such as Interference, Diffraction and Polarization.
• Use the phenomena of Interference, diffraction and Polarization to determine wavelength of light, resolving power of various systems such as telescope, prism, grating etc.</td><td></td></tr>
</table>

References:

1. N. Subramanyam and N. Brijlal: Text Book of Optics, S. Chand & Company Ltd. (1991)
2. Optics, Ajoy Ghatak, Tata McGraw-Hill Publishing Company Ltd (1977).
3. Ghatak and Tyagarajan, Contenprary Optics, Mc Millan (2003).
4. R. S. Longhurst, Geometrical and Physical Optics, Orient Longman (1976 Indian edition).
5. Francis A Jenkins and Harvey E. White, Fundamentals of Optics (1976).
6. D.N. Vasudeva – A textbook of light for BSc students (1962).
7. B. K. Mathur and T.P. Pandya: Principles of Optics, New Global Printing Press, Kanpur (1980).

PYC 104 MODERN PHYSICS (Under CBCS Ordinance (2018 onwards)

PYC 104 SEM IV Section II	**Modern Physics**	**Credit : 3(Theory 2 ; Practical 1**

Course Objectives: This course will provide students with

- Understanding of Lorentz force and the knowledge of the motion of charged particles in parallel and crossed electric and magnetic fields.
- Understanding of the process of electric discharge
- Determination of e/m for cathode rays.
- Understanding of basic physics of particle accelerators.Mass Spectrometers. Review of Bohr's Hydrogen atom
- Demonstrate the concept of quantization of energy levels by studying Frank-Hertz experiment.
- Knowledge of properties of electromagnetic radiation by explaining Black Body Radiation,
- Kirchoff's radiation law, Stefan's law, Wien' law, Raleigh - Jean's law, Planck's law.
- Photoelectric effect and Compton Effect
- To present the basic concepts needed to understand the crystal structure and X-rays.

Theory	
Motion of charged particles in electric and magnetic fields Lorentz force, Motion in a uniform electric field, magnetic field, parallel and crossed fields. Electric discharge through gases, Determination of e/m for cathode rays, Charge and mass of an electron, Atomic masses, Energy and mass units.	6H
Particle Accelerators Linear accelerator and Cyclotron.	3H
Atomic Physics Measurements of Mass: Thomson's positive ray analysis, Dempster's Mass spectrometer, Bainbridge Mass spectrograph. Review of Bohr's Hydrogen atom, Correction due to finite nuclear mass. Frank-Hertz experiment and atomic energy levels.	6H
Properties of electromagnetic radiation Black Body Radiation, Kirchoff's radiation law, Stefan's law, Wien' law, Raleigh - Jean's law, Planck's law. Photoelectric effect and Compton Effect – observation, description, derivations of relevant equations and failure of classical physics to explain the same. Experimental verification of the Photoelectric and Compton effects.	7H
Crystal Structure Crystal lattice, crystal planes and Miller indices, unit cells, typical crystal structures.	3H
X-rays Coolidge tube generator, Continuous X-ray spectra and its dependence on voltage, Duane and Hunt's law, Wave nature of X-rays – Laue's pattern, Diffraction of X-rays by crystal, Bragg's law, Bragg single crystal spectrometer, Analysis of crystal structure - simple cubic crystal.	5H

PRACTICAL(any four)(1 credit):

1. X-ray emission (characteristic lines of copper target) – calculation of wavelength and energy and assigning transitions.
2. Calculation of lattice constant by of Copper – x-ray diffraction pattern is given and student calculates, d-spacing, miller indices and lattice constant.
3. Frank Hertz Experiment.
4. Characteristics of photo cell.
5. Measurement of Boltzmann constant using transistor.
6. Photocell (verification of Photoelectric effect).

~~7.~~ *e/m* by Thomson method.

Learning Outcome: At the end of the course, learners will be able to:

- Understand the concept of Lorentz Force and apply it to the motion of charged particles in electric and magnetic fields.
- Understand the design and working of particle accelerators and mass spectrometers.
- Appreciate the concept of quantization of energy levels by studying Frank-Hertz experiment.
- To define crystalline and amorphous solids.
- To determine miller indices and calculate the "d" spacing of the crystal
- Determine charge to mass ratio of electrons by using Thomson's method.
- Appreciate theory of the concept of Modern physics and also study relevant experiments.
- Apply the concepts of Modern Physics to solve problems and to perform experiments.

References:

1. Arthur Beiser, Concepts of Modern Physics, 5th Edition, McGraw Hill (1985).
2. S.B. Patel, Nuclear Physics, TMH (1991).
3. Irving Kaplan, Nuclear Physics, Narosa Publishing House,(1997).
4. F.K. Richtmyer, E.H. Kennord, J.N. Cooper Introduction to Modern Physics, McGraw Hill (1997).
5. H.Semat and J.R.Albright, Introduction to Atomic and nuclear Physics, Chapman and Hall (1973).
6. J.B.Rajam, Atomic Physics, S.Chand and Co. Ltd.(1950).
7. K. Thyagrajan and A. Ghatak Laser: Theory and Applications, McMillan (2009).
8. K.Thyagarajan and A.Ghatak, Optical Electronics, Cambridge University Press (1997).

9, B.B.Laud, LASERs and Non-linear optics, Wiley Eastern (1991)

PYS 105 ELECTRICAL AND ELECTRONIC INSTRUMENTS

SEM IV PYS-105 (SEC)	ELECTRICAL AND ELECTRONIC INSTRUMENTS	Credit: 4 (Theory: 3, Practical: 1)

Course Objectives:

- To acquire knowledge about D.C & A.C instruments, Power supplies and oscilloscopes.
- To understand the designing and workings of the instruments.
- To understand the components of the instruments and their advantages and disadvantages.

THEORY:

D.C INDICATING INSTRUMENTS: PMMC Galvanometer (D'Arsonval movement) - Principle, construction and working, current sensitivity, voltage sensitivity and megohm sensitivity, advantages and disadvantages, conversion of Galvanometer into Ammeter, Voltmeter and Ohmmeter (series and shunt type), Aryton shunt, Loading effect of voltmeter.	6H
A.C INDICATING INSTRUMENTS: Electrodynamometer-principle, construction and working, merits and demerits, Rectifier type Instruments, thermocouple Instrument (Ammeter), electrostatic voltmeter-principle, construction and working, watt-hour meter.	6H
D.C AND A.C BRIDGES: Wheat stone bridge-determination of resistance, Kelvin double bridge-determination of resistance, Maxwell's L/C bridge-determination of self-inductance, Wien's bridge-determination of frequency, Schering bridge-determination of capacitance.	6H
POWER SUPPLIES: Unregulated D.C power supplies (using full wave, bridge rectifier with C and L-C filter), transistor series and shunt voltage regulators, OP-AMP series and shunt voltage regulators, voltage regulators using IC 78xx series and ICLM317, Switching regulator (step down type).	9H
OSCILLOSCOPES: Block diagram of basic oscilloscope, CRT, deflection sensitivity, electrostatic deflection, electrostatic focusing (explanation only –no mathematical treatment), vertical amplifier, delay line circuit, sweep generator, measurement of voltage, period, frequency and phase difference, sampling oscilloscope, Digital storage oscilloscope – block diagram and working principle.	9H
INSTRUMENTATION AMPLIFIERS AND SIGNAL ANALYZERS: Instrumentation amplifier, Electronic voltmeters - d.c voltmeter with direct coupled amplifier, a.c voltmeter using rectifiers, ramp type digital voltmeter, digital multimeter, function generator, wave analyzers- audio range wave analyzer, heterodyne wave analyzer.	9H

