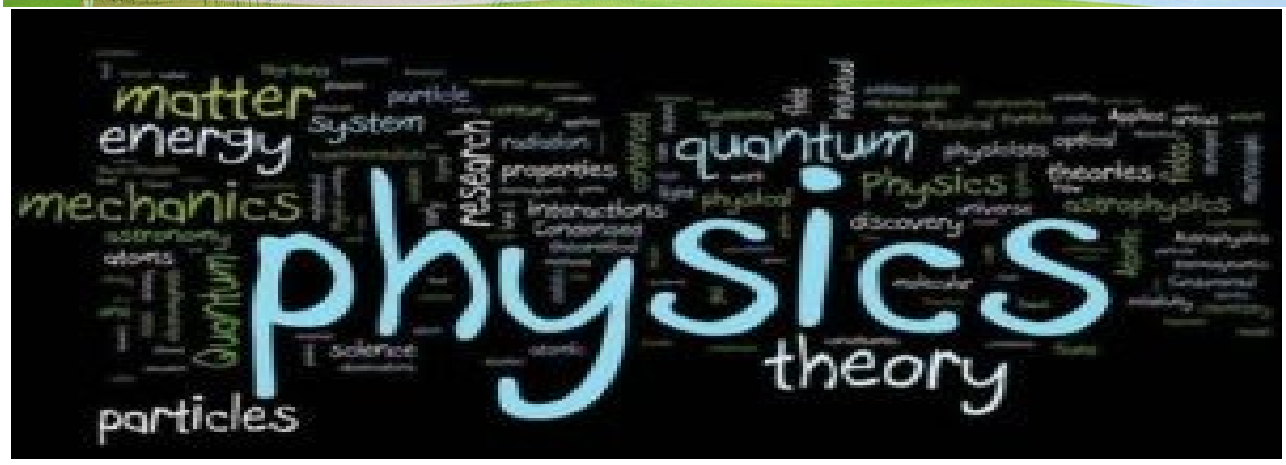
University Dept. Of Physics

Kolhan University, Chaibasa
कोलहान विश्वविद्यालय, चाईबासा



Choice Based Credit System (CBCS)

UNDERGRADUATE PROGRAMME
B. Sc. Physics (Honours)
(Courses effective from Academic Year 2020-21)
KOLHAN UNIVERSITY, CHAIBASA

B. Sc. Hons Under CBCS System

Sem	Subject Code	Full Marks	Total Marks	Credit	Total Credit
I	CC - 1	70	350	4	20
	CC - 2	70		4	
	CC(P) - I	60		4	
	GE – T (Theory)	70		4	
	GE (P) - 1	30		2	
	AECC – I (Eng. / MIL Communication)	50		2	
II	CC - 3	70	350	4	20
	CC - 4	70		4	
	CC(P) - 2	60		4	
	GE – 2 (Theory)	70		4	
	GE (P) - 2	30		2	
	AECC – 2 (Environmental Science)	50		2	
III	CC-5	70	450	4	26
	CC-6	70		4	
	CC-7	70		4	
	CC(P)-3	90		6	
	GE-3 (Theory)	70		4	
	GE(P)-3	30		2	
	SEC-1	50		2	
IV	CC-8	70	450	4	26
	CC-9	70		4	
	CC-10	70		4	
	CC(P)-4	90		6	
	GE-4 (Theory)	70		4	
	GE(P)-4	30		2	
	SEC-2	50		2	
V	CC-11	70	400	4	24
	CC-12	70		4	
	CC(P)-5	60		4	
	DSE-1 (Theory)	70		4	
	DSE-2 (Theory)	70		4	
	DSE(P)-1	60		4	

VI	CC-13	70	400	4	24
	CC-14	70		4	
	CC(P)-6	60		4	
	DSE-3 (Theory)	70		4	
	DSE(P)-2	30		2	
	DSE-4 (Project)	100		6	
	Total		2400		140

NB : All Practical Papers /CIA will be conducted in End Semester Examination involving external examiners.
CC: Core Courses
SEC : Skill Enhancement Courses (Page 43 onward)
DSE: Discipline Specific Elective
AECC: Ability Enhancement Compulsory courses

LETTER GRADE AD GRADE POINT

1.1 Kolhan University adopts absolute grading method for awarding grades in a course.

1.2 The University implements a 10-point grading system with the following letter grades as given below:

Grades and grade Points

Letter Grade	Grade Point	Marks Percentage
O (Outstanding)	10	100%
A++ (Excellent)	9	90% to 99.99%
A+ (Extremely Good)	8	80% to 89.99%
A (Very Good)	7.5	75% to 79.99%
B+ (Good)	7	70% to 74.99%
B (Above Average)	6	60% to 69.99%
C (Average)	5	50% to 59.99%
P (Pass)	4	40% to 49.99%
F (Fail)	0	Less than 40%
Ab (Absent)	0	

1.3 A student obtaining Grade F shall be considered failed and will be required to reappear in the examination.

1.4 For non credit courses ‘Satisfactory’ or ‘Unsatisfactory’ shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

1.5 The Universities can decide on the grade or percentage of marks required to pass in a course and also the CGPA required to qualify for a degree taking into consideration the recommendations of the statutory professional councils such as AICTE, MCI, BCI, NCTE etc.

Note :

(a) Symbol ‘N’ in the grade column will indicate that the student has not appeared in the End-semester examination on account of low attendance.

