DEPARTMENT OF PHYSICS

SHIFT I

LEARNING OBJECTIVES & OUTCOMES

ACADEMIC YEAR 2020-2021

B.Sc Physics

Preamble

Physics is one of the basic and fundamental sciences. The curriculum for the graduate programme in Physics is revised as per the UGC guidelines on Learning Outcome based Course Framework. The learner- centric courses let the student progressively develop a deeper understanding of various aspects of Physics.

The new curriculum offers courses in the core areas of Mechanics, Acoustics, optics and spectroscopy, Atomic physics etc. The courses will train students with sound theoretical and experimental knowledge that suits the need of academics and industry .In addition to the theoretical course work, students also learn physics laboratory methods for different branches of physics, specialized measurement techniques, analysis of observational data, including error estimation.Students will have deeper understanding of laws of nature through the subjects like classical mechanics, quantum mechanics, statistical physics etc. Students' ability of problem solving will be enhanced. Students can apply principles in physics to real life problems. Subjects like Integrated electronics and Microprocessors will enhance the logical skills as well as employability skills. Numerical methods and Mathematical Physics provide analytical thinking and provides a better platform for higher level physics and research.

The restructured courses with well defined objectives and learning outcomes, provides guidance to prospective students in choosing the elective courses to broaden their skills in the field of physics and interdisciplinary areas.The elective modules of the framework offer students choice to gain knowledge and expertise in specialized domains of Physics like Astrophysics, Medical Physics, etc.

Programme Learning Outcome

Nature and Extent of the Programme

The main objective of science education has evolved to concern the education of future citizens being able to contribute to the growth of global issues. Physics is a unique training that provides a basis of key skills, develops innovative ways of tackling problems, addresses fundamental needs of industry and contributes to economic development.

Physics is the most fundamental of the experimental sciences, as it seeks to explain the universe itself from the very smallest particles—currently accepted as quarks, which may be truly fundamental—to the vast distances between galaxies. Classical physics, built upon the great pillars of Newtonian mechanics, electromagnetism and thermodynamics, went a long way in deepening our understanding of the universe. Maxwell's theory of electromagnetism described the behaviour of electric charge and unified light and electricity, while thermodynamics described the relation between energy transferred due to temperature difference and work and described how all-natural processes increase disorder in the universe. However, experimental discoveries dating from the end of the 19th century eventually led to the demise of the classical picture of the universe as being knowable and predictable. Newtonian mechanics failed when applied to the atom and has been superseded by quantum mechanics and general relativity. However, observations remain essential to the very core of physics.The body of scientific knowledge has grown in size and complexity, and the tools and skills of theoretical and experimental physicists have become so specialized that the students need to be highly proficient in both areas.This is very critical in developing a scientific temperament and urge to innovate, create and discover in Physics.

The Degree Programme in physics course allows students to develop traditional practical skills and techniques and increase their abilities in the use of mathematics, which is the language of physics. It also allows students to develop interpersonal and digital communication skills which are essential in modern scientific endeavour and are important life-enhancing, transferable skills in their own right.

Aim of the Programme:

This Programme enables the students to develop scientific temper, observation skills, problem solving and critical thinking skills. It empowers them with knowledge leading to higher learning in applied sciences. It fosters research attitude among the students and helps them serve for the betterment of the society.

Graduate attributes:

After the completion of B.Sc Physics Programme, students will be able to

- ❖ Acquire a thorough understanding of physical phenomena, identify the principles and basic concepts in physics.
- ❖ Tests the validity of Physical theories in a Scientific Method.
- ❖ Use a methodical approach to compare the implications of a theory with the conclusions drawn from its related experiments.
- ❖ Use Observations to test the validity of a theory in a logical, unbiased and repeatable way.
- ❖ Apply Numerical methods and mathematical approach involved in Physics leading to research.
- ❖ Employ critical thinking and efficient problem solving skills in all the basic areas of Physics

ODD SEMESTER

JUNE 2020- NOVEMBER 2020

I YEAR

I SEMESTER

Core Paper – I - PROPERTIES OF MATTER AND SOUND

Learning Objectives:

- students will lean and understand the properties of materials
- To understand the acoustic aspects of buildings
- To acquire basic knowledge of oscillation and sound energy

Learning outcomes

- Study the elastic behaviour and identify the materials based on the moduli of elasticity.
- Understand the principles of elasticity through the experimental study of Young Modulus and Rigidity Modulus.
- To know the different methods of producing ultrasonic waves and its applications, the concepts of acoustic comfort and better understanding of the theories used in building acoustics

Lecture: 60 Hours Credits:5

Unit I: ELASTICITY

Hooke's Law – Stress–Strain diagram –Elastic constants –Poisson's ratio – Relation between elastic constants and Poisson's ratio – Work done in stretching and twisting a wire – Twisting couple on a cylinder – Torsional pendulum (with and without masses)

Unit II: BENDING OF BEAMS

Cantilever– Expression for Bending moment – Expression for depression at the loaded end of the cantilever–Oscillations of a cantilever – Expression for time period-Experiment to find Young's Modulus – Non-Uniform bending– Experiment to determine Young's Modulus by Koenig's method- Uniform bending-Expression for elevation-Experiment to determine Young's Modulus using microscope

Unit III : FLUID DYNAMICS

Surface tension-: Definition – molecular forces– Excess pressure over curved surface – Application to spherical and cylindrical drops and bubbles-Variation of surface tension with temperature —Jaegar's method.

Viscosity:-Definition-Streamline and turbulent motion – Rate of flow of liquid in a capillary tube-Poiseuille's formula –corrections-Terminal velocity and Stoke's formula– Variation of viscosity of a liquid with temperature

Unit IV: WAVES AND OSCILLATIONS

Simple Harmonic Motion – Differential equation of SHM – Graphical representation of SHM – Composition of two S.H.M in a straight line-at right angles-Lissajous's figures-Free, Damped, Forced vibrations - Resonance and Sharpness of resonance.Laws of transverse vibration of strings- Sonometer-Determination of AC frequency using sonometer - Determination of frequency using Melde's apparatus.

