Ranchi Women's College, Ranchi

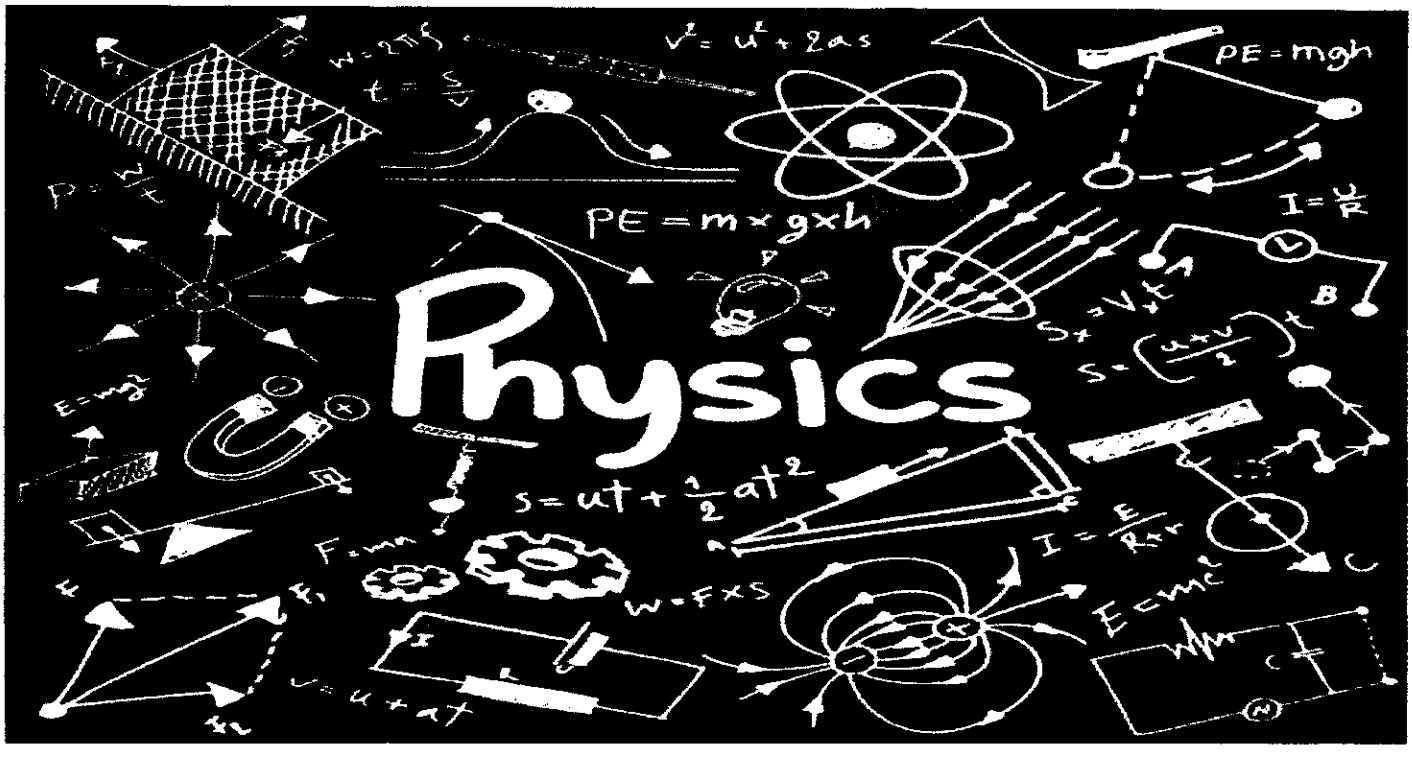
(An Autonomous Unit of Ranchi University from 2012)

Proposed Syllabus For B.Sc. (Honours) Physics

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

From

Academic Session 2018-2019



Department of Physics

Meeting of Board of Studies

A meeting of Board of Studies was held by the Physics Department through VC at Ranchi Women's College Ranchi on 09-06-2021.

Members present were:

1. Dr.Asha Prasad - Chairperson, Head of Department-Physics, Ranchi Women's College
2. Dr. Raj Kumar Singh - University Nominee (Astt. Professor, University Department ofPhysics, Ranchi University, Ranchi, University Nominee
3. Dr. Arun Kumar -Subject Expert (PG Head, University Department of Physics,Ranchi University, Ranchi
4. Dr. Vinita Saran- Subject Expert (Retired Associate Professor & Head, UniversityDepartment of Physics, Ranchi University, Ranchi
5. Dr. Preeti Dipika Minz -Member
6. Dr. Anita Kumari, - Member
7. Ms Anisha Kumari - Meritorious Student

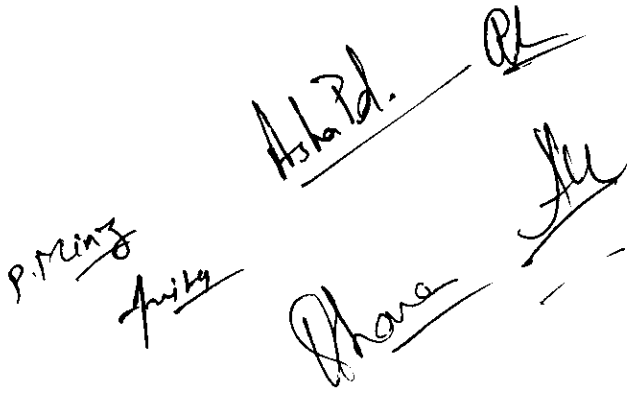
Agenda: Review of the CBCS syllabus of UG Physics for implementation in Session 2021-2022. **Resolution:** It was deliberated during the course of the meeting that the present syllabus is quitesufficient and exhaustive. It is as per the present need of the students designed for their future keeping in view their future prospects.

The proposed syllabus for B.Sc.(Hons) Physics under Choice Based Credit System was formulated and approved by the members of the board.

(Dr. Asha Prasad)
Astt. Professor. RWC, Ranchi
Chairperson- Board of Studies

Table of Content

Physics Generic



COURSE STRUCTURE (PHYSICS-HONOURS)

S.No.	Course	Credits
1.	**CORE COURSE** (14 Papers, C1 to C14)	14×4 = 56
	Core Course Practical (14 Papers, C1 Prac. To C14 Prac.	14×2 = 28
2.	**ELECTIVE COURSE** (8 Papers)	
	Discipline Specific Elective (4 Papers, DSE 1 to DSE 4)	4×4 = 16
	Discipline Specific Elective Practical (DSE 1 Prac. To DSE 4 Prac.)	4×2 = 8
3.	**GENERIC ELECTIVE**	
	Generic Elective (Theory) (4 Papers. GE1 to GE4)	5×4 = 20
	Generic Elective (Tutorial) (4Papers. GE 1 Tut. To GE4 Tut.)	1×4 = 4
4.	**ABILITY ENHANCEMENT COURSES (AEC)**	
	Ability Enhancement Compulsory (2 Papers) Envirnomental Science English/MIL Communication	2×2 = 4
	Ability Enhancement Elective (Skill Based) (2Papers)	2×2 = 4
	TOTAL	**140**

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN

B.Sc. Honours (PHYSICS)

SEM	CORE COURSE (14Papers)	AEC Compulsory Course (AECC) (2 Papers)	AEC Elective Course (SEC) Skill Based (2Papers)	Elective DSE (4 Papers)	Elective Generic (4 Paper)	Total Credits
I	Mathematical Physics-I (4 + 2 = 6 credits) Mechanics (4 + 2 = 6 credits)	Eng./MIL Comm^{n}/Env. Sc. (2 credits)			GE-1 (6 Credits)	**20**
II	Electricity & Magnetism (4 + 2 = 6 credits) Wave & Optics (4 + 2 = 6 credits)	Env.Sc./Eng./MIL Comm^{n} (2 Credits)			GE-2 (6 credits)	20
III	Mathematical Physics-II (4+2= 6 credits) Thermal Physics (4+2=6 credits) Digital Systems and Applications (4+2=6 credits)		SEC-1		GE-3 (6 credits)	26
IV	Mathematical Physics-III (4+2=6 credits) Elements of Modern Physics (4+2=6 credits) Analog Systems & Applications (4+2=6 credits)		SEC-2 (2 credits)		GE-4 (6 credits)	26
V	Quantum Mechanics and Applications (4+2=6 credits) Solid State Physics (4+2= 6 credits)			DSE-1 (6 credits) DSE-2 (6 credits)		24
VI	Electromagnetic Theory (4+2=6 credits) Statistical Mechanics (4+2= 6 credits)			DSE-3 (6 credits) DSE-4 (6 credits)		24
Credits	**84**	**04**	**04**	**24**	**24**	**140**