Practical: Minimum of 4 practical

1. Use of Analog and Digital Multimeter for components testing and measurements (voltage, current and resistance)
2. Design and construction of multi range Voltmeter
3. Design and construction of series type Ohmmeter
4. Study of Maxwell's L/C bridge for determination of inductance
5. Study of Schering bridge for determination of capacitance
6. Design and construction of Wien bridge oscillator using OP-AMP
7. Design and construction of Instrumentation amplifier using OP-AMP
8. Series voltage regulator using transistor/OP-AMP.
9. Shunt voltage regulator using transistor/OP-AMP.
10. Design and construction of Function Generator using IC XR2206.
11. Measurement of frequency and phase on a CRO using Lissajous figures
12. Study of SMPS.

LEARNING OURCOME:

- The student will be able to design and construct voltmeter and ohmmeter.
- One is will have the knowledge of the principles, construction and working of various instruments.

BOOKS:

1. W. D. Cooper and A. D. Helfrik Electronic Instrumentation and Measurement Techniques - PHI Publication
2. H.S. Kalsi, Electronic Instrumentation,Tata McGraw Hill Publication
3. A course in Electrical and Electronic Measurements and Instrumentation by A. K. Sawhney, Dhanpat Rai & Sons
4. Robert Boylestad, Louis Nashelsky, Electronic Devices and Circuit Theory - PHI Publication
5. Ramakant Gayakwad, Op-amps and Linear Integrated Circuits, Pentice Hall, 2000.
Goa University, Taleigao Plateau, Goa.

PYC105: Classical Mechanics and Thermal Physics
(Under CBCS Ordinance from 2019 onwards)

PYC 105 SEM V	Classical Mechanics and Thermal Physics	Credit : 6—Theory 4 Practical 2

Course Objectives

- Discuss the dynamics of system of particles, dynamics under influence of central force, motion of rigid body and motion of coordinate system
- Discuss the power cycles and liquification of gas
- Describe methods to find probability of occurrence of an event and various statistical distribution of an event.

Theory	**6 Credits**
Classical Mechanics:	
Motion of a system of particles Center of mass coordinates, applications of conservation laws for linear momentum, angular momentum and energy - rockets, conveyor belts and planets, critique of conservation of laws. The collision problems, the two body problem, reduction to equivalent one body problem. (Ref: [1,2,3]).	7 CH
Motion under a central force General features of motion, qualitative discussions of orbits under inverse square law force field. Nature of orbits, elliptical orbits, Kepler's problem, hyperbolic orbits, classical scattering, definition of scattering cross section, impact parameter and scattering angle, Rutherford's scattering cross section. (Ref: [1,2]).	10CH
Moving coordinate systems Inertial and non- inertial coordinate frames, rotating coordinate systems, laws of motion on the rotating earth, Coriolis force, Foucault's pendulum, and Larmor's theorem. (Ref: [2,4]).	7CH
Rigid bodies Rotation about an axis, moment of inertia tensor, Euler's equations of motion of a rigid body, torque free motion, qualitative discussion of motion of a symmetric top. (Ref: [1,2,4]).	6CH
Thermal Physics:	
Power cycles. Internal Combustion Engines – The Otto cycle and its efficiency, Diesel cycle and its efficiency. (Ref: [6,7]).	3CH
Production of low temperature. Cooling by evaporation. Vapour compression machines. Refrigerators based on Vapour absorption. Cooling by sudden adiabatic expansion of compressed gases. Efficiency and	13CH

performance of refrigerating machines. Enthalpy and heat flow. Joule Kelvin effect. Expression for Joule Kelvin coefficient and inversion temperature. Application to Van der Waals' gas. Principles of regenerative and cascade cooling. Liquifaction of hydrogen and helium. Production of temperatures below 4o K. Properties of He I and He II. Cooling by Adiabatic Demagnetisation of paramagnetic substances. (Ref: [4,6,7,8]).	
Probability Random Events, Probability, Probability and Frequency, Some basic rules of Probability theory, Continuous random variables, Mean value of discrete and continuous variables, Variance: Dispersion, Probability Distribution, Binomial distribution: Mean value and fluctuation, Stirling's Approximation, Poisson Distribution: Mean value and Standard deviation, Gaussian Distribution: Standard deviation. (Ref: [9,10]).	7CH
Statistical Distributions: Concept of Phase space, Probability of distribution and most probable distribution. Maxwell Boltzmann Statistics. Molecular speeds: mean, most probable and rms speeds. Experimental verification of Maxwell Boltzmann distribution law (Zartman ko experiment). Bose Einstein and Fermi Dirac statistics (qualitative study). (Ref: [4,6,11]).	7CH
Learning Outcome **Learner will be able to** • Explain the laws of conservation of momentum and energy of system of particles and show how two body problem can be reduced to one. Also interpret the motion under central force field and explain Kepler's law of planetary motion. Relate motion in inertial and non-inertial frames. Explain motion of rigid bodies. • Analyse the efficiency of diesel and petrol engine and different methods to liquify the gas. • Solve numerical to obtain probability of occurrence of an event and also explain statistical probability of distribution of an event.	
Text Books & References 1. K. R. Symon, Mechanics, Addison Wesley (1971). 2. R. G. Takawale and P. S. Puranik, Introduction to Classical Mechanics, Tata McGraw-Hill (1997) . 3. Gupta, Kumar and Sharma, Classical Mechanics, Pragati Prakashan. 4. A.V. Namjoshi, J.A. Rao, Classical Mechanics Thermal and Statistical Physics (T.Y. B.Sc Vol. III), Sheth Publishers Pvt. Ltd. 5. C.L. Arora & P.S. Hemne, Physics for Degree Students, S. Chand	

6. Brij Lal & Subrahmaniam, Heat Thermodynamics and Statistical Physics, S. Chand Publications.
7. M.N. Saha and B.N. Shrivastava, Treatise on heat, The Indian Press(1965).
8. M.W. Zemansky and R.H. Ditman, Heat and Thermodynamics, McGraw Hill (1997).
9. B.B. Laud Introduction to Statistical Mechanics, New Age International (2008).
10. . N. Joshi, S.G. Chitale, G. Venkat, S.R. Rege, Statistical Techniques, 11. Perspectives of modern physics – Arthur Beiser, McGraw hill (1995).

