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UNIVERSITY OF MYSORE

Estd. 1916

Vishwavidyanilaya Karyasoudha
Crawford Hall, Mysuru- 570 005

No.AC.2(S)/31/18-19

Dated: 15.06.2018

NOTIFICATION

Sub: Revision of syllabus for Physics (UG) as per CBCS pattern from the academic year 2018-19.

Ref: 1. Decision of Board of Studies in Physics (UG) meeting held on 05.03.2018.
2. Decision of the Faculty of Science & Technology Meeting held on 21.04.2018.
3. Decision of the Deans Committee meeting held on 22.05.2018.

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The Board of Studies in Physics (UG) which met on 05th March, 2018 has recommended to revise the syllabus for B.Sc. Physics as per CBCS pattern from the academic year 2018-19.

The Faculty of Science and Technology and the Deans committee meetings held on 21-04-2018 and 22-05-2018 respectively have approved the above said proposal with pending ratification of Academic Council and the same is hereby notified.

The CBCS syllabus of B.Sc. Physics course is annexed. The contents may be downloaded **from the University Website i.e., www.uni-mysore.ac.in**.

Draft approved by the Registrar

Deputy Registrar(Academic)

To:

1. The Registrar (Evaluation), University of Mysore, Mysore.
2. The Dean, Faculty of Science & Technology, DOS in Physics, Manasagangotri, Mysore.
3. The Chairperson, BOS in Physics, DOS in Physics, Manasagangotri, Mysore.
4. The Chairperson, Department of Studies in Physics, Manasagangotri, Mysore.
5. The Director, College Development Council, Moulya Bhavan, Manasagangotri, Mysore.
6. The Principals of the Affiliated Colleges where UG Program is running in Science stream.
7. The Deputy/Assistant Registrar/Superintendent, AB and EB, UOM, Mysore.
8. The P.A. to the Vice-Chancellor/Registrar/Registrar (Evaluation), UOM, Mysore.
9. Office file.

University of Mysore

Proposed Syllabus for the Six Semesters

B.Sc. (Physics)

Choice Based Credit Scheme 2018

Credit Pattern for Courses

L: Lecture; T: Tutorial; P: Practicals

Sem	Type	Id	Course	L + T + P = Tot.
1	DSC	PHY101	Mechanics, Properties of Matter and Electrostatics	4 + 0 + 0 = 4
1	DSC	PHY102	Practical 1	0 + 0 + 2 = 2
2	DSC	PHY201	Heat, Thermodynamics and Sound	4 + 0 + 0 = 4
2	DSC	PHY202	Practical 2	0 + 0 + 2 = 2
3	DSC	PHY301	Electricity and Electromagnetism	4 + 0 + 0 = 4
3	DSC	PHY302	Practical 3	0 + 0 + 2 = 2
4	DSC	PHY401	Optics and Spectroscopy	4 + 0 + 0 = 4
4	DSC	PHY402	Practical 4	0 + 0 + 2 = 2
5	DSE	PHY501	Nuclear and Theoretical Physics	3 + 0 + 0 = 3
5	DSE	PHY502	Practical 5	0 + 0 + 1.5 = 1.5
5	DSE	PHY503	Practical 6	0 + 0 + 1.5 = 1.5
5	SEC	PHY511	Lasers and Fibre Optics	2 + 0 + 0 = 2
5	SEC	PHY512	Astronomy and Astrophysics	2 + 0 + 0 = 2
5	SEC	PHY513	Nano Materials	2 + 0 + 0 = 2
6	DSE	PHY601	Solid State Physics	3 + 0 + 0 = 3
6	DSE	PHY602	Practical 7	0 + 0 + 1.5 = 1.5
6	DSE	PHY603	Practical 8	0 + 0 + 1.5 = 1.5
6	SEC	PHY611	Optoelectronics	2 + 0 + 0 = 2
6	SEC	PHY612	Renewable Energy Sources	2 + 0 + 0 = 2
6	SEC	PHY613	Solving Problems in Physics	2 + 0 + 0 = 2

Credit means the unit by which the course work is measured. One hour session of Lecture or Tutorial per week for 16 weeks amounts to 1 credit. Two hours session of Practicals per week for 16 weeks amounts to 1 credit per semester.

PHY101 (DSC) Mechanics, Properties of Matter and Electrostatics

Course duration: 16 weeks with 4 hours of instruction per week.

Part A: 32 hours

Frames of reference: Inertial reference frames with examples. Uniform rectilinear motion in an inertial frame—Galilean transformation equation. The Galilean principle of relativity. Motion in a non-inertial reference frame uniformly accelerated rectilinear motion-concept of fictitious force-illustration; plumb line accelerometer and a freely falling elevator. Qualitative discussion of centrifugal force, Coriolis force and earth as a non-inertial frame, Numerical problems. [5 hours]

Motion of a point particle: Point mass. The position vector $\vec{r}(t)$ of a moving point particle and its cartesian components. Velocity and acceleration as the vector derivatives. Derivation of planar vector of a constant magnitude. Radial and transverse components of velocity and acceleration for arbitrary planar motion, deduction of results for uniform circular motion centripetal force, Numerical problems. [4 hours]

Rigid body dynamics: Review of definitions, Moment of inertia and radius of gyration. Review of statements of the theorems of the parallel and perpendicular axes. Expression for kinetic energy of a rigid body. Calculation of moment of inertia of thin uniform rod, rectangular lamina, circular lamina, and solid cylinder. Theory of compound pendulum. Numerical problems. [6 hours]

Conservation of linear momentum: Conservation of the linear momentum for a system of two particles. Rocket motion in a uniform gravitational field (single stage rocket equation with and without gravity). Multistage rocket—elementary ideas. Elastic and inelastic collisions—Elastic head-on collision and elastic oblique collision in a lab frame, Reduced mass. Numerical problems. [6 hours]