SEM	COURSE	COURSE NAME	CREDITS
I	Ability Enhancement Compulsory Course-I	Eng./MIL Commns/ Env. Sc.	2
	Core Course-I	Mathematical Physics-I	4
	Core Course-I Practical/Tutorial	Mathematical Physics-I Lab	2
	Core Course-II	Mechanics	4
	Core Course-II Practical/Tutorial	Mechanics Lab	2
	Generic Elective-2	GE-I	4
	Generic Elective-2 Practical/Tutorial	GE-I Lab	2
II	Ability Enhancement Compulsory Course-II	Env. Sc./Eng./MIL Commns	2
	Core Course-III	Electricity and Magnetism	4
	Core Course-III Practical/Tutorial	Electricity and Magnetism Lab	2
	Core Course-IV	Wave and Optics	4
	Core Course-IV Practical/Tutorial	Wave and Optics Lab	2
	Generic Elective-2	GE-2	4
	Generic Elective-2 Practical/Tutorial	GE-2 Lab	2
III-	Core Course-V	Mathematical Physics-II	4
	Core Course-V Practical/ Tutorial	Mathematical Physics-II Lab	2
	Core Course-VI	Thermal Physics	4
	Core Course-VI Practical/ Tutorial	Thermal Physics Lab	2
	Core Course-VII	Digital Systems and Applications	4
	Core Course-VII Practical/ Tutorial	Digital Systems and Applications Lab	2
	Skill Enhancement Course-1	SEC-1	2
	Generic Elective-3	GE-3	4
	Generic Elective-3 Practical/Tutorial	GE-3 Lab	2
IV	Core Course-VIII	Mathematical Physics III	4
	Core Course-VIII Practical/ Tutorial	Mathematical Physics III Lab	2
	Core Course-IX	Elements of Modern Physics	4
	Core Course-IX Practical/ Tutorial	Elements of Modern Physics Lab	2
	Core Course-X	Analog System and Applications	4
	Core Course-X Practical/ Tutorial	Analog System and Applications Lab	2
	Skill Enhancement Course-2	SEC-2	2
	Generic Elective-4	GE-4	4
	Generic Elective-4 Practical/Tutorial	GE-4 Lab	2
V	Core Course-XI	Quantum Mechanics & Applications	4
	Core Course-XI Practical/ Tutorial	Quantum Mechanics Lab	2
	Core Course-XII	Solid State Physics	4
	Core Course-XII Practical/ Tutorial	Solid State Physics Lab	2
	Discipline Specific Elective-1	DSE-1	4
	Discipline Specific Elective-1 Practical/Tutorial	DSE-I Lab	2
	Discipline Specific Elective-2	DSE-2	4
	Discipline Specific Elective-2 Practical/Tutorial	DSE-2 Lab	2
VI	Core Course-XIII		
	Core Course-XIII Practical/ Tutorial		
	Core Course-XIV		
	Core Course-XIV Practical/ Tutorial		
	Discipline Specific Elective-3		
	Discipline Specific Elective-3 Practical/Tutorial		
	Discipline Specific Elective-4		
	Discipline Specific Elective-4 Practical/Tutorial		
Total			140

CORE PAPERS

(Credit: 4+2 = 6 each, Lectures: Theory-60, Practical-60)

(1 period/ week for tutorials or 4 periods/week for Practical)

C1. Mathematical Physics-I

C2. Mechanics

C3. Electricity and Magnetism

C4. Wave and Optics

C5. Mathematical Physics-II

C6. Thermal Physics

C7. Digital System and Applications

C8. Mathemical Physics III

C9. Elements of Modern Physics

C10. Analog Systems and Applications

C11. Quantum Mechanics and Applications

C12. Solid State Physics

C13. Electromagnetic Theory

C14. Statistical Mechanics

DISCIPLINE SPECIFIC ELECTIVE PAPERS

(Credit: 06 each, Lectures: Theory-75, Tutorial-15)

(DSE 1 to DSE 4)

Any four of the following subjects

1. Nuclear and Particle Physics (5) + Tutorials (1)
2. Classical Dynamics (5) + Tutorials (1)
3. Dissertion (6)
4. Experimental Techniques (4) + Lab (2)
5. Astronomy and Astrophysics (5) + Tutorials (1)
6. Earth Science (5) + Tutorials (1)
7. Medical Physics (4) + Lab (2)
8. Biophysics (5) + Tutorials (1)

Note : Dissertation should be a preferable choice as one of the DSE in Semester VI.

GENERIC ELECTIVE

From Other Discipline (Four Papers GE 1 to GE 4, Credits : 6 each)

GE: Mathematics (Theory-5 + Tutorial-1)

Orany one of the following subjects having four papers GE1 to GE 4

1. Chemistry (4) + Lab (2)
2. Economics (5) + Tut (1)
3. Computer Science (4) + Lab (2)

ABILITY ENHANCEMENT ELECTIVE COURSE (AEEC)

(SKILL ENHANCEMENT COURSE-(SEC))

(Credit :02 each) – AEEC 1 to AEEC 2

Any two of the followings

1. Electrical Circuit Network Skills
2. Basic Instrumentation Skillss
3. Renewable Energy and Energy harvesting
4. Radiation Safety

ABILITY ENHANCEMENT COMPULSORY COURSE (AECC)

(Two Papers, Credit: 02 each)

Semster I: English/ MIL Communication[Hindi/Sanskrit/Urdu/Bengali/TRL]

Semster II: Environmental Science

(Note : If English/MIL Communication [Hindi/ Sanskrit/Urdu/Bengali/TRL] is taken in Semster I then Environmental Science in Semster II and vice-versa)

CORE COURSE (HONOURS IN PHYSICS)

SEMSTER I

PHYSICS-C1:MATHEMATICAL PHYSICS-1

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

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

Calculus:

First Order Differential and Integrating Factor. Second Order Differential equations: Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniquenes Theorem for Initial Value Problems. Particular Integralfor typical source terms like polynomials, exponential, sine. cosine etc and their combinations. **(12+3=15 Lectures)**

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

Vector Calculus :

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

Vector Differention : Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Deland Laplacian operators. Vectors 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 Theorem and their applications (no rigorous proofs). Dirac Delta function and its properties. **(14+3=17 Lectures)**

Orthogonal Curvilinear Coordinates:

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. Arlken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
- An introduction to ordinary differential equations. E.A. Coddington, 2009, PHI learing
- 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, Jonesand Bartlett Learing.
- 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. Das.
- Mathematical methods in Physics, E.Butkov.
- Mathematical methods in Physics, Potrer and Goldberg.

PHYSICS LAB-C I LAB

60 LECTURES

The aim of this Lab is not just to teach 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 consists 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 Windows.*

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory and input/output devices
Basics of scientific computing	Binary and decimal arithemetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, singleand double precision arithmetic, underflow & overflowemphasizethe importance of making equations in termsof dimensionless variables, Iterative methods.
Errors and errors Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computation.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If-statement, If-else statement, Nested if Structure, Else-if Statement, Ternary Operator, Goto Statement, Switch Statement, Unconditional and Conditional Looping, While Loop, Do-While loop, FORLoop, Break and Continue Statements, Nested Loops*), Arrays (1*D* & 2*D*) 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, volume of π.
Solution of Algebraic and Transcendental equations by Bisection, Newton Raphsonand Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan\alpha$; $I=Io[(\sin\alpha)/\alpha]^2$ in optics
Interpolation by Newton Gregory Forward and Backward difference formula, Errorstimation.	Evaluation of trigonometric functions e.g. $\sin\theta, \cos\theta, \tan\theta$, etc.