Practical (2credit)

Minimum of total 8 experiments, but at least 3 experiments from each section

Classical Mechanics

1. Karter's Pendulum.
2. To investigate the motion of coupled oscillators.
3. Surface tension by Quinke's method
4. Y by Koenig's method
5. To determine "Y" by optical lever
6. Viscosity of liquid using Stokes method
7. Verification of parallel & perpendicular axis theorem – using Moment of Inertia
8. Determination of Log decrement & viscosity Thermal Physics

Thermal Physics

9. To determine temperature coefficient of Pt100
10. Specific heat of graphite.
11. Measurement of thermal conductivity of poor conductors. –by Lee's method
12. Measurement of thermal conductivity of good conductors – by Searle's method
13. Computer simulation of Maxwell-Boltzmann distribution, Fermi- Dirac & Bose-Einstein

PYC 106 ANALOG AND DIGITAL ELECTRONICS

(Under CBCS Ordinance from 2019 onwards)

<table>
<tr><th>PYC 106 SEM V</th><th>Analog and Digital Electronics</th><th colspan="2">Credit : 6(Theory 4 ; Practical 2)</th></tr>
<tr><td colspan="4">Course Objectives: This course will provide students with :
• Basic knowledge of the functioning of a transistor as a Switch.
• Knowledge of how the transistor as a switch can be used in switching circuits such as multivibrators.
• Basic knowledge of the functioning of an FET and its different types.
• Knowledge of how the FET can be used in VVR circuits as attenuator, AGC etc.
• Basic knowledge of the application of Operational amplifiers in diode circuits.
• Basic knowledge of the functioning of the IC 555 timer is multivibrator circuits.
• Concept of binary number system in digital electronics</td></tr>
<tr><td colspan="4">Theory (Analog Electronics)</td></tr>
<tr><td colspan="3">Transistors Multivibrators: Transistor as a switch, switching times, Multivibrators – Astable, Monostable, Bistable and Schmitt Trigger.</td><td>6 H</td></tr>
<tr><td colspan="3">Field Effect Transistors: Basic structure of the JFET, Principles of operation, Characteristic curves and parameters, Common source amplifiers, Common gate amplifier (only qualitative discussion), The MOSFET Depletion Mode and Enhancement mode, Dual-Gate MOSFET. FET Phase shift oscillator, FET as VVR and its applications in Attenuator, AGC and Voltmeter circuits.</td><td>11H</td></tr>
<tr><td colspan="3">Application of Op-Amp: Active diode circuits, Integrator, Differentiator, Comparator, Window comparator, Schmitt Trigger, Waveform generator –Square wave, Triangular and Ramp Generator and Monostable.</td><td>6H</td></tr>
<tr><td colspan="3">Voltage regulation: Fixed voltage regulation using IC -78 & 79 Series, adjustable voltage regulators using IC LM317.</td><td>3H</td></tr>
<tr><td colspan="3">Timers: IC- 555 Timer, Basic concept, block diagram, Monostable, Astable, and Voltage controlled oscillator (VCO).</td><td>4H</td></tr>
<tr><td colspan="3">Theory (Digital Electronics)</td><td></td></tr>
<tr><td colspan="3">Number System Logic: Binary number system, Binary to Decimal and Decimal to Binary conversion, Basic logic gates, OR, AND, NOR, NAND, and EX-OR gates. De Morgan's Law's, Boolean Algebra, NAND and NOR gates as universal building blocks in logic circuits, Sum of Products methods and Product of Sum methods of representation of logical functions. Half adder and Full adder, Multiplexer and Demultiplexer.
Logic families – DTL, TTL Standard TTL NAND gate, Schottky TTL, ECL OR and NOR gate, MOS (inverter, NAND and NOR gates) and CMOS (inverter, NAND and NOR gates).</td><td>15H</td></tr>
<tr><td colspan="3">Flip flop and Counters: Basic RS FF, Clocked RS FF, JK FF, D-type and T-type FF, Master Slave Concept, Shift register (shift left, shift right), Applications of FF's in counters, 3 bit count up/count down binary ripple counter, Mod 3, Mod 5, Mod 7 Counters, BCD Decade Counter, Cascade BCD Decade counters, Principle of digital clock.</td><td>15H</td></tr>
<tr><td colspan="3">PRACTICAL (2 credits) Minimum of total 8 experiments but at least 3 experiments from each section.
Analog Electronics:
1. Study and analysis of transistorized Multivibrtaors- Astable, Monostable.
2. Study and analysis of transistorized Multivibrtaors – Bistable, Schmitt trigger.
3. F.E.T Characteristics & F.E.T Common source Amplifier.
4. Op-Amp as a differential (Instrumentation) amplifier and its application in</td><td></td></tr>
</table>

temperature measurement.

5. Op-Amp as a Square wave generator and integrator.
6. Regulated power supply using IC LM 317 with external pass transistor.
7. Study of IC 555 as Astable & VCO/ Monostable multivibrator.

Digital Electronics:

1. Analog/Digital Multiplexer.
2. Verification of De Morgan Laws and Boolean Identities (Construction using gates).
3. Binary addition – Half adder and Full adder using logic gates.
4. NAND and NOR gates as universal building blocks.
5. Study of JK flip flop with JK FF IC's(Ripple counter and Decade Counter).

Learning Outcome: At the end of the course, students will be able to:

- Describe the function of the transistor as a switch and explain its application in switching circuits.
- Describe the application of operational amplifiers in diode circuits and circuits such as Integrator and Differentiator.
- Define the Field effect transistor, its types and differences.
- Explain the application of FET in circuits such as AGC, VVR.
- Explain the use of Op-amp as a comparator and window comparator and hence their applications in wave-shaping circuits.
- Describe the working of a basic timing circuit using the IC 555 and its applications in multivibrator circuits.
- Understand the number logic system using binary numbers and their use in basic logic gates.
- Explain the working of a basic flip-flip and its applications in digital circuits such as counters.

References:

1. A.P. Malvino – Electronic Principles: TMH(2007)
2. Allen Mottershead, Electronic Devices and Circuits: An Introduction, PHI 1997).
3. Millman and Halkias – Electronic Devices and Circuits, McGraw Hill (1967).
4. Millman and Halkias – Integrated Electronics, TMH (1971).
5. V.K. Mehta – Principles of Electronics, S. Chand & Company (2009).
6. Malvino and Leach- Digital Principles and Applications, TMH (1986).
7. R.P. Jain, Modern Digital Electronics, TMH (2003).
8. Ramakant Gayakwad, Introduction to Operational Amplifiers, PHI.