Conservation of angular momentum: Review of angular momentum and Torque. Relation between angular momentum and torque. Law of conservation of angular momentum. Areal velocity derivation $\mathrm{d}A/\mathrm{d}t = {}^1\!/_2\, r^2\dot{\theta}\,\hat{n}$. Central force: Physical insight into the nature of central forces. Kepler's laws of planetary motion—derivation using Newton's law of gravitation. Numerical problems. [5 hours]

Conservation of energy: Conservative force and non conservative forces with examples. Conservation of energy in a conservative force field. Applications: (i) Vertical oscillations of a loaded light spiral spring and (ii) Calculation of escape velocity in the gravitational field of the earth. Conditions for a geo-stationary satellite. Numerical problems. [6 hours]

Part B: 32 hours

Fluid Mechanics: Viscosity—Basic concepts, Variation of viscosity of liquids with temperature and pressure. Theory of rotation viscometer. [3 hours]

Surface Tension: Basic concepts. Pressure inside curved liquid surface, examples. Surface tension and interfacial tension by drop-weight method. Surface tension of mercury by Quincke's method—Theory Numerical problems. [5 hours]

Elasticity: Concepts of moduli of elasticity, Hooke's Law and Poisson's ratio σ. Relation between the elastic constants q, k, n and σ, limiting values for σ. Work done in stretching. Elastic potential energy. Bending moment. Theory of light single cantilever. I-section girders. Torsion—calculation of couple per unit twist. The Torsional pendulum, Static torsion, Searle's double bar experiment. Numerical problems. [12 hours]

Electrostatics: Mechanical force and electric pressure on a charged surface. The path traced by a charged particle in an electric field. The attracted disc electrometer—construction, theory and applications. Numerical problems. [6 hours]

Galvanometers: Moving coil galvanometer—construction, theory, damping correction, current sensitivity and charge sensitivity. Helmholtz galvanometer—Theory. Numerical problems. [6 hours]

References

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- Upadhyaya J C, *Classical Mechanics*, 2nd Edn., Himalaya Publishing House (2017).
- Arora C L, and Hemne P S, *Physics for Degree Students*, Revised Edn., S Chand and Company (2012).
- Charles Kittel, and Walter Knight, *Berkeley Physics Course, Mechanics Vol. 1*, 2nd Edn., Tata McGraw Hill (2011).
- Arora C L, *Refresher Course in B.Sc. Physics Vol. 1*, Revised Edn., S Chand and Company (2008).
- Mathur D S, *Elements of Properties of Matter*, S Chand and Company (2007).
- Mathur D S, *Mechanics*, S Chand and Company (2007).
- Brij Lal, and Subrahmanyam N, *Properties of Matter*, 6th Edn., S Chand and Company (2002).
- Shankara Narayana S R, *Mechanics and Properties of Matter*, 2nd Revised Edn., Sultan Chand and Sons (1998).
- Tewari K K, *Electricity and Magnetism*, S Chand and Company (2007).
- Brij Lal, and Subrahmanyam N, *A Text Book of Electricity and Magnetism*, 19th Edn., Ratan Prakashan Mandir (2016).

PHY102 (DSC) Practical 1

Course duration: 16 weeks with 4 hours of lab work per week.

Any TEN of the following experiments:

1. Bar pendulum: Determination of the acceleration due to gravity and radius of gyration (graphical method).
2. Fly wheel: Determination of moment of inertia, mass and density.
3. Drop weight method: Determination of surface tension of liquid and
4. Drop weight method: Determination the interfacial tension between two liquids.
5. Quincke's method: Determination of surface tension and angle of contact of mercury.
6. Young's modulus: Single cantilever method using travelling microscope; Graphical Method.
7. Searle's double bar: Determination of Young's modulus.
8. Searle's double bar: Determination rigidity modulus and Poisson's ratio (assuming q).
9. Torsional pendulum: Determination of the rigidity modulus
10. Determination of the Young's modulus by Dynamic method (using graph).

11. Spiral spring: Determination of the acceleration due to gravity (graphical method).
12. Determionation of Radius of Gyration and Moment of Inertia of a rectangular body in three different axis.

PHY201 (DSC) Heat, Thermodynamics and Sound

Course duration: 16 weeks with 4 hours of instruction per week.

Part A: 32 hours

Kinetic theory: Maxwell's law of distribution of molecular velocity (no derivation); its interpretation. Degrees of freedom. Principle of equipartition of energy based on Kinetic theory of gases. Derivation of $U = 3/2RT$. Mean free path, Probability of a particle having mean free path. Real gases, Andrew's isothermal, Van der Waals equations—expression for critical constants, calculation of mean velocity, most probable velocity and RMS velocity. Numerical problems. [8 hours]

Thermal conductivity: Equation for the flow of heat through a solid bar. Determination of thermal conductivity of a bad conductor by Lee and Charlton method. Numerical problems. [3 hours]

Radiation: Planck's quantum theory of radiation.Induced and spontaneous emission of radiation. Derivation of Planck's law of radiation using Einstein's A and B coefficients. Deduction of Rayleigh-Jeans law, Stefan's law and Wien's displacement law from Planck's law. Numerical problems. [6 hours]

Low temperature physics: Ideal gas and real gas. Van der Waals equation of state. Porous plug experiment and its theory. Joule-Thomson expansion—expression for the temperature of inversion, inversion curve. Relation between Boyle temperature, temperature of inversion and critical temperature of a gas. Principle of regenerative cooling. Liquefaction of air by Linde's method. Adiabatic demagnetization. Numerical problems. [8 hours]

Thermodynamics: Review of basic concepts, Carnot's theorem, thermodynamic scale of temperature and its identity with perfect gas scale. Clausius-