(b) Symbol ‘X’ in the grade column will indicate that the student was absent in the end-semester examination.

(c) Marks sheet issued to a student getting grade F or symbols N or X in any of the courses shall be marked ‘Provisional’.

Symbol ‘U’ in the grade column will indicate that the student was found guilty of using unfair means in the examinations.

DISTRIBUTION OF MARKS IN UG PRACTICAL PAPERS

1. For Full marks 30 :

	Duration	
(Pass Marks 12)	Experiment	15
	3 Hours	
	Co-curricular activities and Regularity	05
	Notebook & Viva-voce	10

2. For Full marks 60 :

(Pass Marks 24)	Experiment	30
	4 Hours	
	Co-curricular activities and Regularity	10
	Notebook & Viva-voce	20

3. For Full marks 90 :

(Pass Marks 36)	Experiment	45
	6 Hours	
	Co-curricular activities and Regularity	15
	Notebook & Viva-voce	30

CORE COURSE (HONOURS IN PHYSICS)

SEMESTER I

PHYSICS-CC-1: MATHEMATICAL PHYSICS-I
(Credits: Theory-04, Practicals-02) Theory: 60 Lectures
General Instruction for Students

Total Marks -70 Time- 3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

The emphasis of course is on applications in solving problems of interest to physicists.

The students are to be examined entirely on the basis of problems, seen and unseen.

Calculus:

Recapitulation: Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order Differential Equations and Integrating Factor. **(6 Lectures)**

Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral for typical source terms like polynomials, exponential, sine, cosine etc and their combinations. **(12 Lectures)**

Calculus of multivariable functions: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers. **(6 Lectures)**

Vector Calculus:

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their geometrical interpretation. Scalar and Vector fields. **(5 Lectures)**

Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities. **(10 Lectures)**

Vector Integration: Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs). Dirac Delta function and its properties: **(14 Lectures)**

Orthogonal Curvilinear Coordinate:
Orthogonal Curvilinear Coordinates. Expression for Gradient, Divergence, Curl and
Laplacian in orthogonal curvilinear co-ordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. **(7 Lectures)**

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
- Mathematical Physics, B. D. Gupta.
- Mathematical Physics, B. S. Rajput.
- Mathematical Physics, H. K. Dass.
- Mathematical methods in Physics, E. Butkov.
- Mathematical methods in Physics, Potter and Goldberg.

PHYSICS-CC-2: MECHANICS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket. **(6 Lectures)**

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies.

Kinetic energy of rotation. Motion involving both translation and rotation. **(12 Lectures)**

Elasticity: Elastic constants and interrelation between them. Twisting torque on a Cylinder or Wire and twisting couple. **(5 Lectures)**

Flexure of beam: Bending of beam, Cantilever. **(3 Lectures)**

Surface Tension: Ripples and Gravity waves, Determination of Surface Tension by Jaeger's and Quinke's methods. Temperature dependance of Surface Tension. **(6 Lectures)**

Fluid Motion: Kinematics of Moving Fluids, velocity profile: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube and the corrections. **(2 Lectures)**

Central Force Motion: Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution.. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS). Physiological effects on astronauts. **(6 Lectures)**

Oscillations: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(8 Lectures)**

Special Theory of Relativity: Galilean transformations; Galilean invariance. Michelson- Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy- Momentum Minkowski space and Four Vector. **(12 Lecture**

Reference Books:

- Core Physics for Class 11, S B Mathur & A Kumar, Bharati Bhawan, Patna
- Undergraduate Mechanics, Arun Kumar, J P Agrawal and Nutan Lata, Pragati Prakashan, Merrut.
- Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
- University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
- Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
- Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

- A textbook of General Physics, Edser
- Fluid mechanics, Kaufmann
- A treatise of hydromechanics, Basant and Ramsay.
- Oscillations and waves, Satya Prakash.
- A textbook of oscillation, waves and Acoustics, M. Ghosh and D. Bhattacharya

---

PHYSICS LAB- CC(P)-1 LAB
60 Lectures

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

- *Highlights the use of computational methods to solve physical problems*
- *The course will consist of lectures (both theory and practical) in the Lab*
- *Evaluation done not on the programming but on the basis of formulating the problem*
- *Aim at teaching students to construct the computational problem to be solved*
- *Students can use any one operating system Linux or Microsoft Window*

Topics	Description with Applications
Introduction and Overview	Computer architecture and organization, memory and Input/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of Python/ C / C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops*), Arrays (*1D & 2D*) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of **π**
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan\alpha$; $I = I_0 [(\sin\alpha)/\alpha]^2$ in optics
Interpolation by Newton Gregory Forward and	Evaluation of trigonometric functions e.g. *sinθ, cosθ, tanθ, etc.*
Backward difference formula, Error estimation	

Also attempt some problems on differential equations like:

1. Solve the coupled first order differential equations
   $dx/dt=y+x-x^3/3$
   $dy/dt=-x$
   for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4. Plot x vs y for each of the four initial conditions on the same screen for $0 \le t \le 15$.

2. The ordinary differential equation describing the motion of a pendulum is

   $$\vartheta'' = -\sin(\vartheta)$$

   The pendulum is released from rest at an angular displacement α i.e. $\vartheta(0) = \alpha$, $\vartheta'(0) = 0$. Use the RK4 method to solve the equation for α = 0.1, 0.5 and 1.0 and plot ϑ as a function of time in the range $0 \le t \le 8\pi$. Also, plot the analytic solution valid in the small ϑ ($\sin\vartheta \approx \vartheta$).