Unit V: ACOUSTICS OF BUILDINGS AND ULTRASONICS

Intensity of sound – Decibel – Loudness of sound –Reverberation – Sabine's reverberation formula – Acoustic intensity – Factors affecting the acoustics of Buildings. Ultrasonic waves – production of ultrasonic waves – Piezoelectric crystal method –Magnetostriction effect – Application of ultrasonic wave

UNIVERSITY OF MADRAS

DEPARTMENT OF PHYSICS - NON-MAJOR ELECTIVE

SYLLABUS WITH EFFECT FROM 2020-2021

PHYSICS IN DAILY LIFE

SUB. CODE: SR5AA **SEMESTER: I CLASS:I B.Sc. MATHEMATICS**

COURSE OBJECTIVE:

- **To study basic concepts of laws of physics and applications.**
- **To empower students with knowledge leading to higher learning in applied sciences.**
- **To enable students to employ critical thinking and efficient problem solving skills.**

COURSE OUTCOMES:

- **Students acquire knowledge in basic elementary ideas of electricity and magnetism, properties of matter, mechanics and optics.**
- **Students acquire knowledge of heat and different measurement techniques in calorimetry.**
- **Students learn the application of basic laws of physics in the world around.**

- Unit I

  Motion: Velocity, acceleration, momentum – inertia - force - laws of motion. Newton's law of gravitation - acceleration due to gravity- mass and weight, weightlessness.

- Unit II

  Properties of Matter: Different phases of matter - surface tension, viscosity- capillary rise-Heat, temperature-different temperature scales: degree Celsius, Fahrenheit and Kelvin-transverse and longitudinal waves, sound waves.

- Unit III

  Light & lenses: Reflection, refraction, diffraction, interference, scattering (elementary ideas only) – blue color of sky, twinkling of stars. Mirage –rainbow

  Concave and convex lenses – focal length, power of a lens, refractive index-defects of the eye – myopia, hypermetropia, presbyopia and astigmatism and their correction by lens.

- Unit IV

  Electricity: Voltage and current, Ohms law. Electric power (EB Bill), calculation of energy requirement of electric appliances – transformer, generator.

  Magnetism: Electromagnetic induction-super conductivity-Meissner effect-Maglev train.

- Unit V

  Our Universe: Galaxies- Stars, Planets & satellites – solar system, lunar and solar eclipses -black holes. Artificial satellites: Geo stationary and Polar satellites.

II YEAR

III SEMESTER

CORE PAPER III - OPTICS

Course Objective :

To understand the defects in lenses and rectifying methods.
To study the applications of Interference, diffraction and polarisation.
To gain overall knowledge in spectroscopic techniques.

Learning Outcomes :

After completing the course, the student will be able to

- Know the methods of rectifying different defects in lenses.
- Work with interferometers and other optical instruments.
- Distinguish between resolving power and dispersive power.
- Understand the rectilinear propagation of light.

Unit 1 : Geometrical Optics

Spherical aberration in lenses - methods of minimizing spherical aberration - condition for minimum spherical aberration in the case of two lenses separated by a distance - Chromatic aberration in lenses - Condition for achromatism of two thin lenses (in and out of contact) - Dispersion produced by a thin prism - Achromatic prisms - Combination of prisms to produce - Dispersion without deviation - Deviation without dispersion.

Unit 2 : Interference

Analytical treatment of interference - expression for intensity - condition for maxima and minima in terms of phase and path difference - Airwedge - determination of diameter of thin wire - test for optical flatness - Haidinger's fringes - Michelson's interferometer - theory - applications - determination of wavelength; thickness of thin transparent material and resolution of interferometer.

Unit 3 : Diffraction

Fresnel diffraction - diffraction at a circular aperture and narrow wire. Fraunhoffer diffraction - single slit - double slit - (simple theory). Plane diffraction grating - missing order - overlapping spectra - maximum number of orders - Determination of wavelengths using grating - normal incidence - oblique incidence (theory). Dispersive power of a grating. Rayleigh's criterion for resolution - limit of resolution of the eye - resolving power of Telescope and microscope - resolving power of prism and grating - Difference between resolving power and Dispersive power.

Unit 4 : Polarisation

Double refraction - Nicol prims -polarizer and analyzer - Huygen's explanation of double refraction in uniaxial crystals - Dichroism - polaroids and their uses - Double image polarizing prisms - Quarter wave plate and Halfwave plate - plane, elliptically and circularly polarized light - production and detection - Babinet's Compensator - optical Activity - Fresnel's explanation of optical activity - specific rotatory power - determination using Laurent's half shade polarimeter.

Unit 5 : Spectroscopy

Introduction to spectroscopy - Electromagnetic spectrum - characterization of electro magnetic radiation - quantization of energy - regions of the spectrum – classification of molecules – microwave spectroscopy – rigid rotator - vibrational spectroscopy – harmonic oscillator - Raman effect - experimental set up - Characteristics of Raman lines - Laser - Ruby laser - He-Ne, CO_2 laser construction and working - application of laser.

ALLIED PHYSICS PAPER – I (60 Hours) 4 Credits

Learning Objective:

- Students will learn the concept of strength of materials.
- Will learn viscous properties of liquids
- Will learn the resistance of materials, capacity of conductors, effect of magnetic field due to passage of current

Unit 1 : Waves and Oscillations

Simple harmonic motion – composition of two simple harmonic motion at right angles (periods in the ratio 1:1) – Lissajou's figures – uses – laws of transverse vibrations of strings – Melde's string – transverse and longitudinal modes – determination of a.c frequency using sonometer (steel and brass wires) – ultrasonics – production – application and uses – reverberation – factors for good acoustics of hall and auditorium.

Unit 2 : Properties of matter

Elasticity : Elastic constants – bending of beam – Young's modulus by non- uniform bending – energy stored in a stretched wire – torsion in a wire – determination of rigidity modulus by torsional pendulum – static torsion.

Viscosity : Coefficient of viscosity – Poissuelle's formula – comparison of viscosities - burette method – Stoke's law – terminal velocity – viscosity of highly viscous liquid – lubrication.