Clapeyron first Latent heat equation, effect of pressure on melting point of a solid, effect of pressure on boiling point of a liquid. Numerical problems.
[7 hours]

Part B: 32 hours

Entropy: The concept of entropy. Change of entropy in reversible and irreversible cycles. Entropy and nonavailable energy. Second law of thermodynamics in terms of Entropy. Entropy of ideal gas, Entropy of Steam and Mixtures.T-S diagram, concept of absolute zero and the third law of thermodynamics. Numerical problems. [7 hours]

Thermodynamic potentials and Maxwell's thermodynamic relations: Internal Energy, Enthalpy, Helmholtz function, Gibbs function, relations among these functions, Gibbs-Helmholtz equations. Derivation of Maxwell's thermodynamic relations, Tds equations for Cp and Cv, Heat capacity equations. Numerical problems. [8 hours]

Sound: Waves in one dimension—Differential equation of wave motion , Expression for velocity of progressive waves in a medium, Laplace's Correction to Newton's formula. Expression for frequency of vibration of a stretched string—harmonics, Longitudinal vibrations in a rod. Kundt's tube experiment, Numerical problems. [7 hours]

Analysis of complex waves: The Fourier series—evaluation of Fourier coefficients, Example of the square wave, saw tooth wave. [4 hours]

Superposition of simple harmonic motion—Lissajous' figures. Equation for damped vibrations. Forced vibration, solution in exponential form, Resonance, Expression for amplitude and phase at resonance. Numerical problems. [6 hours]

References

- Halliday D, Resnick R, and Walker J, *Principles of Physics*, 9th Edn., Wiley (2013).
- Dittaman R H, and Zemansky M W, *Heat and Thermodynamics*, 7th Edn., The McGraw-Hill (2007).
- Blundell S J, and Blundell K M, *Concepts in Thermal Physics*, 2nd Edn., Oxford University Press (2006).

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- Satya Prakash, *Optics and Atomic Physics*, 11th Edn., Ratan Prakashan Mandir (1994).
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PHY202 (DSC) Practical 2

Course duration: 16 weeks with 4 hours of lab work per week.

Any TEN of the following experiments:

1. Verification of Gaussian distribution law and calculation of standard deviation—Monte Carlo experiment.
2. Specific heat of a liquid by cooling—graphical method.
3. Determination of thermal conductivity of a bad conductor by Lee-Charlton method.
4. Verification of Stefan-Boltzmann law using meter bridge or a potentiometer.
5. Determination of boiling point of a liquid using platinum resistance thermometer.
6. Determination of moment of inertia of irregular body using torsional pendulum.
7. Determination of Young's modulus by Koenig's method.
8. Determination of rigidity modulus by the static torsion method.
9. Determination of Young's modulus by uniform bending method travelling microscope (using graph).
10. Kundt's tube experiment—velocity of sound in air at room temperature.

11. Study of stationary wave on a stretched string—Determination of speed of the transverse waves over the sonometer wire.
12. Helmholtz resonator—Determination of frequency of a tuning fork.

PHY301 (DSC) Electricity and Electromagnetism

Course duration: 16 weeks with 4 hours of instruction per week.

Part A: 32 hours

Thermoelectricity: The Thermocouple. Seebeck, Peltier and Thomson effects. Thermodynamic theory of thermoelectric effect. Neutral temperature. Temperature of inversion, The law of intermediate metals, and the law of intermediate temperatures. Numerical problems. [6 hours]

Network Theorems: Mesh analysis circuits using KVL and KCL. Statement and proof of Thevenin's theorem, Norton's theorem, and Superposition theorem. Applications to DC circuits. Numerical problems. [9 hours]

Electromagnetism: Scalar and Vector fields. The gradient of a scalar field. The divergence and curl of a vector field. The physical significance of gradient, divergence and curl. Statement and theorems of Gauss and Stokes. Numerical problems. [5 hours]

Electromagnetic theory: Equation of continuity, Maxwell's modification of Ampere circuital law; Displacement current. Setting up of Maxwell's field equations. Maxwell's field equations in free space, Poynting vector (definition). Wave equation for the field vectors in free space and in isotropic dielectric. Energy density of electromagnetic wave and Poynting Theorem (Proof). Plane monochromatic electromagnetic waves—Transverse nature. Helmholtz equation. Characteristic impedance of free space. Accelerated charges and oscillating dipole. Hertz's experiment. Radiation loss—Synchrotron radiation. Numerical problems. [12 hours]

Part B: 32 hours

CRO: Construction and working. Measurement of voltage, frequency and phase using a CRO. [3 hours]

DC currents: Growth and decay of Current in RL, RC, and RLC Circuits, Numerical problems. [6 hours]

Alternating current: Average, Peak, and RMS values. Response of LR, CR, and LCR circuits to sinusoidal voltages (discussion using the 'j' symbols). Series Resonance and parallel resonance—half-power frequencies, bandwidth and Q-factor. Power in electrical circuits—power factor. Maximum power transfer theorem for ac circuits (statement and proof). Numerical problems. [11 hours]

Applications of ac circuits: i) ac bridges—Anderson's bridge, Maxwell's bridge, de Sauty bridge, Robinson's bridge. Numerical problems. [6 hours]

ii) Frequency filters—High-pass and low-pass filters with LC, LR, and CR combinations. Expression for cut-off frequency. Band pass filters. Numerical problems including designing the filters. [6 hours]

References

- Tewari K K, *Electricity and Magnetism*, Revised Edn., S Chand and Company (2007).
- Vasudeva D N, *Fundamentals of Magnetism and Electricity*, 9th edn, S.Chand and Company (2013).
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- Hayt W H, and Buck J A, *Engineering Electromagnetism*, 8th Edn., Tata Mc Graw Hill (2017).
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- Bhattacharya A B, and Bhattacharya R, *Undergraduate Physics Vol. 2*, New Central Book Agency (2008).