PYC 107 MATHEMATICAL PHYSICS AND ELECTROMAGNETIC THEORY I
(Under CBCS Ordinance (from 2019 onwards)

<table>
<tr><th>PYC 107 SEM V</th><th>Mathematical Physics & Electromagnetic Theory I</th><th colspan="2">Credit : 6(Theory 4 ; Practical 2)</th></tr>
<tr><td colspan="4">Course Objectives: This course will provide students with :
1. Adequate knowledge of mathematical physics and mathematical skills which is required to understand and solve problems of Electromagnetic Theory and other branches of Physics
2. Understanding of concept of electric force, electric field and potential due to stationary charges.
3. Definitions of discrete and continuous charge distributions.
4. Understanding of Gauss' Law and its applications.
5. Knowledge of different techniques to solve electrostatic problems.
6. Understanding the concept of polarization and electrostatic phenomena in dielectric medium.</td></tr>
<tr><td colspan="4">Theory(Mathematical Physics)</td></tr>
<tr><td colspan="3">Vector Analysis
Vectors and scalar fields, differentiation and integration of scalar and vector fields, directional derivative, gradient, the del operator, divergence and curl, Laplacian operator, Integration of Vector Functions - Line, Surface and Volume Integrals, Gauss Divergence Theorem (without proof), Greens Theorem, Stokes Theorem (without proof), Differential vector Identities, Expression for Laplacian operator in Cartesian, spherical and cylindrical coordinates. Dirac delta function and its application.</td><td>15 H</td></tr>
<tr><td colspan="3">Differential equations
Partial differentiation - definition of the partial derivative, Total differential, Chain rule, Exact and inexact differentials, Useful theorems of partial differentiation, Change of variables, Partial differential equations and separable solutions, Problems (Schaum Series).</td><td>10 H</td></tr>
<tr><td colspan="3">Some special functions in Mathematical Physics
Introduction to Legendre's equation, Legendre polynomials and Fourier series, Introduction to beta and gamma functions.</td><td>5 H</td></tr>
<tr><td colspan="3">Theory (Electromagnetic Theory I)</td><td></td></tr>
<tr><td colspan="3">Electrostatics
Coulomb's Law, Electric Field and electrostatic potential, Continuous Charge distribution, field lines, flux and Gauss' law with applications, the electric dipole- field and potential.</td><td>6 H</td></tr>
<tr><td colspan="3">Techniques to solve electrostatic problems
The electrostatic potential, Poisson's equation, Laplace's equation in one independent variable, solutions to Laplace's equation in spherical co-ordinates (zonal harmonics), conducting sphere in a uniform electric field, method of electrostatic images, point charge in front of grounded conducting plane.</td><td>8 H</td></tr>
<tr><td colspan="3">Electric Fields in matter
Polarization, Fields outside a dielectric medium, electric field inside a dielectric, Gauss's law in a dielectric, the electric displacement vector, electric susceptibility and dielectric constant. Boundary conditions on the field vectors, Dielectric sphere in a uniform electric field.</td><td>6 H</td></tr>
<tr><td colspan="3">Microscopic Theory of Dielectrics
Molecular field in a dielectric, induced dipoles, A simple model, polar molecules, Langevin-Debye formula, permanent polarization, ferroelectricity.</td><td>5 H</td></tr>
<tr><td colspan="3">
Work and Energy in electrostatics</td><td>5 H</td></tr>
</table>

Work and Potential energy of discrete and continuous charge distributions, Energy density of an electric field.	
PRACTICAL (2 credits) Minimum 5 experiments from electromagnetic theory and minimum of 3 tutorials from mathematical physics. **Electromagnetic Theory I(Experiments)** 1. Measurement of Dielectric constant of solids by using parallel plate capacitor. 2. Measurement of dielectric constant & susceptibility of liquid using two co-axial metal tubes 3. Absolute capacity by ballistic galvanometer. 4. Verification of Curie -Weiss law using a disc capacitor. 5. Equipotential lines & electric field 6. Variation of A.C. Resistance of a coil with frequency. 7. Dielectric constant K and Electric Susceptibility χe using series resonance method. 8. Determination of high resistance by leakage using ballistic galvanometer 9. Resistance of ballistic galvanometer by shunting. **Mathematics Physics tutorials** 10. Proof of differential vector identities. 11. First order differential equation. 12. Second order differential equation. 13. Partial differential equations 14. Application of Fourier Series to solution of ODF 15. Application of Fourier Series to solution of PDE	
Learning Outcome: At the end of the course, learners will be able to: 1 Define scalar field & vector field and 'del' operator. 2. Understand vector differentiation and rules of vector differentiation. 3 Learn the concepts of directional derivatives, gradient of a scalar function, divergence and curl of a vector function and apply them to physical problems. 4. Solve problems related to vector calculus. 5 Express laplacian operator in cartesian, spherical and cylindrical co-ordinate systems. 6.Solve ordinary and partial differential equations and apply them to various physics problem. 7 Learn basic laws of electrostatics and define electric field and potential due to discrete and continuous charge distributions. 8 Understand Gauss' Law and its applications. 9. Learn different techniques to solve electrostatic problems. 10 Understand the concept of polarization and electrostatic phenomena in dielectric medium. 11 Find dielectric constant and absolute capacitance experimentally.	
References: 1. Charlie Harper, Introduction to Mathematical Physics, PHI, (1976) 2. H.K. Dass & R. Verma, Mathematical Physics, S. Chand. 3. Mary L Boas, Mathematical methods in physical sciences, John Wiley and sons (1983) 4. Arfken & Weber, Mathematical Methods for Physicists, Elsevier. 5. Reitz and Milford, Foundations of Electromagnetic Theory, Addision- Wesley Publishing Company.(2008) 6. David Griffiths, Introduction to Electrodynamics , Prentice Hall of India Ltd, New Delhi (1995) 7. Mahajan and Rangawala, Electricity and Magnetism, Tata McGraw-Hill Publishing Company Ltd., 1988 8.Chatopadhaya and Rakshit, Electricity and Magnetism, New Central Book Agency, (2013)	

PYD101: **QUANTUM MECHANICS**

(Under CBCS Ordinance from 2019 onwards)

PYD101 SEM V	QUANTUM MECHANICS	Credit : 4—Theory 4 Practical 0

Course Objectives

- To illustrate dual nature of matter and radiation and importance of De-Broglie hypothesis in development of quantum mechanics
- To explain experimental evidence of De-Broglie hypothesis.
- To explain wave group HUP and correspondence principle and Schrodinger's equation.
- To explain applications of STIE
- To explain quantum mechanical aspects of molecular spectra, alpha decay and tunnel diode.