Surface tension : Molecular theory of surface tension – excess of pressure inside a drop and bubble – variation of surface tension with temperature – Jaeger's method.

Unit 3 : Thermal Physics

Joule-Kelvin effect – Joule-Thomson porous plug experiment – theory and application – liquefaction of gasses – Linde's process – Helium I and II – adiabatic demagnetization. Thermodynamic equilibrium – laws of thermodynamics – entropy change of entropy in reversible and irreversible processes.

Unit 4 : Electricity and Magnetism

Capacitor – energy of a charged capacitor - loss of energy due to sharing of charges – magnetic field due to a current carrying conductor – Biot Savart's Law – Field along the axis of the coil carrying current – peak, average and RMS values of ac current and voltage – power factor and current values in an ac circuit – circuit control and protective devices – switch and its types – fuses circuit breaker and relays.

Unit 5 : Geometrical optics

Refraction – Refractive index by microscopy – air cell – refraction at grazing incidence and grazing emergence in prisms – combination of two small angled prisms to produce dispersion without deviation and deviation without dispersion – direct vision prism – constant deviation prism – defects of images – coma – distortion – spherical and chromatic aberration in lenses.

Learning Outcome:

- Students studying allied physics learnt various modulus involved in the Materials .
- They learnt the flow of liquids due to viscous forces.
- They learnt the various thermodynamic laws and the concept of entropy, and the phenomenon like dispersion and deviation and defects in lenses.

III YEARS

V SEMESTER

ELECTRICITY AND ELECTROMAGNETISM

Course Objective:

To give the students a firm understanding of the basics ofElectricity and Magnetism.

To familiarize the fundamentals of electromagnetic theory and applications of electromagnetic Induction

To familiarize the Maxwell's equations and its wide application

Learning Outcomes:

Demonstrate Gauss law, Coulomb's law for the electric field and apply it to systems of point charges as well as line, surface and volume distribution of charges

Understand the principle of capacitors and dielectric properties

Explain Faraday and Lenz's laws to articulate the relation between electric and magnetic fields

Lecture: 60 Hours **Tutorial: 15 Hours** **Credits:4**

Unit 1 : Chemical Effects of Electric Current:

Faraday's laws of Electrolysis - ionic velocities and mobilities. Calculation and experimental determination of ionic mobilities - transport number. Thermoelectricity- Peltier effect - Experimental determination of Peltier coefficient - Thomson coefficient – experimental determination of Thomson coefficient - application of thermodynamics to a thermocouple and connected relations - thermoelectric diagram and uses.

Unit 2 : DC Circuits:

Growth and decay of current in a circuit containing resistance and inductance – growth and decay of charge in a circuit containing resistance and capacitor - growth and decay of charge in an LCR circuit - condition for the discharge to be oscillatory - frequency of oscillation - network analysis - Thevenin and Norton's Theorems.

Unit 3: AC Circuits:

AC Voltage and current - Power factor and current values in and AC circuit containing LCR circuit - series and Parallel resonant circuits - AC motors - single phase, three phase – star and delta connections - electric fuses - circuit brakers.

Unit 4 : Magnetic Effect of Electric Current:

Biot and Savart's law - magnetic field intensity due to a solenoid carrying current – effect of iron core in a solenoid - Helmholtz galvanometer - moving coil ballistic galvanometer – theory - damping correction - determination of the absolute capacity of a condenser using B.G.

Unit 5 : Electromagnetic Induction and Its Applications:

Faraday's laws of electromagnetic induction - inductor and inductance - determination of self inductance of a coil using Anderson method - mutual inductance – experimental determination of absolute mutual inductance - coefficient of coupling - Earth inductor - uses of earth inductor - measurement of horizontal component of the earth's magnetic field - measurement of vertical component of earth's magnetic field - calibration of B.G. – Induction coil and its uses.

NUCLEAR PHYSICS AND PARTICLE PHYSICS

Course Objective:

To study the basic structure of nucleus and nuclear models

To analyse the radioactivity of nuclear substances and radiation hazard

To introduce the concept of elementary particles.

Learning outcomes:

On completion of the course the students will be able to

Describe the nuclear models

Understand the half life and mean life of radioactive substances and the mechanism of radiation

Appreciate the production of nuclear energy through nuclear fission

Lecture:60 Hours **Tutorial:15 Hours** **Credits:4**

Unit 1 : General Properties of Nuclei

Nuclear size, charge, mass-determination of nuclear radius-mirror nucleus method-mass defect and binding energy-packing fraction - nuclear spin - magnetic dipole moment - electric quadrupole moment-nuclear models-liquid drop model-Weizacker semi empirical mass formula-shell model and magic numbers-collective model-nuclear forces-meson theory of nuclear force (qualitative).

Unit 2 : Radioactivity

Natural radioactivity-law of disintegration-half life and mean life period-units of radioactivity-transient and secular equilibrium-radiocarbon dating-age of earth - alpha rays-characteristics-Geiger Nuttal law - α-ray spectra-Gamow's theory of α-decay (qualitative study)-beta rays-characteristics-beta ray spectra-neutrino hypothesis-violation of parity conservation-experimental verification with Co^{60}-gamma rays and internal conversion-nuclear isomerism.

Unit 3 : Radiation Detectors and Particle Accelerators

Ionisation chamber-G.M.Counter-quenching and resolving time-scintillation counter-photo multiplier tube – thermoluminescence -thermoluminescence dosimetry (TLD) - Linear accelerator-cyclotron-synchrocyclotron, betatron.

Unit 4 : Nuclear Reactions

Conservation laws-nuclear reaction Kinematics-Q-value-threshold energy - artificial radioactivity-radioisotopes and its uses-classification of neutrons-nuclear fission-chain reaction - critical mass and size-nuclear reactor-breeder reactor - transuranic elements-nuclear fusion-thermonuclear reactions-sources of stellar energy.

Unit 5 : Elementary Particles

Classification of elementary particles fundamental interaction-elementary particle quantum numbers - isospin and strangeness - conservation laws and symmetry-basic ideas about quark-quark model.