Also attempt some problems on differential equations like:

1. **Solve the coupled first order differential equations**

   $$\frac{dx}{dt} = y + x - \frac{x^3}{3}$$

   $$\frac{dy}{dx} = -x$$

   For four initial conditions $x(0)$, $y(0)$ = -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** $\vartheta'' = -\sin\theta$

   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 $\vartheta(\sin\vartheta \approx \vartheta)$.

3. **Solve the differential equation:**

   $$x^2\frac{d^2y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^2$$

   With the boundary condition at x =1, $y = \left(\frac{1}{2}\right)e^2$, $\frac{dy}{dx} = -\left(\frac{3}{2}\right)e^2 - 0.5$. in the range $1 \le x \le 3$.

   Plot y and $\frac{dy}{dx}$ against x in the given range. Both should appear on the same graph.

Referred Books :

- Introduction to Numerical Analysis. S.S. Sastry, 5th Edn. 2012, PHI Learing Pvt. Ltd.
- Schaum's Outline of Programming with C++ J. Hubb ard, 2000, McGrawHill 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 Learing.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. 2007, 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 – C II: MECHANICS

(Credits : Theory-04, Practical-02)
Theory : 60 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. **Searle's Method**, Twisting torque on a Cylinder or Wire and twisting couple. **(5 + 2 = 7 Lectures)**

Flexure of beam : Bending of beam, Cantilever. **(5-Lectures)**

Surface Tension : Ripples and Gravity waves, Determination of Surface Tension by Jaeger's and Quinke's methods. Temperature dependence 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. **(4-Lectures)**

Central Force Motion : Motion of a particle under a central force field. Two-body problem and its reduction toone-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 transformation; Galilean invariance. Michelson-Morley Experiment and its outcomes. 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 Particle. Mass-energy equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and momentum. Energy-Momentum Minkowski space and Four Vector. **(12-Lectures)**

Reference Books :

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow.1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.I,C.Kiltel, W. Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e, 2008, Willey.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learing.
- Feynman Lectures, Vol.-I, R.P. Feynman, R.B. Leighton, M. Sands. 2008, Pearson Education.
- Introduction to Special Relatively, R. Resnick, 2005, John Wiley and Sons.

- University Physcics. Ronald lane Reese. 2003. Thomson Brooks/Cole.

Additional Books for Reference

- Mechanics, D.S. Mathur, S. Chand & 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 Physics. J.W. Jewett. R.A. Serway 2010. Cengage Learing.
- Theoretical Mechanics, M.R. Spiegel, 2006. Tata McGraw Hill.
- A textbook of General Physics. Edser.
- Fluid mechanics, Kaufmann.
- A treatise of hydromechanics. Basant & Ramsay.
- Oscillations and waves. Satya Prakash.
- A textbook of oscillation. waves and Acoustics. M. Ghosh and D. Bhattacharya.

PHYSICS LAB-C II LAB

60-Lectures

1. Measurements of length (or diameter) using verniercaliper, screw gauge and Travelling Microscope.
2. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method)
3. To determine the Modulus of Rigidity of a bar by method of bending.
4. To determine the elastic Constants of a wire by Searle's method.
5. To determine the value of g using Bar Pendulum.
6. 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. Reprint 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Edn. 2011, Kitab Mahal.

SEMSTER II
PHYSICS-C III: ELECTRICITY AND MAGNETISM

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

Electricity Field and Electrical 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's law in dielectrics. **(8-Lectures)**

Magentic Field: Magentic force between current elements and definition of Magnetic Field **B**. Biot-Savart 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) onecurrent 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**).Magentic Suscepltibility and permeability. Relation between **B,H,M.** Ferromagnetism. B-H curve and Hysteresis. **(4-Lectures)**

Electromagentic Induction: Recapitulation of Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Superposition Theorem. Reciprocity Therem. 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. **(7-Lectures)**

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

Reference Books :

- Electricity, D.C. Tayal.
- Electricity, Magentism & Electromagnetic Theory. S. Mahajan and Choudhury, 2012 Tata McGraw.
- Electricity and Magentism. 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. Tiwary.

PHYSICS LAB-C III 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 compare capacitances using De'Sauty's bridge.
4. To determine self inductance of a coil by Anderson's bridge.
5. To study response curve of a Series LCR circuit and dermine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
6. To study the response curve of a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q.
7. Measurement of charge and circuit sensitivity and CDR of 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 Manual of Physics for undergraduate classes, D.P. Khandewal, 1985, Vani Pub.

PHYSICS-C IV: WAVES AND OPTICS

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

Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Prograssive (Travelling) Waves. Waves Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transfort. 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)**

Waves 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. Lioyd's Mirror and Fresnel's Biprism. Phase change on reflection. Stokes' treatement. 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)**

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 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

- Waves and Acoustics, P.K. Chakraborty and Satyabrata Chowdhury.
- Introduction to Geometrical and Physical Optics, B.K. Mathur.
- Optics, Singh and Agarwal.
- Geometrical and Phyical Optics, P.K. Chakraborty.
- Waves: Berkeley Physics Course, vol.3, Francis Crawford, 2007, Tat 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 Vibrations and Waves, H.J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw-Hill.

PHYSICS LAB-C IV 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 merc.
4. To determine wavelength of sodium light using Newton's Rings.
5. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
6. 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 Edn., 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.

SEMSTER III
PHYSICS-C V : MATHEMATICAL PHYSICS-II

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

The examples 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. **(14-Lectures)**

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential equations and their importance. Forbenius 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 functions, simple recurrence relations. Zeros of Bessel Functions and Orthogonality. **(28-Lectures)**

Some Special Integrals: Beta and Gamma Functions and Relations between them. Expression of Integrals in terms of Gamma Functions. **(4-Lectures)**

Partial Differential Equation: 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 strings. **(14-Lectures)**

Refernce Books:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elseveier.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Mathematics for Physicists. 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, Viv.Books.
- Mathematical Physics, B.D. Gupta.
- Mathematical Physics, B.S. Rajput.
- Mathematical Physics, H.K. Das.
- Mathematical methods in Physics. E. Butkov.
- Mathematical methods in Physics, Potter and Goldberg.

PHYSICS LAB-CV LAB

60 Lectures

The aim of this Lab is to use the computational methods to solve physical problems. Course will consists of lectures (both theory and practical) in the Lab. Evaluation donenot on the programming but on the basis of formulating the problem.

Topics	Description with Applications
Introduction to Numerical computation software Scilab	Introducthion to Scilab. Advantages and disadvantages. Scilab environment. Command window, Figure Window. Edit Window. Variables and arrays. Initial Single Variables in Scilab. Multidimensional arrays. Subarray Special Values. Displaying output data. data file. Scalarand 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 & vectorization. Userdefined 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 fileopening and closing. Binary I/o functions. compairing 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 equation by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigenvectors, eigen values problems.	Solution of mesh equations of electrical circuits (3 meshes) Solution of coupled spring mass system (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. Shanaban, 1940 Jones & Bartlett.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernandez,2014 Springer.
- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444.
- Scilab (A free softaware to Matlab): H.Ramchandran, A.S. Nair 2011 S.Chand & Company.
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing.