PHY302 (DSC) Practical 3

Course duration: 16 weeks with 4 hours of lab work per week.

Any TEN of the following experiments:

1. Anderson's bridge—Determination of the self-inductance of the coil.
2. de-Sauty bridge—Verification of laws of combination of capacitances.

3. Maxwells bridge.
4. B_H using Helmholtz double coil galvanometer and potentiometer.
5. LCR series circuit—Determination of L and Q-factor.
6. Voltage triangle—Measurement of phase difference.
7. Low and High pass filters—Determination of the cut-off frequency.
8. LCR parallel circuit—Determination of L and Q-factor.
9. To study the variation of X_C with f and determination of C.
10. CRO—determination of voltage and frequency.
11. High resistance by leakage method.
12. Measurement of low resistance using potentiometer.

PHY401 (DSC) Optics and Spectroscopy

Course duration: 16 weeks with 4 hours of instruction per week.

Part A: 32 hours

Interference: Concept of coherent sources. Interference by division of wave front—Theory of Fresnel's biprism, Interference by division of amplitude—Thin films of uniform thickness, anti-reflective coatings, Newton's rings. Interference at a wedge. Michelson's interferometer—Measurement of λ and $\mathrm{d}\lambda$. Numerical problems. [8 hours]

Diffraction: Fresnel and Fraunhofer diffraction. Explanation of rectilinear propagation of light. Theory of the zone plate. Comparison with a convex lens. Fresnel diffraction at a straight edge. Fraunhofer diffraction at a single slit. Transmission grating—theory for the case of normal incidence, resolving power and dispersive power of plane grating. Numerical problems. [8 hours]

Polarization: Double refraction in uniaxial crystals. Huygen's theory. Positive and negative crystal. Principal refractive indices. Huygen's constructions of O and E wave fronts in a uniaxial crystal—(i) optic axis in the plane of incidence and parallel to the crystal surface at normal incidence, (ii) optic axis in the plane of incidence and perpendicular to the crystal surface at normal incidence. Retarding plates. Production and analysis of linearly, Circularly and elliptically polarized light. Optical activity, Fresnel's theory, Rotatory polarization. Use of biquartz. Elementary idea of Babinet compensator, Interference of polarized light-Expression for resultant intensity, calculation of thickness of wedge shaped crystal plate(negative and positive), calculation of fringe width. Numerical problems. [11 hours]

Lasers: Properties, Metastable state. Spontaneous emission, stimulated emission, population inversion. Three level laser. The He-Ne laser, Ruby laser. Laser applications: Nuclear fusion, medical, communications, and industrial applications. [5 hours]

Part B: 32 hours

The Electron: Determination of e/m of an electron by Thomson's method. Determination of charge of an electron by Millikan's oil drop method. Numerical problems. [4 hours]

Atomic Spectra: A qualitative account of Sommerfeld relativistic atom model. Excitation and Ionization potentials—Franck-Hertz experiment. Vector model of atom. Electron spin. Space quantization. Magnetic moment of an electron due to its orbital motion. Stern-Gerlach experiment. Spin-orbit interaction and the fine structure of spectral lines. Quantum number and selection rules. Pauli's exclusion principle. Electronic configuration of atoms. Valance electron. Brief mention of LS and JJ coupling for multi-electron atoms. [12 hours]

Zeeman effect: Normal and anomalous effects, Experimental details of normal Zeeman effect, explanation of normal Zeeman effect on the basis of classical model, expression for the Zeeman shift. Numerical problems. [4 hours]

Molecular spectra and The Raman effect: Rotation, vibration and electronic spectra of molecules, associated quantum numbers and selection rules. Theory of pure rotation spectra. Theory of rotational-vibrational spectra. Raman effect—Salient features, experimental setup to study Raman effect. Quantum Theory of Raman effect; Intensity and polarization of Raman lines; Applications. Fluorescence and phosphorescence. Numerical problems. [12 hours]

References

- Bhattacharya A B, and Bhattacharya R,*Undergraduate Physics*, Vol. 2, New Central Book Agency (2008).

- Subrahmanyam N, Brij Lal, and Avadhanulu M N, *A Textbook of Optics*, 24th Revised Edn., S Chand and Company (2015).
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- Jenkins F A, and White H E, *Optics*, 3rd Edn., McGraw-Hill (1957).

PHY402 (DSC) Practical 4

Course duration: 16 weeks with 4 hours of lab work per week.

Any TEN of the following experiments:

1. Newton's rings—Determination of radius of curvature of a plano convex lens.
2. Air wedge—Determination of thickness of a thin paper/diameter of a thin wire.
3. Diffraction grating—Determination of grating constant and wavelength (minimum deviation method).
4. Diffraction at a straight wire—Determination of diameter of a wire.
5. Cauchy's constants using spectrometer.
6. Polarization—Determination of unknown concentration of sugar solution by graphical method using a polarimeter.
7. Determination of refractive indices of calcite and quartz crystal using spectrometer and sodium light.
8. Determination of resistance using time constant of RC circuit by discharging process.
9. Biprism—determination of wavelength.
10. Determination of capacitance using time constant of RC circuit by charging process.
11. Study of hydrogen spectrum using gas discharge tube—Determination of Rydberg constant.
12. Resolving power of plane transmission grating using spectrometer.

PHY501 (DSE) Nuclear and Theoretical Physics

Course duration: 16 weeks with 3 hours of instruction per week.