SOLID STATE PHYSICS

Course Objectives:

To understand the fundamental concepts of crystal structure.
To acquire knowledge on the basics of magnetic phenomena on materials and various types of magnetization.
To learn the properties of superconducting materials.

Learning Outcomes:

Helps as pre-requisite for understanding materials science, nano science, etc.
Gives relationship between structure and properties of the solid state systems.
To understand the importance of superconducting materials in engineering applications.

Lecture:60Hours **Tutorial:15Hours** **Credits:4**

Unit 1 : Crystal Structure

Crystal lattice – primitive and unit cell – seven classes of crystal – Bravais Lattice – Miller Indices – Structure of crystals – simple cubic, hexagonal close packed structure, face centred cubic structure, body centred cubic structure – Sodium chloride structure, Zinc Blende structure, Diamond structure.

Unit 2 : Defects in Solids

X ray diffraction – Bragg's law in one dimension – Experimental methods – Laue Method, powder crystal method and rotating crystal method.

Defects in solids - Point defects - Frenkel and schottky defects - Equilibrium concentrations - Line defects - Edge dislocation and screw dislocation - Surface defects - Grain boundary - Effects of Crystal imperfections.

Unit 3: Chemical Bonds and Crystallography

Interatomic forces - Different types of chemical bonds - Ionic bond - Cohesive energy of ionic Crystals and Madelung constant - Covalent bond - Metallic bond - Van der Waal's bond - Hydrogen bond.

Superconductivity - General properties - Type I and II Superconductors - Meissner effect - BCS theory - applications of super conductors.

Unit 4 : Dielectric Properties

Dielectric materials - Polarization, susceptibility and dielectric constant - Local field or internal field - Clausius - Mossoti relation - Sources of polarizability - Electronic polarizability - lonic polarizability - Orientational polarizability - Frequency and temperature effects on polarization - Dielectric breakdown – Properties of different types of insulating materials.

Unit 5 : Magnetic Properties

Different types of magnetic materials - classical theory of diamagnetism (Langevin theory) - Langevin theory of paramagnetism - Weiss theory of paramagnetism - Heisenberg interpretation on internal field and quantum theory of ferromagnetism - Antiferromagnetism - Hard and soft magnetic materials.

BASIC ELECTRONICS

Course Objectives:

To study the characteristics and application of various semiconductor devices.

To study the basics of electronic Instrumentation.

To study the special semiconductor devices

Learning Outcomes:

Handle basic electronic devices like diode and transistor and Construct amplifiers of different specification

Apply Barkhausen criteria to oscillators

Get an idea about Instrumentation

Lectures: 60 Hours **Tutorial: 15 Hours** **Credit:4**

Unit 1 : Semiconductor

Bandgap - forbidden energy gap - valence and conduction bands, pure semiconductor - Law of mass action, Impurity in semiconductors - energy band diagram and fermi level - PN junction barrier voltage across the junction.

Unit 2 : Transistor Amplifier

Transistor – different modes of operations – CB mode & CE mode - Two port representation of a transistor - h parameter - AC equivalent circuit using h parameters - analysis of an amplifier using h parameters common emitter only - expression for current gain, voltage gain, input impedance, output impedance and power gain - RC coupled amplifier - frequency response - analysis of low, mid and high frequency regions - classification of amplifiers - class A power amplifier – push pull, class B power amplifier - emitter follower.

Unit 3 : Feedback oscillators

Feedback in amplifiers - effect of negative feedback - concept of feedback – Barkhuesen condition - oscillators - phase shift and Wien's bridge oscillators - expression for frequency of oscillation and condition for oscillation in each case.

Unit 4 : Wave shaping circuits and multivibrators

Clipping and clamping circuits - biased clipper - integrating and differentiating circuits - RC time constant - Multivibrators - astable, monostable and bistable multivibrator - using transistors.

Unit 5 : Special semiconductor devices and applications

Field effect transistor (FET) - characteristics - FET amplifier - Unijunction transistor (UJT) - characteristics - saw tooth generator - VVR action - relaxation oscillator - frequency of oscillation - SCR characteristics - SCR as a switch - SCR rectifier.

ELECTIVE 1
NUMERICAL METHODS

Course Objectives:

To study the computational techniques involved in different mathematical manipulation.

Learning Outcomes:

On completion of the course the students will be able to

- Solve simultaneous equations using method of triangularisation
- Find the inverse of a matrix using Gauss Jordan Method
- Solve Algebraic, Transcendental and Differential Equation using different methods
- To fit a curve for the given data using principles of least squares
- Integrate the functions using different rules like Simpsons 1/3 rule

Lecture:60 Hours **Tutorial:15 Hours** **Credits:5**

Unit 1 : Simultaneous Linear Algebraic Equations

Method of triangularisation - Gauss elimination method - Inverse of a matrix - Gauss - Jordan method

Unit 2 : Numerical Solution of Algebraic, Transcendental and Differential Equation

Bisection method – Regula falsi method - Newton - Raphson method - - Horner's method - Solution of ordinary differential equation - Euler's method.

Unit 3 : Interpolation

Finite differences – operators Δ,∇,δ,E,D – relation between operators –linear interpolation – interpolation with equal intervals – Newton forward interpolation formula – Newton backward interpolation formula.

Unit 4 : Curve Fitting

Principles of least squares - fitting a straight line - linear regression - fitting an exponential curve.

Unit 5 : Numerical Integration

Trapezoidal Rule - Simpson's 1/3 rule and 3/8 rule - Applications - Weddle's rule

EVEN SEMESTER

DECEMBER 2020 – APRIL 2021

I YEAR

II SEMESTER

THERMAL PHYSICS

Course Objective:

Students will understand the various thermo dynamical concepts
Will learn principles and to solve problems.
Will learn the thermodynamical laws and theories of Gases are thought.