2. Solve the differential equation:
   $x^2 (d^2y/dx^2)-4x(1+x)(dy/dx)+2(1+x)y=x^3$

   with the boundary conditions: at x = 1, $y = (1/2)e^2$, $dy/dx = -(3/2)e^2-0.5$, in the range $1 \le x \le 3$. Plot y and dy/dx against x in the given range. Both should appear on the same graph.

Referred Books:

- Computational Physics with Python by Dr. Eric Ayars
- Numerical Methods in Engineering with Python by Jaan Kiusalaas, Cambridge University Press.
- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw Hill Pub.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn. , 2 0 0 7 , Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.
- An Introduction to computational Physics, T.Pang, 2nd Edn. , 2006,Cambridge Univ. Press

PHYSICS LAB-CC(P)-1 LAB
60 Lectures

1. Measurements of length (or diameter) using vernier caliper, screw gauge and traveling microscope.
2. To study the random error in observations.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
9. To determine the Modulus of Rigidity of a bar by method of bending.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Reference Books

• Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
• A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011, Kitab Mahal.

SEMESTER II

PHYSICS-CC-3: ELECTRICITY AND MAGNETISM
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures
General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. **(6 Lectures)**

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson Equations and their solutions . The Uniqueness Theorem. Potential and Electric Field due to a dipole. Force and Torque on a dipole. **(6 Lectures)**

Electrostatic energy of system of charges. Conductors in an electrostatic Field. Surface charge and force on a conductor. Parallel-plate capacitor. Capacitance of an isolated conductor. **(10 Lectures)**

Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics. **(8 Lectures)**

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) on point charge (2) on current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. **(11 Lectures)**

Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity (**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis. **(4 Lectures)**

Electromagnetic Induction: Recapitulation of Faraday's Law, Lenz's Law, Self Inductance and Mutual Inductance. Superposition Theorem. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current. **(6 Lectures)**

Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit. **(5 Lectures)**

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. **(4 Lectures)**

Reference Books:

- Core Physics for Class 12, S B Mathur & A Kumar, Bharati Bhawan, Patna.
- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw
- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education
- Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
- Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, Chattopadhyaya and Rakshit
- Electricity and Magnetism, Mahajan and Rangwala
- Electricity and Magnetism, K. K. Tewary.

PHYSICS-CC-4: WAVES AND OPTICS

(Credits: Theory-04, Practicals-02) Theory: 60 Lectures

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves. **(6 Lectures)**

Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. **(6 Lectures)**

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. **(5 Lectures)**

Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. **(12 Lectures)**

Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer – theory and applications. **(6 Lectures)**

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit. **(6 Lectures)**

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Single slit. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. **(10 Lectures)**

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire. **(9 Lectures)**

Reference Books

- Core Physics for Class 11, S B Mathur & A Kumar, Bharati Bhawan, Patna.
- Core Physics for Class 12, Mathur & Kumar, Bharati Bhawan, Patna.
- Waves and Acoustics, P. K. Chakraborty and Satyabrata Chowdhury.
- Introduction to Geometrical and Physical Optics, B. K. Mathur.
- Geometrical and Physical Optics, P. K. Chakraborty.
- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

Manual of Physics for

PHYSICS CC(P)-2 LAB

60 Lectures

---

1. Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown Low Resistance using Potentiometer.
4. To compare capacitances using De'Sauty's bridge.
5. Measurement of field strength B and its variation in a solenoid (determine dB/dx)
6. To verify the Thevenin and Norton theorems.
7. To verify the Superposition, and Maximum power transfer theorems.
9. To determine self inductance of a coil by Anderson's bridge.
9. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
10. To study the response curve of a parallel LCR circuit and determine its (a) Anti resonant frequency and (b) Quality factor Q.
11. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
12. Determine a high resistance by leakage method using Ballistic Galvanometer.

Reference Books

• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
• A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
• A Laboratory undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

PHYSICS CC(P)-2 LAB
60 Lectures

1. Familiarization with: Schuster`s focusing; determination of angle of prism.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine wavelength of sodium light using Fresnel Biprism.
5. To determine wavelength of sodium light using Newton's Rings.
6. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
7. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
• A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
• A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

SEMESTER III

PHYSICS-CC-5 : MATHEMATICAL PHYSICS-II
(Credits: Theory-04, Practicals-02) Theory: 60 Lectures
General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

The emphasis of the course is on applications in solving problems of interest to Physicists. Students are to be examined on the basis of problems, seen and unseen.

Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Analysis of saw-tooth and square wave.Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. **(14 Lectures)**

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions and Orthogonality. **(24 Lectures)**

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral). **(4 Lectures)**

Theory of Errors: Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. **(4 Lectures)**

Partial Differential Equations: Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string.