PHYSICS-C VI : THERMAL PHYSICS

(Credits: Theory-04, Practicals-02)
Theory : 60 Lectures
(Include related problems for each topic)

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 Theprem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. **(10-Lectures)**

Entropy: Concept of Entropy. 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 Potential: 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 Equipartion 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: Behaviour of Real Gases: Deviation 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 Exapansion of a Perfect Gas. Joule-Thomson Porous

Plug Exaperiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling. **(10-Lectures)**

Reference Books:

- Heat and Thermodynamics. M.W. Zemansky, Richard Dittman, 1981. McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastva. 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 LAB-C VI LAB

60 Lectures

1. To determine the Coefficient of Thermal Conductivity of Cu Searle's Apparatus.
2. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee's disc method.
3. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
4. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
5. 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 Edn. 2011, Kitab Mahal.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Laboratory Mannual of Physics for undergraduate classes. D.P. Khandelwal, 1985. Vani Pub.

PHYSICS-C VII: DIGITAL SYSTEMS AND APPLICATIONS

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

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

Data Processing Circuits: Basic idea of Multiplexers, De-multiplexers. Decorders, Encoders. **(6-Lectures)**

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

Sequential Ciruits: 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: Astablemultivibrator and Monostablemultivibrator. **(6-Lectures)**

Shift Registers: Serial-in-Serial-out, Serial-in-Parallel-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 Principles and Applications, A.P. Malvino, D.P. Leach and Saha, 7th Edn., 2011, Tata McGraw.
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn., 2009, PHI Learing Pvt. Ltd.
- Digital Circuits and Systems, Venugopal, 2011, Tata McGraw-Hill.
- Digital Systems: Principles & Applications, R.J. Tocci, N.S. Widmer, 2001, PHI Learing.
- Logic circuits design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- 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 PRACTICAL-C VII 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 bluid Flip-Flop (RS, Clocked RS, D-Type and JK) circuits using NAND gates.
11. To design an astablemultivibrator of given specifications using 555 Timer.
12. To design a monostablemultivibrator of given specifications using 555 Times.

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, McGraw-Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085: Architecture, Programming and interfacing. A. Wadhwa, 2010, PHI Learing.

SEMSTER IV
PHYSICS-VIII: MATHEMATICAL PHYSICS-III

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

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. Cauchy's Inequality. Caucchy's Integral formula. Simply and multiply connected region. Laurentand Taylor's expansion. Residues and Residue Theorem. **(30-Lectures)**

Integral Transformations:
Fourier Transformations: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representations of Dirac Delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier Transform. Properties of Fourier Transforms with examples. Application of Fourier Transform to differential equations: One dimensional Wave and Diffusion/ Heat Flow Equations. **(15-Lectures)**

Laplace Transformations: 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 Edn., 2006, Cambridge University Press.
- Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications.
- Complex variables, A.S. Fokas & M.J. Ablowitz, 8th Edn., 2011, Cambridge Univ. Press.
- Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Edn., 2003, Tata McGraw-Hill.
- First Course in complex analysis with applications, D.G. Zill and P.D. Shanahaa, 1940. Jones & Bartlett.
- Mathematics Physics, B.D. Gupta.
- Mathematical Physics, B.S. Rajput.
- Mathematical Physics, H.K. Das.
- Mathematical methods in Physics, E. Butkov.
- Mathematical methods in Physics, Potter and Goldberg.

PHYSICS PRACTICAL-C VIII LAB

60 Lectures

Scilab based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:

   $\frac{dy}{dx} = e^{-x}$ with y = 0 for x = 0

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

   $\frac{d^2y}{dx^2} + 2\frac{dy}{dx} = -y$

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

2. Dirac Delta Function:

   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}}\int e^{\frac{-(x-2)^2}{2\sigma^2}}(x+3)dx$, for $\sigma = 1, 0.1, 0.01$ and show ittends to 5.

3. Fourier Series: Program to sum $\sum_{n=1}^{\infty}(0.2)^n$
   Evaluate the Fourier coefficients of a given periodic function (square wave).

4. Frobenius methods and Special functions:

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

   Plot $P_n(x)$, $j_v(x)$

   Show recursion relation.

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

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

7. Evaluation of trigonometric functions e.g., sinθ, given Bessel's function at Npoints find its value at an intermediate point. Complex analysis: Integral $\frac{1}{(x^2+2)}$ numerically and check with computer integration.

8. Integral Transform: FET of e^{-x^2}.

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F. Riley, M.P. Hobson and S.J. Bence, 3rd Edn. 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. Fernandez. 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-C IX: ELEMENTS OF MODERN PHYSICS

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

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; Estimation 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 eigen functions, 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:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Quantum mechanics, Nikhil Ranjan Roy, 2016, Vikash Publishing House Pvt. Ltd.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw-Hill.
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Physics for scientists and Engineers with Modern Physics, Jewett an Serway, 2010, Cengage Learing.
- Quantum Mechanics: Theory & Applications, A.K. Ghatak & S.I. Lokanathan, 2004, Macmillan.

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learing.
- 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 PRACTICAL-CIX 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 show the tunnelling effect in tunnel diode using I-V characteristics.
4. To determine the wavelength of laser source using diffraction of single slit.
5. To determine the wavelength of laser source using diffraction of double slits.
6. To determine (1) wavelength and (2) angular spread of He-Ne laser using planed diffraction grating.

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practical, 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-C X: ANALOG SYSTEMS AND APPLICATIONS

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

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-taped and Bridge Full-Wave Rectifiers. Calculation of Ripple Factor and Rectification Efficiency, (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LED's, (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. Load Line Analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff 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 and C Amplifiers. **(10-Lectures)**

Coupled Amplifier: RC-Copupled 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:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata McGraw-Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronics Devices, B.G. Streetman & S.K. Banerjee, 6th Edn., 2009, PHI Learing.
- Electronic Devices & circuits, S.Salivahanan & N.S. Kumar, 3rd Edn., 2012, Tata McGraw-Hill.

- Op-Amps and Linear Integrated Circuits. R.A. Gayakwad. 4th edition. 2000. Prentice Hall.
- Electronic circuits: Handbook of design & applications, U. Tietze. C.Schenk, 2008. Springer.
- Semiconductor Devices, 7/e Thomas L.Floyd. 2008. Pearson India.
- A first course in Electronics. Khan and Dey. PHI.
- Basic Electronics, Arun Kumar.
- Microelectronics. Millman and Grabel.

PHYSICS PRACTICAL-C X 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 Differntiator.

Reference Books:

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

SEMSTER V
PHSYICS-C XI: QUANTUM MECHANICS AND APPLICATIONS

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

Time dependent Schrodinger equation: Postulates of Qauntum Mechanics. Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Waves Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigen values and Eigen functions. 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 eigenfunctions using Frobenius method: Hermite polynomials; ground state, zero point energy & uncertainty principle. **(14-Lectures)**

Atoms in Electric & Magentic 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. Gyromagentic Ratio and Bohr Magneton. Normal and Anomalous Zeeman Effect. **(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. **(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 Edn., 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.Aruldhans, 2nd Edn., 2002, PHI Learing of India.
- Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Barlett Learing.
- 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 Edn., 2005, Pearson Education.
- Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer.

PHYSICS PRACTICAL-C XI LAB

60 Lectures

Use 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:

$$\frac{d^2y}{dr^2} = A(r)u(r) \quad \frac{d^2y}{dr^2} = A(r)u(r) \quad \text{where} \quad V(r) = -\frac{e^2}{r}$$

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 $\approx -13.6eV$. Take $e = 3.795(eV\text{Å})^{1/2}$, $\hbar c = 1973(eV\text{Å})$ and $m = 0.51\times10^6 eV/c^2$.

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

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

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 $V(r) = -e^2/rx\left(e^{-r/a}\right))$

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 $e = 3.795(eV\text{Å})^{1/2}$, $m = 0.511\times10^6 eV/c^2$, and $a = 3\text{Å}, 5\text{Å}, 7\text{Å}$. In these units $\hbar c = 1973(eV\text{Å})$. The ground state energy is expected to be above $-12eV$ in all three cases.

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

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

For the an harmonic oscillator potential $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$ for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Chose $m = 940\,MeV/c^2$, $k = 100\,MeV\,fm^{-2}$, b = 0, 10, 30 MeV fm-3. In these units, $c\hbar = 197.3\,MeV\,fm$. 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:

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

Where μ is the reduced mass of the two –atom system for the Morse Potential.