Learning Outcome:

Upon completion of the course students will be able to:
Acquire knowledge of Heat and different measurement techniques in calorimetry.
Use thermodynamic terminology correctly
Learn the basic aspects of kinetic theory of gases and the mean free path of molecular collision

Lecture: 60 Hours Credits:4

UNIT I :KINETIC THEORY OF GASES AND MEAN FREE PATH

Review of results of kinetic theory of gases: (Pressure exerted by gas -rms, average and most probable speed-Equipartition Theorem – Heat capacities) - Distribution of molecular velocities in a perfect gas-Distribution of molecular speeds-Mean free path (Zeroth and First order)

UNIT II: TRANSPORT PHENOMENA AND REAL GASES

Transport phenomena- Viscosity (Zeroth order approximation)- Effects of Temperature and Pressure on viscosity- Thermal Conductivity- Diffusion – Real gases -Deviations from Perfect gas behaviour- Regnault's Experiment – Vander Waals' equation of state – Discussion of Vander Waals' equation – Joule Experiment – Porous Plug experiment – Joule –Thomson Coefficient for Vander Waals' gas

UNIT III: THERMOMETRY AND CALORIMETRY

Platinum resistance thermometer – Calendar and Griffith's bridge – Thermistor – Specific heat capacity – Specific heat capacity of solids – Dulong and Petit's law – Specific heat capacity of liquid – method of mixtures – Barton's correction – Specific heat capacity of gases – Cp and Cv by Regnault's and Callendar & Barne's methods – Variation of Specific Heat Capacity of Diatomic Gases

UNIT IV: FIRST AND SECOND LAW OF THERMODYNAMICS

Thermodynamic system, surroundings, boundaries-State of system and Thermodynamic variables – Thermodynamic equilibrium- Processes- The Zeroth law and concept of temperature- origin of the first law- Internal energy-Basic thermal, mechanical and diffusive interactions-the first law-applications of first law(heat capacities of gas, adiabatic equation of state and lapse rate)- Enthalpy- Second law –Origin of second law - Heat engines –The Carnot cycle- Carnot cycle as refrigerator –Kelvin, Planck and Clausius statements-Carnot's theorem

UNIT V: ENTROPY AND THERMODYNAMIC RELATIONS

Entropy- Entropy change in reversible processes – Reversible heat transfer- Clausius inequality -Entropy change in irreversible process-the principle of increase of entropy- Joule's expansion-the entropy form of first law- Entropy of an Ideal gas- Entropy of mixing - Unavailable energy: Thermal death of universe - Physical concept of entropy- Maxwell relations- Thermodynamic relations involving heat capacities- TdS equations.

UNIVERSITY OF MADRAS

DEPARTMENT OF PHYSICS - NON-MAJOR ELECTIVE

SYLLABUS WITH EFFECT FROM 2020-2021

PHYSICS OF EVERYDAY LIFE

SUB. CODE: SR5AB SEMESTER: I I CLASS:I B.Sc. MATHEMATICS

COURSE OBJECTIVE:

- **To study basic concepts of laws of physics and applications.**
- **To empower students with knowledge leading to higher learning in applied sciences.**
- **To enable students to employ critical thinking and efficient problem solving skills.**

COURSE OUTCOMES:

- **Students acquire knowledge in basic elementary ideas of calculation of electricity bill and working of common domestic electrical appliances.**
- **Students acquire knowledge of latest technique in the field of mobile communication.**
- **Students learn the application of basic laws of physics in the world around.**

- Unit – I

  Art of Estimation and Fermi Problems: The Fermi Rule-Guesstimation Techniques-Fermi problems in real life(Number of Popcorn venders in Tamilnadu, Delhi, India; how many people in your town own red coloured car etc)

- Unit –II

  Understanding your Electric Bill: Basics of electricity- Ohms law, power consumption, Joule heating-saving electricity-ways to minimize power consumption.

- Unit – III

  Your Car, Refrigerator and Microwave oven: Concept of temperature& electromagnetic waves - Conversion of Work into Heat vice versa-Heat Engines-Carnot's Cycle, Carnot engine & efficiency- Refrigerator-magnetron-design of microwave ovens.

- Unit – IV

  Physics of digital memory devices: Photoelectric effect-recording of audio and video-Operating principles of magnetic hard disk drive-Charge coupled device (CCD)-principle of CCD camera.

- Unit – V

  Mobile communication and Global Positioning System (GPS): Wire and wire-less communication- Common cellular networks components-Protocols. Fundamentals of GSM & CDMA Network, GSM & CDMA Frequency Band. GPS: Operating principles of GPS-Accuracy and errors in GPS navigation.

II YEAR
IV SEMESTER

ATOMIC PHYSICS

Learning Objectives:

To study the transition from particle to wave nature
To study the atomic structure and spectral series with electric and magnetic fields
To inculcate in depth knowledge in Lasers .

Learning Outcomes:

On completion of the course the students will be able to
Use Photo electric effect appropriately
Analyze the atomic structure and associated coupling schemes
Understand the splitting of spectral lines due to electric and magnetic fields
Be familiar with X rays and its applications
Distinguish different types of Lasers

Unit 1 : Discharge Phenomenon Through Gases:

Moving of a charge in transverse electric and magnetic fields - specific charge of an electron - Dunnington's method - positive rays – Aston's , Dempster's mass spectrographs.

Unit 2 : Photo-electric Effect:

Richardson and Compton experiment - Laws of photoelectric emission - Einstein photo electric equation - Millikan's experiment - verification of photoelectric equation - photo electric cells - photo emissive cells - photovoltaic cell - photo conducting cell - photomultiplier.

Unit 3 : Atomic Structure :

Bohr and Sommerfield atom models - Vector atom model - Pauli's exclusion principle - explanation of periodic table - various quantum numbers - angular momentum and magnetic moment - coupling schemes - LS and JJ coupling - special quantisation - Bohr magnetron – Stern and Gerlach experiments.

Unit 4 : Ionisation Potential and Splitting of Energy Levels:

Excitation and ionization potential – Frank and Hertz's experiment - Davis and Goucher's method. Spectral terms and notions - selection rules - intensity rule and interval rule fine structure of sodium D lines - alkali spectra - fine structure of alkali spectra - spectrum of Helium - Zeeman effect - Larmor's theorem - Debye's explanation of normal Zeeman effect. Anamalous Zeeman effect - theoretical explanation. Lande's `g' factor and explanation of splitting of D1 and D2 lines of sodium. Paschen-Back effect - Stark effect (qualitative study only).