Part A: 16 hours

Special theory of relativity: Michelson-Morley experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz transformations (no derivation). Lorentz contraction. Time dilation. Relativistic transformation of velocity, Relativistic addition of velocities. Variation of mass with velocity. Rest mass. Massless particles. Mass energy equivalence, $E = mc^2$. The energy-momentum relation. The principle of equivalence. [8 hours]

Cosmic rays and particle physics: Cosmic ray discovery; Primary and secondary cosmic rays—their composition. Cosmic ray showers. Origin of cosmic rays, Mention of the basic interactions in nature; Particles and anti-particles. Types of interaction between elementary particles, Classification of particles. Conservation laws. A qualitative introduction to quarks (quark model). Numerical problems. [4 hours]

Mass spectrographs: Theory of Dempster and Aston mass spectrograph. Numerical problems. [2 hours]

Nuclear detectors: Bubble chamber. GM counter. Principle of semiconductor detector. [2 hours]

Part B: 16 hours

The nucleus: Properties of nucleus. Discovery of neutron. The proton-neutron hypothesis. Nuclear forces and their characteristics. Yukawa's theory (qualitative). [2 hours]

Radioactive decay: Successive disintegration, Radioactive equilibrium, Range and energy of alpha-particle and their measurements. Theory of alpha-decay (qualitative). Geiger-Nuttal law. Beta Decay—Pauli's neutrino hypothesis, K-electron capture, internal conversion. Nuclear isomerism. Mirror nuclei. Numerical problems. [4 hours]

Accelerators: Cockroft-Walton voltage multiplier, Cyclotron, and Betatron. Numerical problems. [3 hours]

Nuclear reactions: Q-values. Threshold energy of an endoergic reaction. Reactions induced by proton, deuteron and particles. Numerical problems. [2 hours]

Nuclear models: Liquid-drop model. Semi-empirical mass formula. Shell model, and magic numbers. Numerical problems. [2 hours]

Nuclear fission, and fusion: Estimation of the fission energy on the basis of the liquid drop model, The four-factor formula, Thermo-nuclear reactions-sources of stellar energy. The C-N cycle, Numerical problems. [3 hours]

Part C: 16 hours

Matter waves: Failure of classical mechanics in the microscopic domain. Black body radiation, Hydrogen atom, Specific heats of solids, Fine structure of spectral lines, Particle and wave nature in classical mechanics. Dual nature of light and Matter, de Broglie's concept of matter waves, Expression for de Broglie's wave, Phase and group velocity. Experiments of Thomson and of Davisson and Germer. Heisenberg's uncertainty principle, Examples of position-momentum uncertainty—the gamma ray microscope (thought experiment). Numerical problems. [7 hours]

Schrödinger's equation: Eigenvalues, eigenfunctions; Eigenvalue equation, Dynamical variables as operators, Hermitian operators. Postulates of quantum mechanics. Setting up the time-independent Schrödinger equation and time dependent Schrödinger equation. The notion of probability and Born's interpretation of the wave function. Solution of the time-independent Schrödinger equation for particle in one-dimensional infinite potential—calculation of its energy eigenvalues. Harmonic oscillator—mention of energy eigenvalues and eigen zero-point energy. Numerical problems. [9 hours]

References

- Halliday D, Resnick R, and Walker J, *Principles of Physics*, 10th Edn., Wiley India Pvt. Ltd. (2013).
- Duggal B D, and Chabra C L, *Fundamentals of Modern Physics*, 8th Edn., S Nagin Chand and Co. (1997).

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- Beiser A, *Concepts of Modern Physics*, 6th Edn., TMH, New Delhi (2008).
- Kaplan I, *Nuclear Physics*, 2nd Edn., Narosa Publishing House (2002).

PHY502 (DSE) Practical 5

Course duration: 16 weeks with 3 hours of lab work per week.

Any TEN of the following experiments:

1. Characteristics of GM tube.
2. Absorption coefficient of gamma rays.
3. Verification of inverse square law for gamma rays.
4. Solar cell: IV characteristics, efficiency and fill factor.
5. Dielectric constant of a solid.
6. Dielectric constant of a liquid.
7. Determination of wavelength of laser light.
8. e/m of an electron by Thomson's method.
9. Cockcroft-Walton voltage multiplier.
10. Transistor characteristics (CE mode).
11. Determination of Planck's constant using photocell.
12. Determination of charge by Millikan's oil drop method.

PHY503 (DSE) Practical 6

Course duration: 16 weeks with 3 hours of lab work per week.

Any TEN of the following experiments:

1. Zener diode characteristics.
2. Study of Divergence of a diode laser.

3. Determination of mass of an electron.
4. Determination of ionisation potential of Xenon.
5. Verification Thevenin's theorem.
6. Half life of ^{40}K.
7. Detrmination of range of electrons in aluminium using GM Counter.
8. Study of X-ray photograph—determination of interplanar distance.
9. Phase measurement in LCR circuit using CRO.
10. To determine value of Boltzmann constant using VI characteristic of a diode.
11. Triode characteristics.
12. VI characteristics of a thermistor.

PHY511 (SEC) Lasers and Fibre Optics

Course duration: 16 weeks with 2 hours of instruction per week.