Theory **4 Credits**

Waves and particles De Broglie's hypothesis,Review of the Bohr's postulate about stationary states in the light of De Broglie's hypothesis, The concept of quantum (particle) nature of radiation. Demonstration of wave nature of particles-Davisson Germer experiment, electron diffraction experiment of G.P.Thomson, Dual nature of radiation/matter. Complimentary in Duality.	(7+2T)CH
The Wave Function Representation of a De Broglie wave, Velocity of De Broglie wave, Construction of a wave group, Wave packet and its motion in one dimension., Group velocity and particle velocity, Max Born's interpretation of the wave function, probability concept, Acceptable wave function, Normalization of wave function.	(5+2T)CH
Heisenberg's Uncertainty Principle Limitation of wave mechanics to predict the physical state of a particle/system accurately. Heisenberg Uncertainty principle. Illustration by thought experiments (γ - ray microscope, single slit diffraction and double slit experiment), Applications of Heisenberg Uncertainty principle.	(5+2T)CH
Schroedinger's Wave Equation Wave equation for De Broglie waves and Schroedinger's time dependent wave equation, Concept of stationary states. Schroedinger's time independent equation. Postulates of Quantum mechanics, Definition of operators & their necessity, Expectation values,	(12+2T)CH

Extraction of information from solutions in terms of expectation values of physical variables/observable. Eigen value equation, Commutation relations,	
Applications of Schroedinger's Time Independent Wave Equation Free particle, Infinite square well potential: Energy eigen functions and eigen values, One dimensional finite square step potential of height Vo: Comparison of classical and quantum mechanical results for particle energy E>Vo and E<Vo, Rectangular potential barrier and penetration through it, tunnel effect, Qualitative discussion of alpha decay, tunnel diode & scanning tunneling microscope. Simple Harmonic Oscillator, Calculation of $<x>$ and $<p_x>$, $<x^2>$ and $<p_x^2>$. Particle in a three dimensional box, Concept of degeneracy,	(16+5T)CH
Learning Outcome **Learner will be able to** • Students learn about complimentary nature of matter and radiation. • Solve problems using Schrodinger's equation. • Calculate probabilities of particle location and expectation values using quantum mechanical tools • Learn about thought experiments and quantum mechanical arguments in their support • Learn about evolution of modern physics	
Text Books & References • Arthur Beiser,Concepts of Modern Physics, 5th Edition, McGraw Hill (1995) • Arthur Beiser,Perspectives of Modern Physics, 5th Edition, McGraw Hill (1995) • F.K. Richtmayer, E.H.Kennard, J.N. Cooper, Introduction to Modern Physics (1969) • H. E.White H. Semat and J. R.Albright, Introduction to Atomic Physics, McGraw Hill Book Company • H.Semat and J.R.Albright, Introduction to Atomic and nuclear Physics, Chapman and Hall (1972) • Ghatak and Lokanathan, Quantum Mechanics, Theory and Applications, Mc Millan (2004)	

PYD 107 SOLID STATE PHYSICS (Under CBCS Ordinance (from 2019 onwards)

<table>
<tr><td>PYD 107
SEM V</td><td>Solid State Physics</td><td colspan="2">Credit : 4(Theory 3 ; Practical 1)</td></tr>
<tr><td colspan="4">Course Objectives: This course will provide students with :
1. Introduction to basics of solid state physics.
2. The first part considers bonds and crystal structure in solid matter.
3. Later same is extended to understand the phenomenon of waves by the crystal to understand the lattice structure.
4. Concepts such as the reciprocal lattice vector and the Brillouin zone will be introduced.
5. Introduction to the free electron theory of metals with emphasis on Drude's model, Fermi's law.
6. Classification of band structure in conductors, semiconductors and insulators will be introduced.
7. The concepts of dia, para and ferromagnetism is introduced with theories to distinguish between them. Also, concept of domains in the ferromagnets will be covered.
8. The last part will include introductions to dielectric and ferroelectric properties and some important theories of the same.</td></tr>
<tr><td colspan="4">Theory (3 Credits)</td></tr>
<tr><td colspan="3">Crystal Structure: Introduction, Solids – Amorphous and Crystalline Materials, Lattice Translation Vectors, Basis, Unit Cell, Miller Indices, Reciprocal Lattice, Types of Lattices, Brillouin zones, Diffraction of X-Rays by Crystals, Bragg's Law.</td><td>10 H</td></tr>
<tr><td colspan="3">Free electron theory of metals: Drude's free electron model, Fermi-Dirac distribution, Thermionic emission, Contact potential.</td><td>5 H</td></tr>
<tr><td colspan="3">Band Theory of metals: Electrons in periodic lattice, Kronig Penny model (Qualitative approach, Effective mass of an electron, Concept of hole, Classification of materials based on band structure, Effect of magnetic field on electrons, Hall effect.</td><td>7 H</td></tr>
<tr><td colspan="3">Magnetic properties of matter: Diamagnetic, Paramagnetic, Ferrimagnetic & Ferromagnetic materials, Classical Langevin Theory of diamagnetic & Paramagnetic domains, Quantum mechanical treatment of Paramagnetism, Curie Law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domain, Discussion of B-H Curve, Hysteresis and Energy Loss.</td><td>9 H</td></tr>
<tr><td colspan="3">Dielectric properties of materials: Polarization, Local electric field at an atom, Depolarization field, Electric susceptibility, Polarizability, Clausius-Mosotti Equation, Classical theory of electric Polarizability, Langevin-Debye equation, Complex Dielectric constant, Optical phenomenon, Applications: Plasma oscillation, Plasma frequency, Plasmon's, Traverse optic modes</td><td>7 H</td></tr>
<tr><td colspan="3">Ferroelectric properties of materials: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyro electric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss law, Ferroelectric domains, PE hysteresis loop.</td><td>7 H</td></tr>
<tr><td colspan="4">PRACTICAL (1 credit) (Any four)</td></tr>
</table>

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. Measurement of magnetic susceptibility of solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. Variation of Dielectric constant of a dielectric Materials with frequency.
5. To study the PE Hysteresis loop of a Ferroelectric Crystal.
6. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
7. To measure the resistivity of a semiconductor (Si/Ge) with temperature by any method (RT to 15°C) and to determine its band gap.
8. To determine the Hall coefficient of a semiconductor sample.
9. Energy band gap using PN junction.

Learning Outcome: At the end of the course, students will be able to:

1. Explain mechanical properties of solid matter, and connect these to bond type.
2. Explain how diffraction of electromagnetic waves on solid matter can be used to obtain lattice structure.
3. Explain simple theories for conduction electrical current in metals.
4. Classify solid state matter according to their band gaps.
5. Understand how electrons and holes behave in semiconductors, and explain how they conduct current. Also, the effect of magnetic field on these materials.
6. Know the basic physics behind dia, para and ferromagnetism and differentiate between them.
7. Know the basic physics behind dielectric and ferroelectric materials.
8. Explain mechanical properties of solid matter, and connect these to bond type.
9. Explain how diffraction of electromagnetic waves on solid matter can be used to obtain lattice structure.
10. Explain simple theories for conduction of heat and electrical current in metals.
11. Classify solid state matter according to their band gaps.
12. Understand how electrons and holes behave in semiconductors, and explain how they conduct current. Also, the effect of magnetic field on these materials.
13. Know the basic physics behind dia, para and ferromagnetism and differentiate between them.
14. Know the basic physics behind dielectric and ferroelectric materials.

References:

1. Introduction to Solid State Physics, Charles Kittle , 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Solid State Physics, A.J. Dekkar, McMillan, 1969.
3. Solid State Physics, S. O Pillai, McGraw Hill.
4. Solid State Physics, Gupta, Kumar & Sharma.
5. New Course in Physics, Gogawale & Lele, Vol. I, Sheth Publishers.