Unit 5 : X-Rays:

Bragg's law - X-ray spectroscopy - characteristic X-ray spectra - satellite and Auger effect - continuous X-ray spectra - X-ray absorption and fluorescence - Moseley's law - uses of X-rays - Compton effect - experimental verification of Compton effect.

ALLIED PHYSICS – PAPER II(60 Hours) 4 Credits

Learning Objective:

- Students will learn the concepts of properties of light such as diffraction and Interference
- Will learn the idea about the atom models and energy released in breaking of atom
- Will learn the basic of semi conductor diodes, transistor and basic logic gates

Unit 1 : Physical Optics

Velocity of light – Michelson's method. Interference : Colours of thin films –air wedge – determination of diameter of a thin wire by air wedge – test for optical flatness – Diffraction – Fresnel's explanation of rectilinear propagation of light – theory of transmission grating – Normal incidence – polarization – double refraction - optical activity – polarimeter.

Unit 2 : Atomic Physics

Atom model – vector atom model – electron, spin, quantum numbers – Pauli's exclusion principle – electronic configuration of elements and periodic classification of elements – various quantum numbers – magnetic dipole moment of electron due to orbital and spin motion – Bohr magneton – spatial quantisation – Stern and Gerlach experiment.

Unit 3 : Nuclear Physics

Nuclear model – liquid drop model – magic numbers - shell model – nuclear energy – mass defect – binding energy. Radiation detectors – ionization chambers – GM Counter – Fission Controlled and Uncontrolled chain reaction – nuclear reactor – thermonuclear reactions – stellar energy.

Unit 4 : Elements of relativity and quantum mechanics

Postulates of theory of relativity – Lorentz transformation equations – derivation – length contraction – time dilation – mass energy equivalence – uncertainty principle – postulates of wave mechanics – Schrodinger's equation – application to a particle in a box.

Unit 5 : Electronics

Basic Electronics: Zener diode – voltage regulator – LED – Transistor RC coupled amplifier – feedback principle – condition for oscillation – phase shift oscillator – Wein's bridge oscillator.

Digital Electronics : NAND and NOR gates – Universal building blocks – Boolean algebra – Demorgan's theorem – verification – elementary ideas of ICs – SSI , MSI, LSI and VLSI – Half adder, Full adder, Half Subtractor and Full subtractor.

Learning Outcome

- Students learnt about Interference and diffraction.
- They learnt the atoms models and how energy can be released in nuclear fission and fusion processes.
- They learnt about the construction of a rectifier, amplifiers and oscillator, basic digital electronics principles through logic gates and the laws governing them.

III YEAR
VI SEMESTER

SEMESTER - VI

CORE PAPER 11 - RELATIVITY AND QUANTUM MECHANICS

Lecture:60 Hours **Tutorial:15 Hours** **Credits:4**

CourseObjective:

- To introduce to the undergraduate students the development and formulation of Relativity and Quantum Mechanics
- Understand the wave nature of the matters around them.
- Its underlying Mathematical and Physical principles through exactly solvable problems and concepts.

Learning Outcomes:

On completion of the course the students will be able to

- Know the concepts of relativity and its associated concepts
- Know the inadequacies of classical mechanics in explaining microscopic phenomena
- Introduce with the concept of matter waves and their existence proved by experimental procedure and uncertainty principle in physical measurements

Unit 1 : Relativity

Frames of reference - Galilean transformation - Michelson - Morley experiment - Postulates of special theory of relativity - Lorentz transformation - length Contraction - time dilation - Relativity of simultaneity - addition of velocities - variation of mass with velocity – Mass energy relation - Elementary ideas of general relativity.

Unit 2 : Wave Nature of Matter

Phase and group velocity - wave packet - expression of De Brogile's wave length - Davisson and Germer's experiment - G.P.Thompson's experiment - Electron microscope - Heisenberg's uncertainty principle and its consequences.

Unit 3 : Schrodinger Equation

Inadequacy of classical mechanics - Basic postulates of quantum mechanics - Schrodinger equation - Properties of wave function - Probability interpretation of wave function - linear operators - self adjoint operators - expectation value - eigenvalues and eigenfunctions - commutativity and compatibility.

Unit 4 : Angular Momentum in Quantum Mechanics

Orbital angular momentum operators and their commutation relations - separation of three dimensional Schrodinger equation into radial and angular parts - Elementary ideas of spin angular momentum of an electron - Pauli matrices.

Unit 5 : Solutions of Schrodinger Equation

Free particle solution - Particle in a box - Potential well of finite depth (one dimension) - linear harmonic oscillator - rigid rotator and hydrogen atom.

CORE PAPER 12 - MATHEMATICAL METHODS IN PHYSICS

Course Objective :

- To familiarize students with essential mathematical methods for solving advanced problems in theoretical physics.
- Develop the skill of problem-solving ability.
- Understand electromagnetic theory with Vector Calculus

Learning Outcomes :

Upon completion of the course, the student should be able:

- To use advanced mathematical methods and theories on various mathematical and physics problems.
- Use Matrices to solve simultaneous equations
- Solve quantum mechanical problems using special functions and polynomials.

Unit 1 : Matrices and Special Functions

Characteristic equation of a matrix - Eigenvalues and Eigenvectors - Hermition and Unitary matrices - Properties of their eigenvalues and eigenvectors - Diagonalisation of matrices.

Special functions - Gamma and Beta functions - Series solutions of Legendre, Bessel and Hermite equations - Orthogonality properties of Legendre and Hermite Polynomials and Bessel functions.

Unit 2 : Elementary Complex Analysis

Functions of a Complex variable - Continuity and differentiability - single and multivalued functions - Analytic function - Cauchy - Riemann conditions (necessity and sufficiency). Cauchy - Riemann Conditions in the Polar (r,θ) coordinates.

Unit 3 : Vector Analysis

Scalar and Vector fields - Gradient, Divergence and Curl - Equations of motion in the vector notation - equations of motion (components) in cartesian coordinates and spherical polar coordinates - equation of motion in the polar coordinates.