$(r) = D\left(e^{-2ar'} - e^{-ar'}\right)$, $r' = \frac{(r - r_0)}{r}$

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

Take: $m = 941 \times 10^6 eV / C^2$, D=0.755501 eV, α = 1.44, $r_0 = 0.131349$Å

Laboratory based experiments:

1. Study of Electron Spin resonance-determine magnetic field as a function as the resonance frequency.
2. Study of Zeeman effect: with external magnetic field; Hyperfine splitting.
3. To show the Tunneling effect in tunnel diode using I-V characteristics.
4. 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 VandeWouwer, P. Saucez, C.V. Fernandez.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-C XII: SOLID STATE PHYSICS

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

Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Unit Cell. Miller Indices. Reciprocal Lattice. Type of Lattices. Briliouin Zones. Diffrcation 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 Paramegnetism. 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 of Solids State Physics, Charles Kittel, 8th Edn., 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 2nd Edn., 2016, Prentice-Hall of India.
- Introduction to Solids. Leonid V. Axaroff, 2004, Tata McGraw-Hill.
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning.
- Solid State Physics. H. Ibatch 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.
- Introduction to Solid State Physics, Arun Kumar.
- Solid State Physics, J.P. Shrivastava.
- Solid State Physics, Mahan and Mahto.

PHYSICS PRACTICAL- C XII LAB

60 Lectures

1. Measurement of susceptibility of paramagnetic solution (Quinck's Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. Verificatin 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 BII curve of Fe using Solenoid & determine energy loss from Hysteresis.
7. To measure the resistivity of a semiconductor (Ge) with termperature by four-probe method (room temperature to 150°C) 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 Edn., reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Edn., 2011, Kitab Mahal.
- Elements of Solid State Physics, J.P.Srivastava, 2nd Edn., 2006, Prentice-Hall of India.

SEMSTER VI
PHYSICS-XIII: ELECTROMAGENTIC THEORY

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

Maxwell Equations: Review of Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary condition at Interference 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 interference between two media. Reflection & Refraction of plane waves at plane interference 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 Electromagentic 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 Agrarwal.
- Electromagnetics, B.B. Laud.
- Electromagentic Theory, Satya Prakash.
- Electromagnetic Theory, Gupta and Kumar.
- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Elements of Electromagnetic, M.N.O.Sadiku, 2001, Oxford University Press.
- Introduction to Electromagentic Theory, T.L. Chow, 2006, Jones & Bartlet Learning.

- Fundamentals of Electromagentics, M.A.W. Miah. 1982. Tata McGraw-Hill.
- Electromagentic field Theory, R.S. Kshetrimayun, 2012, Cengage Learing.
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner. 2010, Springer.

Additional Books for Reference

- Electromagnetic Fields & Waves, P.Lorrain & D. Corson, W.H. Freeman & Co.
- Electromagnetics, J.A.Edminster, Shaum Series, 2006, Tata McGraw-Hill.
- Electromagnetic Field Theory Fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press.

PHYSICS PRACTICAL-C XIII LAB

60Lectures

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 glass interface.
5. To study the polarization of light by reflection and determine the polarizing angle of 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 Edn., 2011, Kitab Mahal.
- Electromagentic Field Theory for Engineers &Physicists, G. Lehner, 2010. Springer.

PHYSICS-C XIV: STATISTICAL MECHANICS

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

Classical Statistics: Macrostate & Microstate, Elementary Concept of Ensemble, Phase Spce, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sacur 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. Kirchoff's Law. Stefan-Boltzmann Law: Thermodynamic proof. Radiation Pressure. Wien's Displacement Law. Wien's Distribution Law. Rayleigh-Jean's Law. **(9-Lectures)**

Qauntum 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) Rayleight-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 Degenrate Bose Gas, Bose Einstein condensation, properties of liquid He (qualitative description). Radiation as a photon gas and Thermodynamic functions of phonon 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 Edn., 1996, Oxford University Press.
- Statistical Physics, Berkeley Physics Cource, 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. Haung.

PHYSICS PRACTICAL-C XIV LAB

60 Lectures

Use 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 Rayleigh-Jeans Law at high temperature (room temperature) and low temperature.
2. Plot Specific Heat of Solids by comparing (a) Dulong-Petit law, (b) Einsstein 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 distribuithion function versus temperature.
4. Plot Fermi-Dirac distribution function versus temperature.
5. Plot Bose-Einstein distribution function versus temperature.

Reference Books:

- Elementary Numberical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.
- Statistical mechanics, R.K. Pathria, Butterworth Heinemann:2nd Edn., 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. Fernandez ISBN:978-3319067896.
- Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444.
- Scilab Image Processing: L.M. Surhone, 2010, Betascript Pub., ISBN : 978-6133459274.

DISCIPLINE SPECIFIC ELECTIVE

PHYSICS-DSE 1:NUCLEAR AND PARTICLE PHYSICS

(Credits: Theory-05, Tutorials-01)

Theory:75 Lectures

General Properties of Nuclei: Constituents of nucleus and their intrinsic properthies. 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, electrical moments, nuclear exictes 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)**

Radiactive decay: (a) Alpha decay: basics of α-decay processes. Theory of α-emission. Gammow factor, Geiger Nutall Law, α-decay spectroscopy. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture. Neutrino hypothehis. (c) Gamma decay: Gamma rays emission & kimatics, internal conversion. **(12-Lectures)**

Nuclear Reactions: Type 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 (Bether-Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter. Photoelectric effect, Compton scattering, pair production, neutrino 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 Scintilation 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. Symmetric 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).
- Conceopts 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. Griffiths, John Wiley & Sons.
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.
- Basic Ideas and concepts in Nuclear Physics-An Indtroductory Approach by K. Hevde (IOP- Institute of Physics Publishing, 2004).
- Radiation detection and Measurement, G.F. Knoll (John Wile, & Sons. 2000).
- Physics and Engineering of Radiation Detection, Sayed Naeem Ahmed (Academic Press, Elsevier, 2007).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub. Inc., 1991).

PHYSICS-DSE2: CLASSICAL DYNAMICS

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

The emphasis of the course is an applications in solving problems of intersect 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. Cannonical 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 Transformation. 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 charges particle & Maxwell's equations in tensor form. Motion of charges particles in external electric and magnetic fields. **(38-Lectures)**

Electromagnetic radiation: Review of retarted 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:

- Introduction to Classical mechanics, Nikhil Ranjan Roy, 2016, Vikash Publishing House, Pvt. Ltd.
- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safro, 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.

PHYSICS-DSE3: DISSERTATION

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

PHSYICS-DSE 4: EXPERIMENTAL TECHNIQUES

(Credits: Theory-04, Practicals-02)

Theory: 60 Lectures

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, efficieny, 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 electric 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 systems- 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 Learing Pvt. Ltd.
- Experimental Methods for Engineers, J.P. Holman, McGraw-Hill.
- Introduction to Measurements and Instrumentation, A.K. Ghosh, 3rd Edition. PHI Learing Pvt. Ltd.
- Transducers and Instrumentation, D.V.S. Murty, 2nd Edn., 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 Learing Pvt. Ltd.
- Electronic circuits: Handbook of design & applications. U. Tietze. Ch. Schenk, Springer.

PRACTICAL-DSE-4 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 mnV 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.
11. To measure Q of a coil and influence of frequency, suing a Q-meter.