PYC108: Atomic and Molecular Physics
(Under CBCS Ordinance from 2019 onwards)

PYC 108 SEM VI	Atomic and Molecular Physics	Credit: 6—Theory 4 Practical 2

Course Objectives

- Discuss the application of Schrodinger's equation to hydrogen atom.
- Describe the structure of alkali metal elements and effect of magnetic field on atom and to discuss X-ray spectra.
- Discuss spectra of diatomic molecules and Raman spectra

Theory **6 Credits**

Hydrogen Atom Schrodinger's equation for the H-atom, separation of variables, Quantum numbers-n, l, ml, spin, magnetic moment, J and m_J, Angular momentum, Magnetic moment and Bohr magneton. (Ref: [1,2,3]).	6CH
Many Electron Atoms Pauli exclusion principle and classification of elements in periodic table. Symmetric and Antisymmetric wave functions, Electron configuration, Hund's rule, Spin orbit interaction, Vector atom model, Total angular momentum, L-S coupling, J-J coupling. (Ref: [1]).	10CH
Atomic Spectra Spectroscopic notation, Selection rules (derivation from transition probabilities), Alkali metal type spectra, Principal, Sharp, Diffused and Fundamental series, fine structure in alkali spectra. (Ref: [1]).	8CH
Atoms in a Magnetic Field Effects of magnetic field on an atom, The Stern-Gerlach experiment, Larmor Precession, The Normal Zeeman effect, Lande 'g' factor, Zeeman pattern in a weak field (Anomalous Zeeman effect). (Ref: [1,4]).	8CH
X-ray Spectra Characteristic spectrum, Moseley's law, Explanation of X-ray spectra on the basis of quantum mechanics, Energy levels and characteristic X-ray lines, X-ray absorption spectra, Fluorescence and Auger effect. (Ref: [4]).	6CH
Spectra of Diatomic Molecules Rotational energy levels, Rotational spectra, Vibrational energy levels, Vibration-Rotation spectra, Fortrat Parabolas and explanation of band structure on its basis, Electronic spectra (Ref: [5,7,10]).	14CH
Raman Effect Raman Effect: Classical and Quantum mechanical explanation, Pure rotational Raman spectra, Vibrational Raman spectra, Rotational fine structure, Experimental set up for Raman spectroscopy. (Ref: [10])	8CH

Learning Outcome

Learner will be able to

- Apply Schrodinger's equation to hydrogen atom and obtain the three quantum numbers. and discuss effect on atom due to spin orbit interaction.
- Explain the fine structure observed in alkali element due to spin orbit interaction and due to applied magnetic field.
- Analyse the diatomic spectra of the molecule

Text Books & References

1. Arthur Beiser, Perspectives of Modern Physics, 5th Edition, McGraw Hill (1995)
2. F.K. Richtmayer, E.H. Kennard, J.N. Cooper, Introduction to Modern Physics (1969)
3. H.E. White H. Semat and J.R. Albright, Introduction to Atomic Physics, McGraw Hill Book Company (2003)
4. H. Semat and J.R. Albright, Introduction to Atomic and nuclear Physics, Chapman and Hall (1972)
5. Barrow, Introduction to Molecular Physics, McGraw Hill (1962)
6. Anne P. Thorne, Spectrophysics, Chapman and Hall(1974)
7. Banwell, Fundamentals of Molecular Spectroscopy, TMH (2012)
8. P.T. Matthews, Introduction to Quantum Mechanics, TMH (1974)
9. Ghatak and Lokanathan, Quantum Mechanics, Theory and Applications, Mc Milan (1967)
10. G. Arhuldas, Molecular Structure & Spectroscopy PHI.

Practical (2credit)

Minimum of 8 experiments

1. To determine the wavelength of H-alpha emission line of Hydrogen atom. Hydrogen source / Rydberg Constant
2. Balmer series & Emission spectra
3. Determination of specific rotation of optically active substances.
4. To determine the value of e/m by helical method.
5. Absorption spectrum of a liquid KMnO4 or KI
6. To determine the charge of an electron using Millikan oil drop apparatus
7. Resolving fine structure of Sodium D lines using Diffraction (reflection/ transmission) grating
8. Determination of Cauchy's constants of a given Flint glass prism using fine structure of Na D

lines 9. To determine refractive index of liquid by hollow prism 10. To determine the absorption lines in the rotational spectrum of Iodine vapour. 11. Analysis of Rotational / Vibrational spectra to find bond length and bond strength 12. Zeeman effect 13. GM counter	

PYC 109 SOLID STATE DEVICES AND INSTRUMENTATION (Under CBCS Ordinance(2019 onwards)

<table>
<tr><th>PYC 109 SEM VI</th><th>Solid State Devices and Instrumentation</th><th colspan="2">Credit : 6(Theory 4 ; Practical 2)</th></tr>
<tr><td colspan="4">Course Objectives: This course will provide students with :
Basic knowledge of two terminal devices such as Power diodes, Tunnel diodes, Schottky barrier diode.
Basic knowledge of industrial devices such as SCR, DIAC, TRIAC and their use in various applications.
Basic knowledge on the principle of CCD’s and the Basic LED TV.
Basic knowledge on the use of PMMC as a measuring instrument in analog DC ammeter and voltmeter and multimeters.
Knowledge on the basic building blocks of a simple CRO and the function of its various stages.
Basic knowledge on the meaning of a transducer, the different types of electrical and mechanical transducers and their applications.</td></tr>
<tr><td colspan="4">Theory (Solid State Devices)</td></tr>
<tr><td colspan="3">Two Terminal Devices: Tunnel diodes, Power diodes, Varicap diodes, Schottky Barrier diode, Semiconductor photoconductive cell, Photovoltaic cell, Photodiode, Light emitting diodes (LED), Liquid Crystal display (LCD), Solar cells and Photocouplers.</td><td>10H</td></tr>
<tr><td colspan="3">Industrial Devices: Silicon controlled rectifier (SCR), SCR characteristics, rating, construction and terminal identification, SCR applications, Silicon controlled switch (SCS), Gate turn off switch (GTO), Light activated SCR (LASCR), Shockley diode, Diac, Triac, Typical Diac-Triac Phase control circuit, Unijunction transistor (UJT). Phototransistor.</td><td>15H</td></tr>
<tr><td colspan="3">Image Capture Devices: Solid State image scanners (CCD’s), Basic LED TV.</td><td>5H</td></tr>
<tr><td colspan="3">Theory(Instrumentation)</td><td></td></tr>
<tr><td colspan="3">Measuring Instruments: Errors in measurement, Basic PMMC, Analog DC ammeter, Multirange ammeter, Universal shunt, AC & DC voltmeter, Multirange voltmeter, Extending voltmeter range, Transistor voltmeter, Ohmmeter – Series and shunt type, Multimeter, Digital voltmeter, Resolution and sensitivity of digital meters, multimeter and frequency meter, Q meter.</td><td>12H</td></tr>
<tr><td colspan="3">Oscilloscope: CRT, CRO block diagram (simple CRO), vertical and horizontal deflection system, Vertical amplifier, sweep generator, delay line</td><td>4H</td></tr>
<tr><td colspan="3">Transducers: Introduction, Electrical transducer, selecting a transducer, Resistive transducers, Strain gauges, resistance wire gauge, type of strain gauge, foil strain gauge, semiconductor strain gauge, Resistance thermometer, Thermister, Inductor transducer, LVDT, Capacitive transducer, Piezo electric transducer and Hall effect transducers</td><td>10H</td></tr>
<tr><td colspan="3">Signal Generator: Standard signal generator, AF sine and square wave generator, Function generator.</td><td>4H</td></tr>
<tr><td colspan="3">PRACTICAL (2 credits) Minimum of 8 experiments.
Light emitting diode; V-I characteristic, determination of Planck’s constant and Energy gap.
Photodiode/Photo-transistor: Characteristics, variation of conductivity with Intensity and spectral response. Application as a switch.
UJT characteristics and its use in relaxation oscillator.
SCR characteristics and gate-controlled ac half-wave rectifier.
DIAC-TRIAC characteristics, Gate triggering application.
Design and construction of analog two range voltmeter & ohmmeter.</td><td></td></tr>
</table>