(14 Lectures)

Reference Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
- Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books
- Mathematical Physics, B. D. Gupta.
- Mathematical Physics, B. S. Rajput.
- Mathematical Physics, H. K. Dass.
- Mathematical methods in Physics, E. Butkov.
- Mathematical methods in Physics, Potter and Goldber

PHYSICS-CC-6: THERMAL PHYSICS (Credits: Theory-04, Practicals-02) Theory: 60 Lectures

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

INTRODUCTION TO THERMODYNAMICS

Zeroth and First Law of Thermodynamics:

Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes. **(8 Lectures)**

Second Law of Thermodynamics: Reversible and Irreversible process with examples. Heat Engines. Carnot's Cycle, Carnot engine & efficiency. Refrigerator & coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

(10 Lectures)

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics (Nearst's Heat Theorem). Unattainability of Absolute Zero.

(7 Lectures)

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films. Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples. **(7 Lectures)**

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, (1) Clausius Clapeyron equation, (2) Value of C_p-C_v, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases. **(7 Lectures)**

KINETIC THEORY OF GASES

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas. Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases. **(7 Lectures)**

Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. **(4 Lectures)**

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Critical Constants. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling. **(10 Lectures)**

Reference Books:

• Core Physics for Class 11, S B Mathur & A Kumar, Bharati Bhawan, Patna.
• A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
• Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
• Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
• Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
• Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
Heat and Thermodynamics, A. B. Gupta and H. P. Roy.
Heat and Thermodynamics, P. K. Chakraborty.

PHYSICS-CC-7: DIGITAL SYSTEMS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

……..

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates. NAND and NOR Gates as Universal Gates. XOR and XNOR Gates. **(10 Lectures)**

Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **(10 Lectures)**

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **(6 Lectures)**

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders, 4-bit binary Adder. **(6 Lectures)**

Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop. **(10 Lectures)**

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **(6 Lectures)**

Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits). **(6 Lectures)**

Counters (4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. (**6 Lectures)**

Reference Books:

- Digital Systems and Applications by Nutan Lata, Pragati Prakashan, Merrut
- Basic Electronics, Arun Kumar, Bharati Bhawan, Patna.
- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
- Logic Circuit Design, Shimon P. Vingron, 2012, Springer.
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S.Goankar, Prentice Hall.
- Digital Electronics, Floyd.
- Digital Computer Electronics, Malvino
- Digital Logic and Computer Design, M. Morris Mano.

PHYSICS CC(P)-3 LAB
60 Lectures

The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem

Topics	Description with Applications
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting, Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization. User defined functions, Introduction to Scilab functions, variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program.
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation Fixed difference method	First order differential equation, Radioactive decay, Current in RC, LC circuits with DC source, Newton's law of cooling, Classical equations of motion, Second order Differential Equation, Harmonic oscillator (no friction), Damped Harmonic oscillator, Over damped, Critical damped, Oscillatory, Forced Harmonic oscillator, Transient and, Steady state solution Apply above to LCR circuits also.

Reference Books:

• Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.Bence, 3rd ed., 2006, Cambridge University Press
• Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
• First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
• Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
• Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
• Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
• Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

PHYSICS- CC(P)-3 LAB
60 Lectures

……..

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee's disc method.
4. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
5. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
6. To calibrate a thermocouple to measure temperature in a specified Range using (1) Null Method and to determine Neutral Temperature.

Reference Books

• Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
• A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
• A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, Vani Pub

PHYSICS PRACTICAL-CC(P)-3 LAB
60 Lectures

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Adder and Full Adder Truth table verification using I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To design an astable multivibrator of given specifications using 555 Timer.
12. To design a monostable multivibrator of given specifications using 555 Timer.

Reference Books:

• Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
• Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
• Microprocessor Architecture Programming and applications with 8085, R.S.Goankar, 2002, Prentice Hall.
• Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI Learning.

SEMESTER IV

PHYSICS-CC-8: MATHEMATICAL PHYSICS-III
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures
General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles, order of singularity, Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals. **(30 Lectures)**

Integrals Transforms:
Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations. **(15 Lectures)**

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Convolution Theorem. Inverse LT. Application of Laplace Transforms to Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits. **(15 Lectures)**

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
- Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett.
- Mathematical Physics, B. D. Gupta.
- Mathematical Physics, B. S. Rajput.
- Mathematical Physics, H. K. Dass.
- Mathematical methods in Physics, E. Butkov.
- Mathematical methods in Physics, Potter and Goldberg.

PHYSICS-CC-9: ELEMENTS OF MODERN PHYSICS (Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Quantum theory of Light: Wave-particle duality, Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. **(15 Lectures)**

Quantum Uncertainty: Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle**.** **(6 Lectures)**

Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Physical quantities as operators, Position, Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. **(10 Lectures)**

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier. **(10 Lectures)**

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. **(10 Lectures)**

Fission and fusion- mass deficit, Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions). **(3 Lectures)**

Lasers: Einstein’s A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. **(6 Lectures)**

Reference Books:

- Introduction to Quantum mechanics, Nikhil Ranjan Roy, 2016, Vikash Publishing House Pvt. Ltd.
- Introduction to Solid State Physics, Arun Kumar, PHI Learning Pvt. Ltd., New Delhi.
- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

PHYSICS-CC-10: ANALOG SYSTEMS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Semiconductor Diodes: P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. **(10 Lectures)**

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode, (3) Solar Cell. **(6 Lectures)**

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cut off and Saturation Regions. **(6 Lectures)**

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. **(10 Lectures)**

Coupled Amplifier: RC-coupled amplifier and its frequency response. (**4 Lectures)**

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **(5 Lectures)**

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. **(6 Lectures)**

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. **(4 Lectures)**

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier **(9 Lectures)**

Reference Books:

- Basic Electronics, Arun Kumar, Bharati Bhawan, Patna
- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning

Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill

- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer

- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
- A first course in Electronics, Khan and Dey, PHI
- Microelectronics, Millman and Grabel

PHYSICS PRACTICAL-CC(P)-4 LAB
60 Lectures

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:

$dy/dx = e^{-x}$ *with* $y=0$ *for* $x = 0$.