Reference Books:

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

PHYSICS-DSE5: EARTH SCIENCE

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

1.The Earth And The Universe:

a. Origin of universe. creation of elements and earth. A Holistic understanding of our dynamic planet through Astronomy. Geology. Meteorology and Oceanography. Introduction to various branches of Earth Sciences.
b. General characteristics and origin of the Universe. The Milky Way galaxy. solar system, Earth's orbit and spin. the Moon's orbit and spin. The terrestrial and Jovian Planets. Meteorites & Asteroids. Earth in the Solar system. origin , size. shape. mass. density, rotational and revolution parameters and its age.
c. Energy and particle fluxes incident on the Earth.
d. The Cosmic Microwave Background. **(17-Lectures)**

2.Structure:

a. The Solid Earth: Mass. dimensions. shape and topography. internal structure. magnetic field,geometrical energy. How do we learn about Earth's inerior?
b. The Hydrosphere: The osceans. their extent. depth. volume. chemical composition. River systems.
c. The Atomsphere: variation of temperature, density and composition with altitude. clouds.
d. The Cryosphere: Polar caps and ice sheets. Mountain glaciers.
e. The Biosphere: Plants and animals. Chemical composition, mass. Marine and land organisms. **(18-Lectures)**

3.Dynamical Processes:

a. The Solid Earth: Origin of the magnetic field. Source of geothermal energy. Convention in Earth's core and production of its magnetic field. Mechanical layering of the Earth. Introduction to geophysical methods of earth investigations. Concept of plate tectonics: sea-floor spreading and continental drift. Geodynamic elements of Earth: Mid Oceanic Ridges, trenches transform faults and island arcs. Origin of oceans, continents, mountains and drift valleys. Earthquake and earthquake belts. Volcanoes: types, products and distribution.
b. The Hydrosphere: Ocean circulations. Oceanic current system and effect of coriolis forces. Concepts of eustasy, tend - air-sea interaction: wave erosion and beach processes. Tides, Tsunamis.
c. The Atmosphere: Atmospheric circulation. Weather and climate changes. Cyclones.
d. Climate:
    i.Earth's temperature and green house effect.
    ii. Paleoclimate and recent climate changes.
    iii. The Indian mansoon system.
e. Biosphere: Water cycle. Carbon cycle. Nitrogen cycle, Phosphorous cycle. The role of cycles in maintaining a steady state. **(18-Lectures)**

4.Evolution:

Nature of stratigraphic records, Standard stratigraphic time scale and introduction to the concept of time in geological studies. Introduction to geochronological methods in their application in geological studies. History of development in concepts of uniformnitarianism, catastrophism and neptunism. Law of superposition and faunal succession. Introduction to the geology and geomorphology of Indian subcontinent.

a. Time line of major geological and biological events.
b. Origin of life on Earth.
c. Role of the biosphere in shaping the environment.
d. Future of evoluthion of the Earth and solar system: Death of the Earth. **(18-Lectures)**

5. Disturbing The Earth – Contemporary Dilemmas

a. Human population growth.
b. Atmosphere: Green house gas emissions, climate change, air pollution.
c. Hydrosphere: Fresh water depletion.
d. Geosphere: Chemical effluents, nuclear waste.
e. Biosphere: Biodiversity loss.
Deforestation. Robustness and fragility of ecosystems. **(4-Lectures)**

Reference Books:

- Planetary Surface Processes, H.Jay Melosh, Cambridge University Press, 2011.
- Consider a Spherical Cow: A course in environmental problem solving, John Harte. University Science Books.
- Holme's Principles of Physical Geology, 1992, Chapman & Hall.
- Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of Life and Environment. Cambridge University Press.

PHYSICS-DSE6: MEDICAL PHYSICS

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

Physics of The Body-I

Mechanics of the Body: Skelton, forces, and body stability. Muscles and the dynamics of body movement, Physics of body crashing.

Energy household of the body: Energy balance in the body. Energy consumption of the body. Heat losses of the body.

Pressure system of the body: Physics of breathing, Physics of cardiovascular system.

(10-Lectures)

Physics of The Body-II

Acoustics of the body: Nature and characteristics of sound. Production of speech. Physics of the ear. Diagnostics with sound and ultrasound.

Optical system of the body: Physics of the eye.

Electrical system of the body: Physics of the nervous system. Electrical signals and information transfer. **(10-Lectures)**

Physics of Diagnostic and Therapeutic Systems-I

X-rays: Electromagnetic spectrum. production of x-rays. x-ray spectra-Brehmsstrahlung. Chracteristic x-ray. X-ray tubes. Coolidge tube. x-ray tube design. tube cooling stationary mode. Rotating anode x-ray tube. Tube rating, quality and intensity of x-ray. X-ray generator circuits, half wave and full wave rectication. filament circuit, kilo voltage circuit, high frequency generator.

(7-Lectures)

Radiation Physics: Radiation units, exposure, absorbed dose, effective dose, inverse square law, interaction of radiation with matter. linear attenuation coefficient. Radiation Detectors, Geiger counter, Scintillation counter, ionization chamber, semiconductor detectors. **(7-Lectures)**

Medical Imaging Physics: X-ray diagnostics and imaging, Physics of nuclear magnetic resonance (NMR), NMR imaging, MRI Radiological imaging, X-ray film, film processing, fluoroscopy, computed tomography scanner, principle function, display, generations, mammography, Ultrasound imaging, magnetic resonance imaging, thyroid uptake system. Gamma camera(Only Principle, function and display). **(9-Lectures)**

Radiation Therapy Physics: Radiotherapy, kilo voltage machine, deep therapy machines, Telecobalt machines, Telecobalt units, Medical linear accelerator. Basics of Teletherapy units, deep x-ray, Radiation Protection, external beam characteristics, phantom, dose maximum and build up bolts, percentage depth dose, back scatter factor. **(6-Lectures)**

Radiation and Radiation Protection: Principles of radiation protection, protective materials-radiation effects, somatic, genetic stochastic & deterministic effect, Personal monitoring devices, TLD film badge, pocket domister. Radiation dosimetry. Natural radioactivity, Biological effects of radiation. **(6-Lectures)**

Physics of Diagnostic and Therapeutic Systems-II

Diagnostic nuclear medicine: Radiopharmaceuticals for radioisotope imaging, Radioisotope imaging equipment, Single photon and positron emission tomography.

Therapeutic nuclear medicine: Interaction between radiation and matter. Dose and disodose in radiation treatement. **(5-Lectures)**

Reference Books:

- Medical Physics, J.R. Cameron and J.G. Skofronick, Wiley (1978).
- Basic Radiological Physics Dr. K. Thayalan – Jayapee Brothers Medical Publishing Pvt. Ltd. New Delhi (2003).
- Christensen's Physics of Diagnostic Radiology: Cury, Dowdey and Murry – Lippincot Williams and Wilkins (1990).
- Physics of the Human body, Irving P. Herman, Springer (2007).
- Physics of Radiation Therapy: F.M. Khan – Williams and Wilkins, 3rd edition (2003).
- The essential physics of Medical Imagine: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edn. (2002).
- The Physics of Radiology-H E Johns and Cunningham.

PHYSICS-DSE 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 sightdness) 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: Cury, 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 Imagine: Bushberg, Seibert, Leidholdt and Boone Lippincot Williams and Wilkins, Second Edn. (2002).
- The Physics of Radiology-H E Johns and Cunningham.

PHYSICS-DSE7: BIO-PHYSICS

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

Building Blocks & Structure of Living State: Atoms and ions. molecules essential for life, what is life.
Living state interactions: Forces and molecular bonds. electric & thermal interactions, electrical dipoles, casimir interactions, domains of physics in biology. **(18-Lectures)**

Heat Transfer in biomaterials: Heat transfer mechanism. The Heat equation. Joule heating of tissue.
Living State Thermodynamics: Thermodynamic equilibrium. first law of thermodynamics and conservation of energy. Entropy and second law of thermodynamics. Physics of many particle system. Two state systems. continuous energy distribution. Composite systems. Casimir contribution of free energy. Protein folding and unfolding. **(19-Lectures)**

Open system and chemical thermodynamics: Enthalpy. Gibbs Free energy and chemical potential, activation energy and rate constants, enzymatic reactions. ATP hydrolysis & synthesis. Entropy of mixing. The grand canonical ensemble. Haemoglobin.**Diffusion and transport** Maxwell-Boltzmann statistics, Planck's law of diffusion, sedimentation of Cell Cultures, diffusion in a centrifuge, diffusion in an electric field, Lateral diffusion in membranes, Navier stokes equation, Low Reynold's Number Transport, Active and passive membrane transport.
(19-Lectures)

Fluids: Laminar and turbulent fluid flow,Bernoulli's equation, equation of continuity, venture effect, Fluid dynamics of circulatory systems, capillary action.
Bioenergetics and Molecular motors: Kinesins, Dyneins and microtubule dynamics, Brownian motion, ATP synthesis in Mitochondria, Photosynthesis in Chloroplasts, Light absorption in biomolecules, vibrational spectra of bio-biomolecules. **(19-Lectures)**

Reference Books:

- Introductory Biophysics, J. Claycomb, JQP Tran, Jones & Bartelett Publishers
- Aspects of Biophysics, Hughe S W, John Willy and Sons.
- Essentials of Biophysics by P Narayanan, New Age International.