Part A: 16 hours

Laser basics: Coherence properties of laser light, temporal coherence, monochromaticity, spatial coherence, directionality, line width, brightness, divergence, line shape broadening, focusing properties of laser radiation, laser modes—axial and transverse, mode selection, single mode operation, selection of laser emission line. [5 hours]

Laser oscillator: Pumping schemes, Gain–threshold conditions; Optical resonators. [3 hours]

Types of lasers: Construction and principles of working of Nd-YAG, CO2 and dye lasers and semiconductor laser. [4 hours]

Laser diodes: Lasing conditions and gain in a semiconductor, selective amplification and coherence, Materials for laser diodes, quantum well lasers, surface emitting lasers, characterization and modulation of lasers. [4 hours]

Part B: 16 hours

Fibre optics and dielectric wave guides: Wave Guide—Slab wave guide, Modes, V number, Modal material and waveguide dispersions, Numerical problems. [3 hours]

Optical fibre: Types, functions, light propagation, optical power, velocity of propagation, critical angle, acceptance angle, numerical aperture, mode of propagation. Numerical problems. [4 hours]

Index profile: Single mode step-index optical fibre, multimode step-index fibre, graded index fibre; advantages and disadvantages. Numerical problems. [3 hours]

Energy losses in optical fibre: Bit rate, dispersion optical fibre communication, and optical bandwidth, Absorption and scattering, optocoupler. [6 hours]

References

- Wilson J, and Hawkes J, *Optoelectronics: An Introduction*, 3rd Edn., Prentice Hall (1998).
- Singh J, *Optoelectronics: An Introduction to Materials and Devices*, McGraw-Hill (1996).
- Bhattacharya P, *Semiconductor Optoelectronic Devices*, Prentice Hall International (1997).
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PHY512 (SEC) Astronomy and Astrophysics

Course duration: 16 weeks with 2 hours of instruction per week.

Part A: 16 hours

Astronomical scales: Astronomical distance, mass and time; scales; brightness, radiant flux and luminosity, measurement of astronomical quantities astronomical distances, stellar radii, masses of stars, stellar temperature. Basic concepts of positional astronomy—celestial sphere, geometry of a sphere, spherical triangle, astronomical coordinate systems, geographical coordinate systems, horizon system, equatorial system, diurnal motion of the stars, conversion of coordinates. Measurement of time—sidereal time, apparent solar time, mean solar time, equation of time, calendar the Julian date and its importance in astronomical observation. Basic parameters of stars—determination of distance by parallax method; brightness, radiant flux and luminosity, apparent and absolute magnitude scale, distance modulus. Numerical problems. [16 hours]

Part B: 16 hours

Stars: Surface or effective temperature, and color of a star. Intrinsic temperature of a star. Expression for average temperature, core temperature and core pressure of a star based on the linear density model of a star. Numerical problems. [3 hours]

Stellar characteristics: Spectral classification, Edward Charles Pickering classification (i.e., OBAFGKM), Harvard sequence and Yerke's luminosity classification. Size (radius) of a star. Expression for radius using Stefan-Boltzman law. Spectral signature of elements present in the stellar atmosphere. Mass-luminosity relationship and expression for lifetime of a star. Color index HD classification and HR diagram. Main sequence stars and their general characteristics. The stellar evolution. The evolutionary track of stars—Protostars, premain sequence stars, main sequence stars. Evolution of a star to white dwarf stage through red giant stage. Supernova explosion. Formation of a pulsar or neutron star and black hole (qualitative). Numerical problems. [10 hours]

Cosmology: Basic assumptions and limitations of cosmology; Expansion of the Universe and its evidence; Hubble's Law: Big bang theory and thermal history of the universe. Size and age of the universe. [3 hours]

References

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- Shu F, *The Physical Universe: An Introduction to Astronomy*, 1st Edn., University Science Books (1982).
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PHY513 (SEC) Nano Materials

Course duration: 16 weeks with 2 hours of instruction per week.

Part A: 16 hours

Nanoscale systems: Length scales in physics. Nanostructures—1D, 2D, and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size effects in nano systems, Quantum confinement: Applications of Schrödinger equation—Quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. [8 hours]

Synthesis of nanostructure materials: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. [8 hours]

Part B: 16 hours

Characterization: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. [8 hours]

Optical properties: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals, Radiative processes: General formalization—absorption, emission and luminescence. Optical properties of heterostructures and nanostructures. [8 hours]

References

- Poole Jr P C, Owens F J, *Introduction to Nanotechnology*, Wiley India (2003).
- Kulkarni S K, *Nanotechnology: Principles and Practices*, Capital Publishing Company (2015).
- Chattopadhyay K K, and Banerjee A N, *Introduction to Nanoscience and Technology*, PHI Learning (2009).
- Booker R, and Boysen E, *Nanotechnology*, John Wiley and Sons (2005).

PHY601 (DSE) Solid State Physics

Course duration: 16 weeks with 3 hours of instruction per week.

Part A: 16 hours

Semiconductors: Concept of bands in solids. Intrinsic and extrinsic semiconductors. Depletion region, drift velocity, expression for electron and hole concentration in intrinsic semiconductor under thermal equilibrium. Derivation of the expression for electrical conductivity of intrinsic semiconductors; electron and hole mobilities; Expression for the energy gap; Hall effect in semiconductors. Numerical problems. [6 hours]

Semiconductor devices: Diode current equation, IV characteristics, Bridge rectifier, Expression for ripple factor and efficiency. Filters—Zener breakdown and avalanche breakdown. Phenomenon of photoconductivity, photovoltaic cells, LED, FET. Numerical problems. [4 hours]

Transistors: Type and configuration, h parameters; Methods of transistor biasing—voltage divider bias; Fixing operating point, drawing load line. Effect of temperature on the operating point. [2 hours]

Amplifier: Two stage transistor RC coupled amplifier, mathematical analysis, frequency response curve, half power frequency bandwidth. [2 hours]

Oscillators: The feedback concept—positive and negative feedback. Mention of the Barkhausen criterion. Hartley oscillator. [2 hours]

Part B: 16 hours

Statistical physics: Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac energy distribution formulae (no derivation). A qualitative comparison of the three distribution formulae. [2 hours]

Dielectric properties: Dielectric materials; their properties. Method of determining dielectric constant for solids and liquids. [2 hours]