$dy/dx + e^{-x}y = x^2$

$d^2y/dt^2 + 2dy/dt = -y$

$d^2y/dt^2 + e^{-t}\, dy/dt = -y$

2. Fourier Series:

Program to sum $\sum_{n=1}^{\infty} (0.2)^n$

Evaluate the Fourier coefficients of a given periodic function (square wave).

3. Frobenius method and Special functions:

$$\int_{-1}^{+1} P_n(\mu) P_m(\mu) d\mu = \delta_{n,m}$$

1

$$Plot \quad P_n(\quad j_v(x)$$

$x)$,

Show recursion relation.

4. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).

5. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

6. Evaluation of trigonometric functions e.g. *sin θ*, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration

7. Integral transform: FFT of e^{-x^2}

Reference Books:

• Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press

• Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications

• Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

• Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444

• Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company

• Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

---

PHYSICS PRACTICAL-CC(P)-4 LAB
60 Lectures

1. Measurement of Planck's constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck's constant using LEDs of at least 4 different colours.
5. To determine the value of e/m by using a Bar magnet.
6. To show the tunneling effect in tunnel diode using I-V characteristics.
7. To determine the wavelength of laser source using diffraction of single slit.
8. To determine the wavelength of laser source using diffraction of double slits.
9. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating

Reference Books

• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House

• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

• A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn, 2011,Kitab Mahal

PHYSICS PRACTICAL-CC(P)-4 LAB
60 Lectures

……

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
7. To design a phase shift oscillator of given specifications using BJT.
8. To study the Colpitt`s oscillator.
9. To study the analog to digital convertor (ADC) IC.
10. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
11. To design inverting amplifier using Op-amp (741,351) and study its frequency response
12. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
13. To add two dc voltages using Op-amp in inverting and non-inverting mode
14. To investigate the use of an op-amp as an Integrator.
15. To investigate the use of an op-amp as a Differentiator.

Reference Books:

• Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
• OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
• Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
• Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson

SEMESTER V

-

PHYSICS-CC-11: QUANTUM MECHANICS AND APPLICATIONS
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures
General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Time dependent Schrodinger equation: Postulates of Quantum Mechanics, Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle. **(8 Lectures)**

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigen values; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Position-momentum uncertainty principle. **(12 Lectures)**

General discussion of bound states in an arbitrary potential- continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy & uncertainty principle. **(14 Lectures)**

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Moment. Stern-Gerlach Experiment. Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton. Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). **(14 Lectures)**

Hydrogen and Many electron atoms: Pauli's Exclusion Principle, Symmetric & Antisymmetric Wave Functions (Qualitative idea only). Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms- L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.). **(12 Lectures)**

Reference Books:

- Introduction to Quantum mechanics, Nikhil Ranjan Roy, 2016, Vikash Publishing House Pvt. Ltd.
- A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.

- Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
- Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
- Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press
- Quantum mechanics, Satya Prakash

Additional Books for Reference

- Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

---

PHYSICS-CC-12: SOLID STATE PHYSICS
(Credits: Theory-04, Practicals-02) Theory: 60 Lectures

……

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor. **(12 Lectures)**

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law. **(12 Lectures)**

Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of Dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss **(10 Lectures)**

Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. **(9 Lectures)**

Elementary band theory: Periodic potential and Bloch Theorem, Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of

Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. **(11 Lectures)**

Superconductivity: Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, Idea of BCS theory (No derivation) **(6 Lectures)**

Reference Books:

- Introduction to Solid State Physics, Arun Kumar, PHI Learning Pvt. Ltd., New Delhi.
- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edition, 2006, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications
- Solid State Physics, Dekker
- Solid State Physics, J. P. Srivastava
- Solid State Physics, Mahan and Mahto

PHYSICS PRACTICAL-CC(P)-5 LAB
60 Lectures

Use Python/C/C++/Scilab for solving the following problems based on Quantum Mechanics like

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = 2m/h^2 \times [V(r) - E] \text{ where } V(r) = -e^2/r$$

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511x10^6 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = 2m/h^2 * [V(r) - E]$$

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential $V(r) = -e^2/r \times (e^{-r/a})$

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511x10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = 2m/h^2 \times [V(r) - E]$$

For the anharmonic oscillator potential V(r) = ½ kr^2 + 1/3br^3 for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}. In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:

$$\frac{d^2y}{dr^2} = A(r)u(r), A(r) = 2\mu / h^2 \times [V(r) - E]$$

Where μ is the reduced mass of the two-atom system for the Morse potential

$(r) = D(e^{-2\alpha r'} - e^{-\alpha r'})$, r' = $(r-r_0)/r$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: m = 940x106eV/C^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å.

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

Reference Books:

• Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-- ‑ Hill Publication
• Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
• An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
• Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.
• Scilab (A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
• Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

…….

PHYSICS PRACTICAL-CC(P)-5 LAB

60 Lectures

……..