PHYSICS-DSE8: ASTRONOMY & ASTROPHYSICS

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

Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature.**Basic concepts of positional astronomy:** Celestial Sphere, Geometry of s Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates, Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, equation of Time, Calendar, Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star; Determination of Masses from Binary orbits: Stellar Spectral Classification, Hertzsprung-Russell Diagram. **(22-Lectures)**

Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).
Physical principles: Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium, Theory of Radiative Transfer (Radiation Field, Radiative Transfer equation), Optical Depth; Solution of Radiative Transfer Equation, Local Thermodynamic Equilibrium. **(6-Lectures)**

The Sun:(Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere, Corona, Solar Activity, Basics of Solar Magnetohydrodynamics, Helioscismology). **The Solar family**(Solar System,: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.**Stellar spectra and classification Structure** (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approcimathion, H R Diagram, Luminosity Classification). **(7-Lectures)**

Stellar Structure: Hydrostatic equilibrium of a Star, Virial Theorem, Sources of Stellar Energy, Modes of Energy Transport, Simple Stellar Model, Polytropic Stellar Model. **Star formation:** Basic composition of Interstelar medium, Interstellar Gas, Interstellar Dust. Formation of Protostar, Jeans criterion, Fragmentation of collapsing clouds, From protostar to Pre-Main Sequence, Hayashi Line. **(8-Lectures)**

Nucleosynthesis and stellar evolution: Cosmic Abundances, Stellar Nucleosynthesis, Evolution of Stars. **Compact Stars:** Basic Familiarity with Compact stars, Equation of State and Degenerate gas of Fermions, Theory of White Dwarf, Chandrasekhar Limit, Gravitational Red-Shift of Neutron Star, Detection of Neutron Star: Pulsars, Black Hole. **The milky way:** Basic Structure and Properties of the Milky way. Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus.
(11-Lectures)

Galaxies: Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Balo) The Milkly Way Galaxy, Gas and Dust in the Galaxy, Spiral Arms. **(5-Lectures)**

Active Galaxies: Activities of Active Galaxies, Classiefication of the Active Galaxies. Behaviour of Active Galaxies – Quasars and Radio Galaxies. The Nature of the Central engine, Unified Model of the Various Active Galaxies. **(8-Lectures)**

Large scale structure & expanding universe: Hubble's Law (Distance-Velocity Relation), Clusters of Galaxies (Virial Theorem and Dark Matter), Friedmann Equation and its solutions, early Universe and Nucleosynthesis (Cosmic Background Radiation, evolving vs. Steady State Universe) **(8-Lectures)**

Reference Books:

- Modern Astrophysics, B.W. Carroll & D.A. Ostilie, Addison-Wesley Publishing Co.
- Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edn., Saunders College Publishing.
- The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
- Fundamentals of Astronomy (Fourth Edition), H. Kartteunen et al. Springer.
- K.S. Krishnasamy, ' Astro Physics a modern perspective.' Reprint, New AgeInternational (P) Ltd.,New Delhi, 2002,
- Baidyanath Basu, ' An introduction to Astro physics', Second printing, Prentice-hall of India Private Limited, New Delhi, 2001.
- Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

SKILL ENHANCEMENT COURCES

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, voltemeter and ammeter. **(4-Lectures)**

Understanding Electrcal Ciruits: Main Electrical circuits 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. Bround-fault protection. Grounding and isolating. Phase reversal. Sugre 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 conncetion. 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 Techonology – B L Theraja-S.Chand & Co.
- A text book of Electrical Technology – A K Theraja.
- Performance and design of A 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 Measurements: 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 as millivoltmeter specifications and their significance. **(4-Lectures)**

Cathode Ray Oscilliscope: Block diagram of basic CRO Construction of CRT. Electron gun, electrostatic focusing and acceleration (Explanation only –no mathematical treatement), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specificatins 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 Intruments: 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 a 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 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.
5. Study the layout of receiver circuit.
6. Trouble shooting a circuit.
7. Balancig of bridges.

Laboratory Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across alow 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.
5. 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 & Co.
- Performance and design of AC machines, M G Say ELBS Edn.
- Digital Circuits and systems, Venugoapl, 2011, Tata McGraw-Hill.
- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learing.
- Electronic Devices and circuits, S. Salivahanan & N.S. Kumar, 3rd Edn., 2012, Tata McGraw-Hill.
- Electronic circuits, Handbook of design and applications, U.Tietze, Ch. Schenk, 2008, Spinger.
- 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 in the students but to Provide them with exposure and hand-on learing wherever possible.

Fossil fuels and Alternate Sources of energy: Fossil fueld and Nuclear Energy. their limitation, nced 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, biomas, 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 tracting 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 modelling 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. Agrwal-S.Chand& 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 Assement 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.

Basic of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristics 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 – Beta-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles-Collisions 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 Geiger Muller Counter), Sclintillation Detectors (Inorganic and Organic Scintillators), Solid State Detectors and Neutron Detectors, Thermoluninescent 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:

1. Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
2. Study the counting statistics using background radiation using GM counter.
3. Study of radiation in various materials (e., KSO_4 etc.).Investigation of possible radiation in different routine materials by operating GM at operating voltage.
4. Study of absorption of beta particles in Aluminum using GM counter.
5. Detection of α particles using reference source & determining its half life using spark counter.
6. Gamma spectrum of Gas Light mantle (Source of Thorium).

Reference Books:

- W.E. Burchan and M. Jobes- Nuclear and Particles Physics-Longman (1995).
- G.F. Knoll, Radiation detection and measurements.
- Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adan 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 Handbook Series, No. 6, Adam Hilger Ltd., Bristol 1981.
- Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowentaland P.L. Airey, Cambridge University Press, U.K., 2011.
- NCRP, ICRP, ICRU, IAEA, AERB Publications.
- W.R. Hendee, "Medical Radiation Physics", Year Book – Medical Publishers Inc. London, 1981.

SEC-5

APPLIED OPTICS (Credits:02) THEORY:30 Lectures

Theory includes only qualitative explanation. Minimum five experiments should be performed covering minimum three sections.

(i) Sources and Detectors (9-Periods)

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser. Semiconductor lasers.

Experiments on Lasers:

a. Determination of the grating radial spacing of the Compact Disc (CD) by reflection using He-Ne of solid state laser.
b. To find the width of the wire or width of the slit using diffraction pattern obtained by a He-Ne or solid state laser.
c. To find the polarization angle of laser light using polarizer and analyzer.
d. Thermal expansion of quartz using laser.

Experiments on Semiconductor Sources and Detectors:

a. V-I characteristics of LED.
b. Study the characteristics of solid state laser.
c. Study the characteristics of LDR.
d. Photovoltaic Cell.
e. Characteristics of IR sensor.

(ii). Fourier Optics (6-Periods)

Concept of Spatial frequency filtering.

Fourier transforming property of a thin lens.

Experiments on Fourier Optics:

a. Fourier optic and image processing.
   1. Optical image addition/subtraction.
   2. Optical image differentiation.
   3. Fourier optical filtering.
   4. Construction of an optical 4f system.

b. Fourier Transform Spectroscopy Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science. Experiment: To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done.