Thermal properties of solids: Dulong and Petit's law; its limitations. Einstein's theory of specific heat. Debye's theory of specific heat. Numerical Problems. [3 hours]

Electrical properties of metals: Band theory of solids—review, Free electron theory of metals—classical theory and quantum theory. Expression for electrical conductivity—Ohm's law, Wiedemann-Franz law. Statement of number of the available energy states between E and $E + \mathrm{d}E$. Expression for the Fermi energy. Hall effect and magnetoresistance in metals. Expression for Hall coefficient in metals. Numerical problems. [6 hours]

Logic gates: Construction of AND, OR, and NOT logic gates using Diodes and transistors (two input). Symbols and discussion of truth table using Boolean expressions for NOR, NAND, and XOR logic gates. Half adder and full adder. [3 hours]

Part C: 16 hours

Superconductivity: Elementary ideas and experimental facts. Meissner effect. Magnetic properties of type-I and type-II superconductors, Critical magnetic field. Influence of external agents on superconductivity, Cooper pairs, BCS theory (qualitative). Applications of superconductivity. Introduction to high temperature superconductors. [4 hours]

Liquid crystals: Symmetry, structure, and classification of liquid crystals; polymorphism in thermotropics. [2 hours]

X-rays: Brag's law and the Bragg spectrometer. A brief mention of the different types of crystals. Miller indices, structure of NaCl and KCl crystals. Continuous

X-ray spectrum and its origin, Duane and Hunt limit. Characteristic X-ray spectra and its origin. Mosley law and its significance. Compton effect—Expression for Compton shift, Compton wavelength, Verification of change in wavelength; Reason for non-observance of Compton effect in visible light. Numerical problems. [10 hours]

References

- Sedha R S, *A Textbook of Applied Electronics*, 2nd Edn., S Chand Limited (2007).
- Theraja B L, and Sedha R S, *Principles of Electronic Devices and Circuits*, 2nd Edn., S.Chand Limited (2008).
- Mehta V K, *Principles of Electronics*, 2nd Edn., S Chand and Company (2005).
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PHY602 (DSE) Practical 7

Course duration: 16 weeks with 3 hours of lab work per week.

Any TEN of the following experiments:

1. Basic logic gates using transistors.
2. Harteley oscillator.
3. Transistor characteristics (CB mode).
4. Characteristics of LED.
5. CE Amplifier—gain and bandwidth.
6. Verification of maximum power transfer theorem.
7. Phase shift oscillator.
8. Zener diode as voltage regulator.
9. Energy gap of a semiconductor using meter bridge.
10. Determination of enery gap of a semiconductor using four probes.

11. Negative feedback amplifier.
12. Calculation h parameters by drawing static characteristics of a transistor in CE mode.

PHY603 (DSE) Practical 8

Course duration: 16 weeks with 3 hours of lab work per week.

Any TEN of the following experiments:

1. Bridge rectifier with C and Pi filter.
2. Fermi energy of copper using meter bridge.
3. Logic gates—AND, OR, NOT, NOR, and X-OR using IC 7400 and 7402.
4. Half adder.
5. Full adder.
6. Phototransistor characteristics.
7. Two stage RC coupled amplifier—gain and bandwidth.
8. Verification of inverse square law of light Using photodiode.
9. Wein bridge oscillator.
10. FET characteristics.
11. Measurement of susceptibility of a paramagnetic solution.
12. DC load line—Determination of Q point of a transistor using voltage divider bias.

PHY611 (SEC) Optoelectronics

Course duration: 16 weeks with 2 hours of instruction per week.

Part A: 16 hours

Optical process in a semiconductor: Electron-hole pair formation and recombination, absorption in semiconductor direct and indirect band gap semiconductors, effect of electric field on absorption, Franz-Keldysh effect in semiconductors. [4 hours]

Optoelectronic devices: Light Emitting Diodes—Materials for light emitting diodes, Principle of action of LED, expression for light power in terms of photon energy, homostructured LED and Heterojunction LED, drawbacks of homostructured LED. Types of LED structures—planar, dome type, surface emitter, edge emitter, super luminescent structure. Performance characteristics of LED—Optical output power-current characteristics, forward current voltage characteristics, Modulation bandwidth, power bandwidth product, Lifetime, Rise time/fall time, reliability, Internal quantum efficiency, advantages / disadvantages of using LED. Numerical problems. [10 hours]

Organic optoelectronic devices: Organic light emitting diodes (OLED), The principle of OLED, characterisation, structure, efficiency, multilayer OLED. [2 hours]

Part B: 16 hours

Photo detectors: Important parameters of photodetectors, Detector responsivity, spectral response range, response time, quantum efficiency, capacitance, noise characteristics. Absorption of radiation—absorption coefficient, mention of expression for photocurrent, long wavelength cut off, direct and indirect absorption. Types of photodiodes—Junction photodiodes, pin diode, avalanche photodiodes, CCD photodetectors; Comparison of different detectors, Photomultiplier tubes. Phototransistors—characteristics. Photo conductive detectors—expression for photoconductive gain (as in the book of Kasap S. O.). Numerical problems. [10 hours]

Photovoltaic devices: Solar cell—IV characteristics, efficiency, materials. Organic photovoltaic diodes (OPVD)—fundamental process, exciton absorption, exciton dissociation, charge transport, charge collection, characterisation. Numerical problems. [6 hours]

References

- Keiser G, *Optical Fibre Communications*, 3rd Edn., McGraw Hill (2000).
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- Wilson J and Hawkes J F B, *Optoelectronics An Introduction*, 3rd Edn., Prentice Hall (1998).

PHY612 (SEC) Renewable Energy Sources

Course duration: 16 weeks with 2 hours of instruction per week.