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. Verification of Curie-Weiss Law for a ferroelectric material.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the refractive index of a dielectric layer using SPR
6. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
7. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150^0C) and to determine its band gap.
8. To determine the Hall coefficient of a semiconductor sample.

Reference Books

• Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
• A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
• Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

DISCIPLINE SPECIFIC ELECTIVE DSE-1 (Theory)

……..

PHYSICS-DSE-1: NUCLEAR AND PARTICLE PHYSICS

(Credits: Theory-05, Tutorials-01)
Theory: 75 Lectures

……..

In the beginning (1st week) of 5th & 6th Semester, each department & colleges should confirm the particular elective courses, along with the name of faculty & number of students, for that Semester. This list will be sent to the P G. Head & Controller of Examinations, through the Principal.

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. **(10 Lectures)**

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

(12 Lectures)

Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α- emission, Gamow factor, Geiger Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. (**12 Lectures)**

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering). **(10 Lectures)**

Interaction of Nuclear Radiation with matter: Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter. **(7 Lectures)**

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for

charge particle and photon detection (concept of charge carrier and mobility), neutron detector. **(10 Lectures)**

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Concept of quark model. **(14 Lectures)**

Reference Books:

• Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
• Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
• Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
• Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
• Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
• Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
• Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
• Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
• Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
• Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991

PHYSICS-DSE-2 (Theory) : CLASSICAL DYNAMICS

(Credits: Theory-05, Tutorials-01)

Theory: 75 Lectures

……..

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Classical Mechanics of Point Particles: Generalised coordinates and velocities. Hamilton's Principle, Lagrangian and Euler-Lagrange equations. Applications to simple systems such as coupled oscillators. Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, particle in a central force field. Poisson brackets. Canonical transformations. **(22 Lectures)**

Special Theory of Relativity: Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. Time-dilation, length contraction & twin paradox. Four-vectors: space-like, time-like & light-like. Four-velocity and acceleration. Four-momentum and energy-momentum relation. Doppler effect from a four vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle. Electric and magnetic fields due to a uniformly moving charge. Equation of motion of charged particle & Maxwell's equations in tensor form. Motion of charged particles in external electric and magnetic fields. **(38 Lectures)**

Electromagnetic radiation: Review of retarded potentials. Potentials due to a moving charge: Lienard Wiechert potentials. Electric & Magnetic fields due to a moving charge: Power radiated, Larmor's formula and its relativistic generalisation. **(15 Lectures)**

Reference Books:

•Undergraduate Mechanics, Arun Kumar, J P Agrawal and Nutan Lata, Pragati Prakashan, Merrut

- Introduction to Classical mechanics, Nikhil Ranjan Roy, 2016, Vikash Publishing House Pvt.

Ltd.

Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.

• Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.

• Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.

• The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.

• Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.

• Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.

• Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

---

PRACTICAL- DSE(P)-1 LAB: EXPERIMENTAL TECHNIQUES
60 Lectures

……..

1. Determine output characteristics of a LVDT & measure displacement using LVDT
2. Measurement of Strain using Strain Gauge.
3. Measurement of level using capacitive transducer.
4. To study the characteristics of a Thermostat and determine its parameters.
5. Study of distance measurement using ultrasonic transducer.
6. Calibrate Semiconductor type temperature sensor (AD590, LM35, or LM75)
7. Comparison of pickup of noise in cables of different types (co-axial, single shielded, double shielded, without shielding) of 2m length, understanding of importance of grounding using function generator of mV level & an oscilloscope.
8. To design and study the Sample and Hold Circuit.
9. Design and analyze the Clippers and Clampers circuits using junction diode
10. To plot the frequency response of a microphone.
using a Q-meter.
11. To measure Q of a coil and influence of frequency,

Reference Books:

• Electronic circuits: Handbook of design and applications, U. Tietze and C. Schenk, 2008, Springer
• Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1990, Mc-Graw
• Measurement, Instrumentation and Experiment Design in Physics & Engineering, M. Sayer and A. Mansingh, 2005, PHI Learning.

PHYSICS-DSE(P)-1 LAB: MEDICAL PHYSICS
60 Lectures

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

Reference Books:

• Basic Radiological Physics, Dr. K. Thayalan - Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003)
• Christensen's Physics of Diagnostic Radiology: Curry, Dowdey and Murry - Lippincot Williams and Wilkins (1990)
• Physics of Radiation Therapy : F M Khan - Williams and Wilkins, 3rd edition (2003)
• The essential physics of Medical Imaging: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edition (2002)
• The Physics of Radiology-H E Johns and Cunningham.

SEMESTER VI

PHYSICS-CC-13 : ELECTROMAGNETIC THEORY
(Credits: Theory-04, Practicals-02)
Theory: 60 Lectures
General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting vector and Poynting Theorem. Electromagnetic (EM) Energy Density. **(14 Lectures)**

EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth. **(10 Lectures)**

EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. **(12 Lectures)**

Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light **(12 Lectures)**

Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter. **(5 Lectures)**

Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only). **(3 Lectures)**

Reference Books:

- Electromagnetic Theory, Chopra and Agarwal.
- Electromagnetics, B. B. Laud.
- Electromagnetic Theory,, Satya Prakash
- Electromagnetic Theory, Gupta and Kumar
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Additional Books for Reference

• Electromagnetic Fields & Waves, P.Lorrain & D.Corson, 1970, W.H.Freeman & Co.
• Electromagnetics, J.A. Edminster, Schaum Series, 2006, Tata McGraw Hill.
• Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press

…….