Unit 4 : Classical Mechanics

Generalised coordinates - configuration space - Lagrange's equation - simple applications : to find equations of motion given a lagrangian; central potential and conservation of angular momentum - Hamilton function and Hamilton's equations - harmonic oscillator.

Unit 5 : Statistical Physics

Quantum statistics of identical particles - Maxwell - Boltzmann, Bose - Einstein and Fermi - Dirac statistics - Derivation of Planck's radiation formula from Bose - Einstein statistics - Degenerate Fermi gas.

SEMESTER – VI ELECTIVE 2

INTEGRATED ELECTRONICS

Lecture:60Hours Tutorial:15 Hours Credits:5

Course Objectives:

- To study the different number systems associated with digital computation
- To introduce the counters and registers.
- To have in-depth knowledge in arithmetic operations of an operational amplifier.

Learning Outcomes:

On completion of the course the students will have:

- Through knowledge on different number systems
- The skill to simplify the logics using Karnaugh map and Boolean algebra
- Detailed knowledge in storing and retrieving a data through mux and demux

Unit 1 : Fundamental Digital Electronics

Number systems – binary – hexadecimal – Binary addition – subtraction (1's and 2's compliment method) – multiplication - division - BCD – Conversion – simplification of logic circuits - using (i) Boolean algebra, (ii) Karnaugh map – Demorgan's theorems - NAND and NOR as universal building blocks.

Unit 2 : Combinational Logic Circuits

Half adder, full adder, half subtractor and full subtractor – 4 bit adder/subtractor - decoder, encoder - multiplexer - demultiplexer.

Unit 3 : Sequential Logic Circuits

R.S flip flop, D flip flop and JK flip flops - JK Master Slave flip flop - synchronous and ripple counters - BCD counter – Up/Down counters - shift registers - serial and parallel registers - ring and twisted ring counter.

Unit 4 : OP-AMP Basic Applications

Characteristics parameters – differential gain – CMRR – Slew rate – bandwidth - applications – inverter, non-inverter, integrator, differentiator, summing, difference and averaging amplifier - solving simultaneous equations - comparator - square wave generator - Wien's bridge oscillator - Schmitt trigger

Unit 5 : Timer, DAC/ADC

Timer 555 - Internal block diagram and working - astable multivibrator - schmitt trigger.

D/A converter - binary weighted method - A/D converter - successive approximation method.

ELECTIVE 3
MICROPROCESSOR FUNDAMENTALS

Lecture:60Hours Tutorial:15 Hours Credits:5

Course Objective:

- To study the architecture of the microprocessor 8085
- To understand the Interfacing of memory & various I/O devices with 8085 microprocessor
- To understand the concepts of interrupts and microcontrollers

Learning Outcome :

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

- Describe the general architecture of a microcomputer system and architecture &organization of 8085 Microprocessor and understand the difference between 8085 and advanced microprocessor
- Understand and classify the instruction set of 8085 microprocessor and distinguish the use of different instructions and apply it in assembly language programming.
- Understand the architecture and operation of Programmable Interface Devices and realize the programming & interfacing of it with 8085 microprocessor.

Unit 1 : Architecture

Architecture of 8085 – registers, flags, ALU, address and data bus, demultiplexing address/data bus – control and status signals – control bus, Programmer's model of 8085 – Pin out diagram – Functions of different pins.

Unit 2 : Programming Techniques

Instruction set of 8085 – data transfer, arithmetic, logic, branching and machine control group of instructions – addressing modes – register indirect, direct, immediate and implied addressing modes.

Assembly language & machine language – programming techniques: addition, subtraction, multiplication, division, ascending, descending order, largest and smallest (single byte)

UNIT 3 : Interfacing memory to 8085

Memory interfacing – Interfacing 2kx8 ROM and RAM, Timing diagram of 8085 (MOV R_d, R_s – MVI R_d,data(8)) .

Unit 4 : Interfacing I/O Ports to 8085

Interfacing input port and output port to 8085 – Programmable peripheral interface 8255 – flashing LEDs.

Unit 5 : Interrupts

Interrupts in 8085 - hardware and software interrupts – RIM, SIM instructions – priorities – simple polled and interrupt controlled data transfer.

PRACTICALS
AT THE END OF EVEN SEMESTER
ALL THREE YEARS

Core Paper III

Practical - I

(At the end of the Second semester - Any Fifteen Experiments) Credits:4

1. Young's modulus – Non-uniform Bending – Pin and microscope.
2. Young's modulus – Uniform Bending – Scale and Telescope
3. Rigidity modulus – Torsional pendulum (without symmetrical masses)
4. Rigidity modulus and Moment of Inertia – Torsional pendulum (With symmetric masses)
5. Surface Tension and Interfacial Surface Tension – Drop Weight Method
6. Coefficient of Viscosity of Liquid – GraduatedBurette (radius of capillary tube by Mercury pellet method).
7. Sonometer–Frequency of Tuning Fork
8. Sonometer – Relative Density of a Solid and Liquid
9. Specific heat capacity of liquid–Method of Mixtures (Half-time correction).
10. Comparison of Viscosities of two Liquids–Burette Method
11. Focal length, Power, R and Refractive Index of a long Focus Convex Lens
12. Focal length, Power, R and Refractive Index of a Concave Lens
13. P.O. Box – Temperature coefficient of resistance
14. Spectrometer – Refractive index of a Glass Prism
15. Spectrometer – Hollow Prism- Refractive index of a liquid.
16. Newton's law of cooling-Specific heat Capacity of the Liquid
17. Carey Foster's Bridge-Resistance and Specific Resistance
18. Potentiometer – Calibration of a Low Range Voltmeter
19. Deflection magnetometer – Tan A Position

CORE PAPER VI

Practical - II

(At the end of Fourth semester - Any Fifteen Experiments) Credits:4

1. Young's Modulus-Cantilever-Depression-(Static method-Scale and Telescope).
2. Young's Modulus –Uniform bending – Pin &Microscope.
3. Rigidity Modulus-Static Torsion (Scale and Telescope)
4. Compound Pendulum-g and k
5. Sonometer-A.C. Frequency-Steel and Brass wires.
6. Melde's string- Frequency, Relative Density of a solid and liquid.
7. Thermal conductivity o f a bad conductor-Lee's disc method.
8. Spectrometer-Grating N and λ-minimum deviation method.
9. Spectrometer-μ of a glass prism -i-d Curve
10. Airwedge-Thickness of a wire.
11. Deflection Magnetometer – Tan B position
12. m and BH -Deflection Magnetometer-Tan C position and vibration magnetometer
13. Carey Foster Bridge - Temperature coefficient of resistance of a coil.
14. Potentiometer – Specific resistance of the given wire.
15. Potentiometer-Ammeter calibration.
16. Potentiometer- Emf of thermocouple.
17. Figure of merit of galvanometer (Mirror or Table Galvanometer).
18. Surface tension – Capillary rise method.
19. Specific heat of capacity – Joule's calorimeter.