7. Solar cell characteristics(V-I at different wavelength), spectral response, maximum power point. 8. Determination of transition capacitance of Varactor diode as function of revere bias voltage and use as a variable/tunning capacitor in any one application. 9. Crystal Oscillator: Determination of velocity of ultrasonic waves in a liquid medium, different liquids/same liquid. 10. Study of strain Gauge to determine Young's Modulus. 11. Study of LVDT – calibration and its use in any one application. 12. Signal Generator – XR 2206.	
Learning Outcome: At the end of the course, students will be able to: • Understand the working of two terminal devices such as Power diodes, tunnel diodes, Varicap diodes, Schottky diode and their applications. • Understand the working of Industrial devices such as SCR, TRIAC, DIAC and their applications in various circuits. • Explain the working principle of solid state image scanners (CCD's) and the Basic LED TV. • Understand the use of PMMC in basic measuring instruments such as analog DC ammeter, voltmeter, Ohmmeter, Multimeter. • Describe the simple CRO building block and its various stages. • Define transducers, types of transducers(Electrical and Mechanical), Semiconductor strain gauge, LVDT, Capacitive and Peizo electric. • Describe the Standard Signal generator, AF Sine and square wave generator and the basic function generator.	
References: 1. Robert Boylestead and Louis Nashelsky: Electronic Devices & Circuit Theory, 11^{th} Ed. PHI(2009). 2. R.R. Gulati: Monochrome and Colour TV, 2^{nd} ED., New Age International, 2005. 3. Allen Mottershead: Electronic Devices and Circuits- An Introduction: PHI(1997). 4. Malvino, Electronic Principles, TMH (2007). 5. J. Millman and C. Halkias, Electronic Devices and Circuits, Mc Graw Hill(1972). 6. H.S. Kalsi , Electronic Instrumenttaion: TMH (2004). 7. Willian David Cooper, Electronic Instrumentation and Measurement Techniques, PHI(2003). 8. A.K. Sawhney: A course in Electrical and Electronic Measurement, Dhanpat Rai and Co(2001).	

PYC 110 ELECTROMAGNETIC THEORY II AND THEORY OF RELATIVITY
(Under CBCS Ordinance(from 2019 onwards)

<table>
<tr><td>PYC 110 SEM VI</td><td>Electromagnetic Theory II & Theory of Relativity</td><td colspan="2">Credit : 6(Theory 4 ; Practical 2)</td></tr>
<tr><td colspan="4">Course Objectives: This course will provide students with :
1. Basic knowledge of magnetic effects produced by steady currents.
2. Understanding of the basic laws explaining magnetic fields produced by steady currents and magnetic vector potential.
3. Basic knowledge of Maxwell’s equations and electromagnetic energy
4. Understanding of postulates of special theory of relativity, Lorentz transformation equations and various phenomena related to special theory of relativity.</td></tr>
<tr><td colspan="4">Theory (Electromagnetic Theory II)</td></tr>
<tr><td colspan="3">Steady currents and their magnetic fields
Steady currents, current density, Biot-savart’s law and its applications, Ampere’s circuital law, magnetic vector potential, magnetic field of a distant circuit, magnetic dipoles, dipole moment and the field of a point magnetic dipole, magnetic scalar potential.</td><td>8 H</td></tr>
<tr><td colspan="3">Magnetic Field in material media
Magnetization, magnetic field produced by magnetized material, magnetic pole density, sources of the magnetic field, magnetic intensity H (Auxiliary magnetic field), The field equations, magnetic susceptibility and permeability, Hysteresis, Boundary conditions on B and H vectors, current circuits containing magnetic media, Magnetic circuits, Magnetic circuits containing permanent magnets.</td><td>12 H</td></tr>
<tr><td colspan="3">Microscopic Theory of Magnetism
Molecular field inside matter, Origin of Diamagnetism, Origin of Paramagnetism, theory of Ferromagnetism, Ferromagnetic domains, ferrites.</td><td>6 H</td></tr>
<tr><td colspan="3">Magnetic Energy
Magnetic energy of coupled circuits, Energy density in the magnetic field, Hysteresis Loss.</td><td>5 H</td></tr>
<tr><td colspan="3">Maxwell’s Equations
Faraday’s Law of electromagnetic induction, Generalization of Ampere’s Law-Displacement current, Maxwell’s equations and their empirical basis, Electromagnetic energy-Poyntings theorem.</td><td>6 H</td></tr>
<tr><td colspan="3">Theory (Theory of Relativity)</td><td></td></tr>
<tr><td colspan="3">Experimental Background of the Theory of Special Relativity
Galilean Transformations, Newtonian Relativity, Michelson Morley Experiment, Attempts to preserve the concept of a preferred Ether frame, (Lorentz-Fitzgerald Hypothesis), Einstein’s Postulates of Special Relativity.</td><td>7 H</td></tr>
<tr><td colspan="3">Relativistic Kinematics
Relativity of Simultaneity , Derivation of the Lorentz Transformations and derivation of its consequences such as Length Contraction and Time dilation, Relativistic Addition of velocities, Aberration and Doppler Effect.</td><td>6 H</td></tr>
<tr><td colspan="3">Relativistic Dynamics
Dynamics and relativity, Need to redefine momentum, Relativistic Momentum, Relativistic Force law, and dynamics of a single particle, Longitudinal and transverse mass, Equivalence of mass and energy $E= Mc^2$, Lorentz transformation of Momentum, Energy, Mass and Force, Twin Paradox (qualitative approach).</td><td>10 H</td></tr>
<tr><td colspan="3">PRACTICAL (2 credits) Minimum 6 experiments and 2 tutorials.
Experiments</td><td></td></tr>
</table>

1. Measurement of Core losses and copper losses in a transformer
2. Measurement of Hysteresis loss using CRO.
3. Hysteresis by magnetometer
4. To study Hall effect, measurement of hall coefficient and its application as a transducer
5. Self inductance: Rayleigh's method
6. Mutual inductance by ballistic galvanometer.
7. Mutually coupled tuned series LCR circuits
8. Magnetic circuit – determination of flux and reluctance
9. Helmholtz coil & measurement of Faraday's number
10. Magnetic susceptibility of paramagnetic substances by Guoy's Balance