PHYSICS-CC-14: STATISTICAL MECHANICS
(Credits: Theory-04, Practicals-02) Theory: 60 Lectures

……..

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations. **(18 Lectures)**

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Rayleigh-Jean's Law. **(9 Lectures)**

Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law. **(5 Lectures)**

Bose-Einstein Statistics: B-E distribution law, Thermodynamic functions of a Degenerate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description), Radiation as a photon gas and Thermodynamic functions of photon gas. Bose derivation of Planck's law. **(13 Lectures)**

Fermi-Dirac Statistics: Fermi-Dirac Distribution Law, Thermodynamic functions of a Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit. **(15 Lectures)**

Reference Books:

• Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
• Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill
• Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall
• Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
• Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
• An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press
Statistical Mechanics, K. Huang.

PHYSICS PRACTICAL CC(P)-6 LAB
60 Lectures

……..

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
5. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.
6. To verify the Stefan`s law of radiation and to determine Stefan's constant.
7. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books

• Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
• Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
• A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
• Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

---

PHYSICS PRACTICAL-CC(P)-6 LAB
60 Lectures

……..

Use Python/C/C++/Scilab for solving the problems based on Statistical Mechanics like

1. Plot Planck's law for Black Body radiation and compare it with Wein's Law and Raleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature (room temperature) and low temperature and compare them for these two cases
3. Plot Maxwell-Boltzmann distribution function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

Reference Books:

• Elementary Numerical Analysis, K.E.Atkinson, 3 r d Edn. 2007, Wiley India Edition
• Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University

Press.
• Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W.Sears and Gerhard L. Salinger, 1986, Narosa.
• Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
• Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
• Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
• Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978-613345927

PHYSICS-DSE-3(Theory) : EXPERIMENTAL TECHNIQUES

(Credits: Theory-03, Practicals-02)
Theory: 60 Lectures

……..

General Instruction for Students

Total Marks -70 Time-3 Hours

Group A is compulsory and will contain 10 objective type questions, each of 2 Marks, Gr. B is Short answer type and will have 8 questions of 5 Marks each out of which 4 are to be answered. Gr. C is Long answer type and will have 4 questions each of 15 Marks out of which any 2 are to be answered. Questions will be set from all the units in the paper and the distribution of the number of questions from each unit will be equal as far as practicable. If possible divide each paper in 4 units each of 15 Lecturers.

Measurements: Accuracy and precision. Significant figures. Error and uncertainty analysis. Types of errors: Gross error, systematic error, random error. Statistical analysis of data (Arithmetic mean, deviation from mean, average deviation, standard deviation, chi-square) and curve fitting. Guassian distribution. **(8 Lectures)**

Signals and Systems: Periodic and aperiodic signals. Impulse response, transfer function and frequency response of first and second order systems. Fluctuations and Noise in measurement system. S/N ratio and Noise figure. Noise in frequency domain. Sources of Noise: Inherent fluctuations, Thermal noise, Shot noise, 1/f noise **(8 Lectures)**

Shielding and Grounding: Methods of safety grounding. Energy coupling. Grounding. Shielding: Electrostatic shielding. Electromagnetic Interference. **(4 Lectures)**

Transducers & industrial instrumentation (working principle, efficiency, applications): Static and dynamic characteristics of measurement Systems. Generalized performance of systems, Zero order first order, second order and higher order systems. Electrical, Thermal and Mechanical systems. Calibration. Transducers and sensors. Characteristics of Transducers. Transducers as electrical element and their signal conditioning. Temperature transducers: RTD, Thermistor, Thermocouples, Semiconductor type temperature sensors (AD590, LM35, LM75). Sinear Position transducer: Strain gauge, Linear variable differential transformer (LVDT), Capacitance charge transducers. Radiation Sensors: Principle of Gas filled detector, ionization chamber, scintillation detector. **(21 Lectures)**

Digital Multimeter: Comparison of analog and digital instruments. Block diagram of digital multimeter, principle of measurement of I, V, C. Accuracy and resolution of measurement. **(5 Lectures)**

Vacuum Systems: Characteristics of vacuum: Gas law, Mean free path. Application of vacuum. Vacuum system- Chamber, Mechanical pumps, Diffusion pump & Turbo Modular pump, Pumping speed, Pressure gauges (Pirani, Penning, ionization). **(14 Lectures)**

Reference Books:

• Measurement, Instrumentation and Experiment Design in Physics and Engineering, M. Sayer and A. Mansingh, PHI Learning Pvt. Ltd.
• Experimental Methods for Engineers, J.P. Holman, McGraw Hill

• Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition, PHI Learning Pvt. Ltd.
• Transducers and Instrumentation, D.V.S. Murty, 2nd Edition, PHI Learning Pvt. Ltd.
• Instrumentation Devices and Systems, C.S. Rangan, G.R. Sarma, V.S.V. Mani, Tata McGraw Hill
• Principles of Electronic Instrumentation, D. Patranabis, PHI Learning Pvt. Ltd.
• Electronic circuits : Handbook of design & applications, U.Tietze, Ch. Schenk, Springer.