ALLLIED PHYSICS –PRACTICALS

(At the end of even Semester - Any Fifteen Experiments) Credits:4

1. Young's Modulus by Non-uniform bending using Pin and Microscope
2. Young's Modulus by Non-uniform bending using Optic lever–Scale and telescope
3. Rigidity modulus by Static torsion method.
4. Rigidity modulus by Torsional oscillations without mass
5. Surface tension and Interfacial Surface tension–Drop Weight method
6. Comparison of Viscosities of two liquids–Burette method
7. Specific heat Capacity of a liquid–Half time correction
8. Sonometer–Determination of a.c frequency
9. Newton'srings-Radiusof curvature
10. Airwedge–Thicknessof awire.
11. Spectrometer–Grating–Wavelengthof Mercurylines–Minimum deviation method
12. Potentiometer–VoltmeterCalibration
13. P.O. Box–Specific resistance
14. B.G.–Figureof Merit (table galvanometer)
15. Construction of AND, OR, NOT gates–using diodes and Transistor
16. Zener Diode–Characteristics
17. NAND gate as a universal gate

Note: Use of Digital Balance Permitted

CORE PAPER XIV

Practical – III (General)

(At the end of Sixth Semester - Any Fifteen Experiments) Credits:4

1. Young's modulus of the material of the beam- Non uniform Bending - Koenig's method.
2. Young's modulus of the material of the beam- Uniform Bending - Koenig's method.
3. Newton's rings - R_1, R_2 and μ of convex lens.
4. Spectrometer - (i - i') curve - Refractive Index.
5. Spectrometer - Small angled prism - Normal incidence and emergence. Determination of the refractive index of the material of prism.
6. Spectrometer – Dispersive power of a prism.
7. Spectrometer – Dispersive power of a grating.
8. Spectrometer - Cauchy's constant.
9. Bifilar pendulum – Parallel threads – verification of two theorems.
10. Field along the axis of a circular coil - Deflection magnetometer - B_H and M.
11. Field along the axis of a circular coil - vibration magnetic needle - B_H.
12. Potentiometer - Calibration of high range voltmeter.
13. Potentiometer – conversion of galvanometer into voltmeter.
14. Potentiometer – conversion of galvanometer into ammeter.
15. Ballistic Galvanometer - Absolute capacitance of a capacitor.
16. Ballistic Galvanometer-Charge Sensitivity
17. Ballistic Galvanometer- Comparison of Mutual inductances.
18. Ballistic Galvanometer.-Comparison of Capacities
19. Determination of wavelength He-Ne Laser by diffraction.
20. Spectrometer Grating-Normal incidence method -Wavelength of Mercury Spectrum

CORE PAPER XV

Practical – IV (Basic Electronics)

(At the end of Sixth Semester - Any Fifteen Experiments) Credits:4

1. A.C. Circuit – LCR – Series resonance.
2. A.C. Circuit – LCR – Parallel resonance.
3. Bridge rectifier - Zener regulated power supply - 9V characteristics.
4. Verification of Demorgan's theorem.
5. Emitter follower.
6. FET characteristics.
7. Common Source FET amplifier.
8. UJT characteristics
9. UJT as Relaxation oscillator.
10. SCR characteristics.
11. Transistor – Astable multivibrator.
12. Transistor – Bistable multivibrator.
13. Transistor – Phase shift oscillator.
14. Transistor – Wien's bridge oscillator.
15. NAND and NOR as universal gates.
16. Half Adder &Full adder (using basic logic gates and Ex-OR gate or NAND gates only).
17. Half Subtractor& Full subtractor (using basic logic gates and Ex-OR gate or NAND gates only).
18. RC coupled single stage CE Transistor amplifier – frequency response.
19. Decode Counter using 7490
20. 4 Bit Shift Register using 7473/7476
21. 4 Bit ripple Counter using 7473/7476

CORE PAPER XVI

Practical – V (Applied Electronics)

(At the end of Sixth Semester - Any Fifteen Experiments) Credits:2

1. Microprocessor – 8085 – 8 bit Addition
2. Microprocessor – 8085 – 8 bit Subtraction
3. Microprocessor – 8085 – 8 bit Multiplication
4. Microprocessor – 8085 – 8 bit Division
5. Microprocessor – 8085 – Sorting of given set of numbers in ascending order
6. Microprocessor – 8085 – Sorting of given set of numbers in descending order
7. Microprocessor – 8085 – Finding the largest no. in a given set of numbers.
8. Microprocessor– 8085 – Finding the smallest no. in a given set of numbers.
9. Microprocessor– 8085 – reversing the elements in an array.
10. Microprocessor – 8085 – Addition of N Number of single byte numbers
11. Op amp 741 - Inverting, Non - Inverting amplifier, unity follower.
12. Op amp 741 - Summing and difference amplifier
13. Op amp 741 – Differentiator, integrator
14. OP amp 741 – Solving simultaneous equations.
15. OP amp 741 – Astable multivibrator.
16. Op amp 741 – Wien's Bridge oscillator
17. Op amp 741 - Phase Shift oscillator
18. Op amp 741-Solving Simultaneous Equations
19. 555 - Timer - Schmitt Trigger
20. 555 - Timer - Astable operation
21. D/A Converter – 4 bit, binary weighted resistor method