Tutorials

1. Problems on length contraction/ time dilation
2. Problems on relativistic velocity addition
3. Twin Paradox
4. Pole –Barn Paradox

Learning Outcome: At the end of the course, students will be able to:

1 Understand the Biot-Savart's law, Ampere's law and apply them to various cases.
2 Understand the concept of magnetic vector and scalar potential.
3 Define magnetic susceptibility, permeability and obtain relation between them.
4 Derive boundary conditions on field vectors.
5 Understand paramagnetism, dimagnetism and ferromagnetism
6 Understand magnetic circuits and study various cases of magnetic circuits.
7 Derive expressions for magnetic energy of coupled circuits and energy density.
9 Understand Maxwell's equations and Poynting theorem
10 Study Michelson Morley experiment and understand postulates of special theory of relativity.
11 Derive the equations of Lorentz transformation and their consequences.
12 Derive the equations of relativistic addition of velocities.
13 Understand Doppler effect and solve the problems.
14 Understand various aspects of Relativistic dynamics and equivalence of mass and energy.
15 Discuss Twin Paradox qualitatively.

References:

1. 1. Reitz and Milford, Foundations of Electromagnetic Theory, Addision- Wesley Publishing Company (2008).
2. David Griffiths, Introduction to Electrodynamics , Prentice Hall of India Ltd, New Delhi (1995).
3. Mahajan and Rangawala, Electricity and Magnetism, TMH, , (1988).
4. Chatopadhaya and Rakshit, Electricity and Magnetism, New Central Book Agency, (2013).
5. P. Lorrain, D. Corson, Electromagnetic Fields and Waves, 1988.
6. Robert Resnik, Introduction to Special Relativity Wiley(1968).
7. N.C. Garach, Understanding Relativity, Vol. I, Sheth Publishers

PYD 106 NUCLEAR PHYSICS

(Under CBCS Ordinance (from 2019 onwards)

PYD 106 SEM VI	**Nuclear Physics**	**Credit : 4 (Theory 4 ; Practical 0)**
Course Objectives: This course will provide students with : • Brief overview of modern nuclear physics. • Idea about nuclear forces with concepts of Binding energy and nuclear masses. • Knowledge of successive decays (growth of daughter activities to achieve radioactive equilibrium). • Knowledge of radioactive decays such as alpha, beta and gamma decay. • Origin of neutrinos. • Knowledge of nuclear reactions & nuclear models. • Overview of nuclear programs in India. • Knowledge of different ways of detecting nuclear radiations.		
Theory (4 Credits)		
Nuclear Properties: Constituents of nucleus – Isotopes, Isotones, Isobars, Radii & Density of Nucleus, Definition of a. m. u, Mass of nuclei, Mass Defect, Packing Fraction, Binding Energy, Stability of Nuclei, Magnetic & Electrical Dipole moments.		**5 H**
Nuclear Forces: Main Characteristics, Deuteron Problem, Meson Theory & Estimation of mass of meson, Yukawa potential.		**5 H**
Radioactivity: Law of Radioactive decay, Derivation of exponential decay, Half and mean life, Statistical Nature (Numericals), A-B-C type transformation Transient and secular equilibrium, Radioactive series, Carbon Dating, Applications, Numericals.		**10 H**
Nuclear Reactions: Artificial Transmutation, Compound Nucleus, Types of Nuclear Reactions, Conservation laws, Energetics of Nuclear Reaction, Q-Value Threshold Energy, Cross-sections of nuclear reaction, Discovery and determination of neutron and its mass, Numerical		**8 H**
Radioactive Decay: Alpha Decay, Velocity and energy, Gieger-Nuttal law, Alpha spectra and fine structure, Short range and long range of alpha particle, Gamow Theory of alpha decay, Beta Decay and types, Energies of beta decay, Continuous spectrum of beta particle, Difficulties in understanding the spectrum, Pauli's neutrino hypothesis, Fermi's theory, K-capture, Gamma Decay, Internal conversion, Nuclear isomerism		**12 H**
Nuclear Models: Liquid drop model, Compound nucleus theory, Analogy – liquid drop & Nucleus, Wiezsacker's mass formula, Mass parabola Predictions of stability, Spontaneous and induced fission, Bohr-wheeler theory, Condition for spontaneous fission – basis of Z/A, Emission of energy released from BE curve, Nuclear shell model, Evidence of magic numbers, Evidences that led to shell model, Main assumptions of single particle shell model, Jensen – Mayer scheme, Shell model- spin & Parity.		**10 H**

Nuclear Energy: Neutron induced fission, Chain reaction, Mass yield in an asymmetrical fission, Four factor formula, Nuclear reactor and its working Principle of breeder reactor, Nuclear programs in India.	**7 H**
Detection of Nuclear Radiation: Ionization Chamber, Proportional Chamber G M Counter, Photographic emulsion, Semiconductor detectors.	**3 H**
PRACTICAL (0 credit)	
(No practical's)	

Learning Outcome: At the end of the course, students will be able to:

- Demonstrate a knowledge of fundamental aspects of the structure of the nucleus.
- Explain the phenomenon of radioactive decay, nuclear reactions.
- Have knowledge of the different nuclear models.
- Explain the nuclear reaction at the reactor and the functioning of the nuclear reactor.
- Cite the contribution of Indian science community towards the building of nuclear science in our country and abroad.
- Explain theories behind different detectors used for detecting the neutral nuclear radiations.

References:

- Irving Kaplan, Nuclear Physics, Narosa Publishing House.
- Atomic and Nuclear Physics, A.B. Gupta and Dipak Ghosh, Books and Allied (P) Ltd.
- Arthur Beiser, Perpectives of Modern Physics, 5th Edition, McGraw Hill (1995).
- F.K.Richtmyer, E.H. Kennord, J.N. Cooper, Introduction to Modern Physics, 6th edition, McGraw Hill (1997).
- S.B. Patel, Nuclear Physics, TMH.
- K. Hangovan, Nuclear Physics, MJP publishers.

PYD 109 PROJECT (Under CBCS Ordinance (from 2019 onwards)

<table>
<tr><td>PYD109 SEM VI</td><td>Project</td><td colspan="2">Credit : 4</td></tr>
<tr><td colspan="4">Course Objectives: This course will provide students with :
1. Self learning techniques to undertake self study on a topic related to Physics discipline not covered under the syllabus and use research methodology for reviewing literature, sampling and collection of data, analysis and discussions, field work , library work and experimentation for validation and drawing inferences and conclusion.</td></tr>
<tr><td colspan="3">Syllabus based on topics to be chosen by the students under the guidance of project supervisor from among physics faculty.</td><td></td></tr>
<tr><td colspan="4">Learning Outcome: At the end of the course, students will be able to:</td></tr>
<tr><td colspan="4">• Students learn techniques of research methodology, field work and experimentation and physics of measurement</td></tr>
<tr><td colspan="4">• References : Project bibliographies</td></tr>
</table>