DSE(P)-2 LAB

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
7. Study the layout of receiver circuit
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
6. Measurement of rise, fall and delay times using a CRO.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

• A text book in Electrical Technology - B L Theraja - S Chand and Co.
• Performance and design of AC machines - M G Say ELBS Edn.
• Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
• Logic circuit design, Shimon P. Vingron, 2012, Springer.
• Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
• Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
• Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
• Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

PHYSICS-DSE4: DISSERTATION

……

Every student shall undertake one project dissertation approved by the concerned subject teacher of the Department/College of the department. The progress of the project dissertation shall be monitored, at regular intervals, by the faculty member.

The dissertation will be evaluated according to the relevance of topic, intensity of actual work done, conceptual understanding of the work. The marking guidelines are following

- Marks Awarded for 2 Reviews of works (20 + 20) (Guide + External Examiner) = 40 Marks
- Evaluation of the Dissertation (20 + 20) : (Guide + External Examiner) = 40 Marks
- Presentation (15 Min) followed by Viva-voce Examination (05 Min) : 20 Marks (10 + 10)

Total : 100 Marks

ABILITY ENHANCEMENT ELECTIVE COURSE (AEEC)
(SKILL ENHANCEMENT COURSE-(SEC))
(Credit: 02 each) - AEEC1 to AEEC 2

Any two of the followings, one each in 3rd and 4th Semester:
1. Electrical Circuit Network Skills
2. Basic Instrumentation Skills
3. Renewable Energy and Energy harvesting
4. Radiation Safety

In the beginning (1st week) of 3rd & 4th Semester, each department & colleges should confirm the particular elective courses (AEEC / SEC), along with the name of faculty & number of students, for that Semester. This list should be sent to the P. G. Head & Controller of Examinations, through the Principal.

SKILL ENHANCEMENT COURSES

……..

SEC-1: ELECTRICAL CIRCUIT NETWORK SKILLS
(Credits: 02) Theory: 30 Lectures

……..

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. (4 Lectures)
Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. (6 Lectures)
Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. (4 Lectures)
Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor. (6 Lectures)
Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) (6 Lectures)
Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. (4 Lectures)
Reference Books:

• A text book in Electrical Technology - B L Theraja - S Chand & Co.
• A text book of Electrical Technology - A K Theraja
• Performance and design of AC machines - M G Say ELBS Edn.

…….

SEC-2: BASIC INSTRUMENTATION SKILLS
(Credits: 02) Theory: 30 Lectures

……..

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. (4 Lectures)

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance. (4 Lectures)

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. (6 Lectures)

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working. (4 Lectures)

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis. (4 Lectures)

Digital Instruments: Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter. (4 Lectures)

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution. (4 Lectures)

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
6. Measurement of rise, fall and delay times using a CRO.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope
2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Reference Books:

• A text book in Electrical Technology - B L Theraja - S Chand and Co.
• Performance and design of AC machines - M G Say ELBS Edn.
• Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

• Logic circuit design, Shimon P. Vingron, 2012, Springer.
• Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
• Electronic Devices and circuits, S. Salivahanan & N. S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
• Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer
• Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

---

SEC 3: RENEWABLE ENERGY AND ENERGY HARVESTING

(Credits: 02) Theory: 30 Lectures

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Fossil fuels and Alternate Sources of energy: Fossil fuels and Nuclear Energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. (3 Lectures)

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. (6 Lectures)

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. (3 Lectures)

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. (3 Lectures)

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass. (2 Lectures)

Geothermal Energy: Geothermal Resources, Geothermal Technologies. (2 Lectures)

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources. (2 Lectures)

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power (4 Lectures)

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications (2 Lectures)

Carbon captured technologies, cell, batteries, power consumption (2 Lectures)

Environmental issues and Renewable sources of energy, sustainability. (1 Lecture)

Demonstrations and Experiments

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

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

SEC 4: RADIATION SAFETY
(Credits: 02) Theory: 30 Lectures

The aim of this course is for awareness and understanding regarding radiation hazards and safety. The list of laboratory skills and experiments listed below the course are to be done in continuation of the topics

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission. (6 Lectures)

Interaction of Radiation with matter: Types of Radiation: Alpha, Beta, Gamma and Neutron and their sources, sealed and unsealed sources, Interaction of Photons - Photoelectric , Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, Interaction of Charged Particles: Heavy charged particles – Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), Interaction of Neutrons- Collision, slowing down and Moderation. (7 Lectures)

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). Radiation detection: Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors (Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry. (7 Lectures)

Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management. (5 Lectures)

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime detection, Mining and oil. Industrial Uses: Tracing, Gauging, Material Modification, Sterization, Food preservation. (5 Lectures)

Experiments:

1. Study the background radiation levels using Radiation meter Characteristics of Geiger Muller (GM) Counter:
2) Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
3) Study of counting statistics using background radiation using GM counter.
4) Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
5) Study of absorption of beta particles in Aluminum using GM counter.
6) Detection of α particles using reference source & determining its half life using spark counter
7) Gamma spectrum of Gas Light mantle (Source of Thorium)

Reference Books:

• W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
• G.F.Knoll, Radiation detection and measurements
• Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook

• W.J. Meredith and J.B. Massey, “Fundamental Physics of Radiology”. John Wright and Sons, UK, 1989.
• J.R. Greening, “Fundamentals of Radiation Dosimetry”, Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
• Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
• Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
• NCRP, ICRP, ICRU, IAEA, AERB Publications.
• W.R. Hendee, “Medical Radiation Physics”, Year Book – Medical Publishers Inc. London, 1981