Part A: 16 hours

Solar energy: Basic ideas—Origin, Spectral distribution of solar radiation, Attenuation of beam radiation, Basic earth solar angle and derived solar angle, GMT, LCT, LST, Day length, Estimation of average solar radiation, sunshine recorder. Numerical problems. [6 hours]

Solar collectors: Principle of conversion of solar energy into heat, classification of solar collectors, Flat plate and concentrating collectors, construction, Thermal efficiency and coating, Heat losses, Solar cell and its efficiency, PV Panels. Numerical problems. [6 hours]

Photothermal devices: Solar cooker, Solar dryer, solar hot water systems—principles and working. [2 hours]

Photovoltaic systems: Solar lantern, water pumps and street lights—principles and working. [2 hours]

Part B: 16 hours

Wind energy: Origin, estimation of energy obtainable from wind, velocity and power duration curves, energy, pattern factors. Theory of power—Momentum transfer, power coefficients, principle of wind turbine, power vs velocity characteristics of wind turbine generator, cutin speed and cutout speed. Numerical problems. [8 hours]

Wind driven machines: Characteristics of wind turbine; Types—Horizontal and vertical axis types, vertical axis darrieus rotor wind turbine, Horizantal axis propeller type—twin blade and three blade. Blade pitch control. Advantages and disadvantages of two blade and three blade systems. Numerical problems. [8 hours]

References

- Rai G D, *Non-Conventional Energy Sources*, 4th Edn., Khanna Publishers (2009).
- Aarwal M P, *Solar Energy*, S Chand and Co. (1985).
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- Jayakumar P, *Resource Assessment Handbook*, APCTT (2009).
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PHY613 (SEC) Solving Problems in Physics

Course duration: 16 weeks with 2 hours of instruction per week.

Part A: 16 hours

Topics 1:

Frames of reference, Rigid body dynamics Conservation of Linear and angular momentum, Conservation of energy, Surface Tension, Elasticity, Kinetic theory, Thermal conductivity, Radiation, Joule-Thomson expansion, Clausius-Clapeyron first latent heat equation, Entropy, Thermodynamic potentials.

Sound waves motion in one dimension, Superposition of simple harmonic motion, Mechanical force and electric pressure on a charged surface, Galvanometers—moving coil Helmholtz, Thermoelectricity, DC currents, Alternating current fundamentals AC bridges, Network theorems, Frequency filters.

Part B: 16 hours

Topics 2:

Interference—division of wave front and division of amplitude, Diffraction—Fresnel and Fraunhofer diffraction, Polarization, Laser fundamentals.

Atomic Spectra—Bohr and vector atom model, Zeeman effect, Molecular Spectra and Raman Effect, Special theory of relativity, Matter waves, Schrödinger's equation—particle in a box, Mass spectrographs, Radioactive decay, Nuclear reactions, Particle accelerators, Nuclear fission, Electrical properties of metals, Semiconductors and devices, X-rays—Bragg's law and crystal structure, Moseley law, Compton effect.

References

- Halliday D, Resnick R, and Walker J, *Fundamentals of Physics*, 6th Edn., Wiley India Pvt. Ltd. (2001).
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- Brij Lal, and Subramanyam N, *Atomic an Nuclear Physics*, Revised by Jivan Sheshan, S Chand Publications (2008).
- Young H D, Freedman R A, Sears F, and Zeemansky M, *University Physics Vols. 1 and 12*, 13th Edn., Pearson (2011).

Scheme of Valuation for Practicals

C1 and C2 are internal tests to be conducted during 8th and 16th weeks respectively of the semester. C3 is the semester-end examination conducted for 3 hours. The student will be evaluated on the basis of skill, comprehension and recording the results.

The student has to compulsorily submit the practical record for evaluation during C1 and C2. For C3, the record has to be certified by the Head of the Department.

- The student is evaluated for 10 marks in C1 and C2 as per the following scheme: Experiment: 8, Record: 2.

  The marks scored is then normalised for 5.

- The student is evaluated for 40 marks in C3 as per the following scheme:

Heading	Marks
Experiment	25
Viva	10
Record	5
Total	40

  The experiment portion of evaluation is carried out as per the following scheme:

Heading	Marks
Formula with proper units and explanation	5
Setting up the apparatus / circuit connections	5
Taking readings and tabulating	5
Calculations	5
Graph and accuracy of result	5
Total	25

Question Paper Pattern

DSC Courses: 101, 201, 301, 401, and similar courses

Max Marks: 80	Time: 3 hours
Part A	
Long answer questions; Answer 2 out of 3	$2 \times 12 = 24$
Part B	
Long answer questions; Answer 2 out of 3	$2 \times 12 = 24$
Part C	
Numerical problems; 2 from each part; Answer 3 out of 4	$3 \times 4 = 12$
Part D	
Short answer questions; 6 from each part to be given; 10 to be answered	$10 \times 2 = 20$

DSE Courses: 501, 601, and similar courses

Max Marks: 80	Time: 3 hours
Part A	
Long answer questions; Answer 2 out of 3	$2 \times 8 = 16$
Part B	
Long answer questions; Answer 2 out of 3	$2 \times 8 = 16$
Part C	
Long answer questions; Answer 2 out of 3	$2 \times 8 = 16$
Part D	
Numerical problems; minimum 1 from each part; Answer 3 out of 5	$3 \times 4 = 12$
Part E	
Short answer questions; 6 from each part to be given; 10 to be answered	$10 \times 2 = 20$

SEC Courses: 511–513, 611–613, and similar courses

Max Marks: 40	Time: 2 hours

Part A

Long answer questions; Answer 2 out of 3	$2 \times 8 = 16$

Part B

Long answer questions; Answer 2 out of 3	$2 \times 8 = 16$

Part C

Short answer questions; 4 questions from each part; Answer 3	$4 \times 2 = 8$