(iii). Holography (6-Periods)

Basic principle and theory: coherence , resolution, Types of holograms, white light reflection hologram, application of holography in microscopy, interferometry, and character recognition.

Experiments on Holography and interferometry:

1. Recording and reconstructing holograms.
2. Constructing a Michelson interferometer or a Fabry Perot interferometer.
3. Measuring the refractive index of air.
4. Constructing a Sagnac interferometer.
5. Constructing a Mach-Zehnder interferometer.
6. White light Hologram.

(iv) Photonics:Fibre Optics (9-Periods)

Optical fibres and their properties, Principal of light propagation through a fibre, The numerical aperature, Attenuation in optical fibre and attenuation limit, Single mode and multimode fibres, Fibre optic sensors: Fibre Bragg Grating **Experiments on Photonics: Fibre Optics**

a. To measure the numberical aperture of an optical fibre.
b. To study the variation of the bending loss in a multimode fibre.
c. To determine the mode field diameter (MFD) of fundamental mode in a single-mode fibre by measurements of its far field Gaussian pattern.
d. To measure the near field intensity profile of a fibre and study its refractive index profile.
e. To determine the power loss at a splice between two multimode fibre.

Reference Books:

- Fundamental of optics, F.A. Jenkins & H.E. White. 1981, Tata McGraw-Hill.

❖ **LASERS:**

- Fundamental & applications, K. Thyagranjan & A.K. Ghatak, 2010, Tata McGraw Hill.
- Fibre optics through experiments. M.R. Shenoy, S.R. Khijwania, et.al. 2009, Viva Books.
- Nonlinear Optics, Robert W. Boyd, (Chapter-I), 2008, Elsevier.
- Optics, Karl Dieter Moller, Learing by computing with model examples, 2007, Springer.
- Optical System and Processes, Joseph Shamir, 2009, PHI Learing Pvt. Ltd.
- Optoelectronic Devices and Systems, S.C. Gupta, 2005, PHI Learing Pvt. Ltd.
- Optical Physics, A. Lipson, S.G. Lipson, H. Lipson, 4th Edn., 1996 Cambridge Univ. Press.

Ranchi Women's College, Ranchi

(An Autonomous Unit of Ranchi University from 2012)

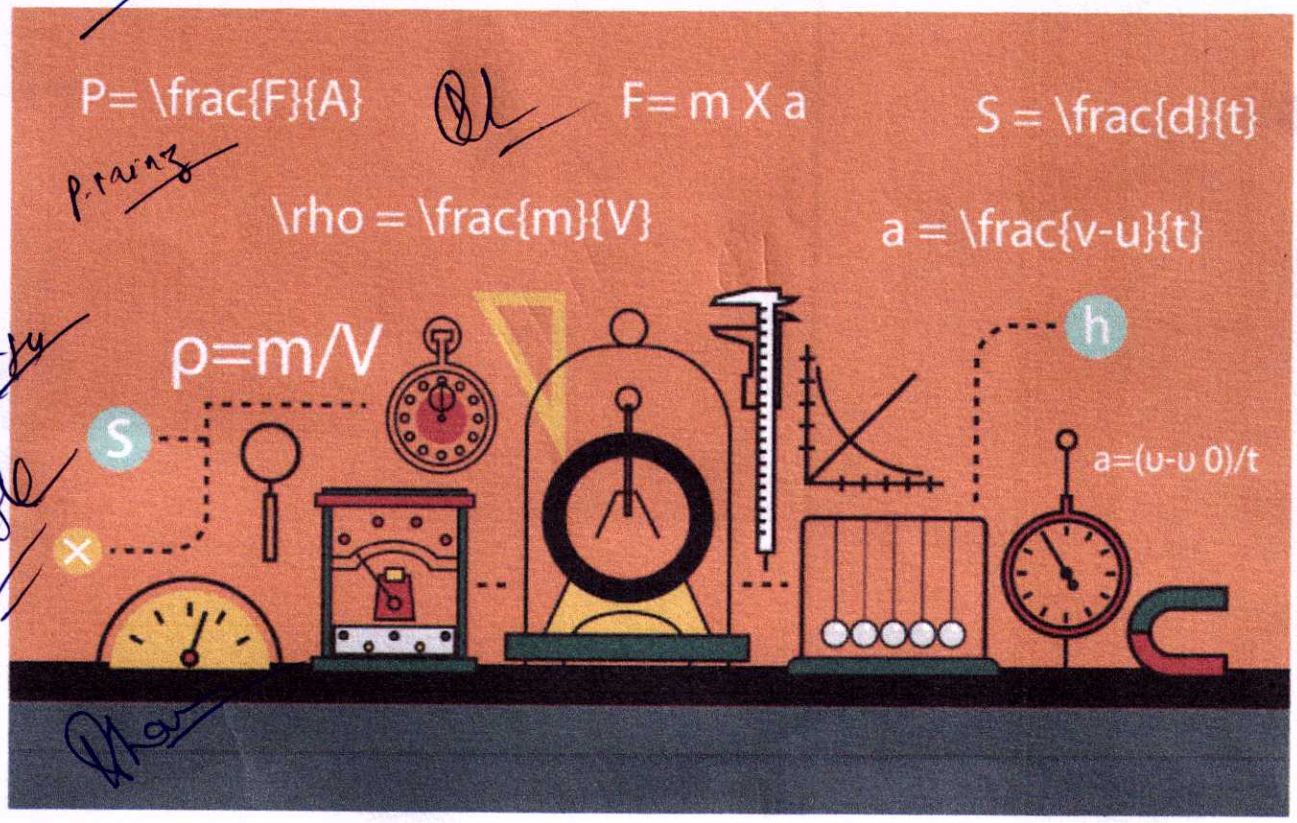
Proposed Syllabus For B.Sc. (Subsidiary) PHYSICS

UNDER CHOICE BASED CREDIT SYSTEM (CBCS)

From

Academic Session 2018-2019

Generic Elective Papers (GE) (Minor-Physics)
For other Departments/ Disciplines



Semester-I

GE-I: MECHANICS

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

Vectors:
Vector algebra. Scalar and Vector products. Derivatives of a vector with respect to a parameter. **(4-Lectures)**

Ordinary Differential Equations:
1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients. **(6-Lectures)**

Laws of Motion:
Frame of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **(10-Lectures)**

Momentum and Energy:
Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. **(6-Lectures)**

Rotational Motion:
Angular velocity and angular momentum. Torque/ Conservation of angular momentum. **(5-Lectures)**

Gravitation:
Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane. Angular momentum is conserved, areal velocity is constant). Kepler's Laws (Statement Only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness. **(8-Lectures)**

Oscillations:
Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy. Total Energy and their time averages. Damped oscillations. **(6-Lectures)**

Elasticity:
Hooke's Law. Stress-Strain diagram. Elastic moduli-Relation between elastic constants. Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants. Work done in stretching and work done in twisting a wire. Twisting couple on a cylinder. Determination of Rigidity modulus by Static torsion-Torsional pendulum. Determinathion of Rigidity modulus and moment of inertia-q,η and σ by Searle's method. **(7-Lectures)**

Special Theory of Relativity:
Constancy of speed of light. Postulates of Special Theory of Relativity. Lorentz Transformation. Length contraction. Time Dilation. Relativistic addition of velocities. **(7-Lectures)**

Notes: *Students are not familiar with vector calculus. Hence all examples involve differentiation either in one dimension or with respect to the radial coordinate.*

Reference Books:

- University Physics. F.W. Sears. M.W. Zemansky, and H.D. Young, 13/e, 1986, Addison-Wesley.
- Mechanics Berkeley Physics, v.1: Charles Kittel, et. At. 2007, Tata McGraw-Hill.
- Physics-Resnick Halliday & Walker 9/e, 2010, Wiley.
- University Physics, Ronald lane Reese, 2003, Thomson Brooks/ Cole.

PHYSICS LAB: GE-I LAB: MECHANICS

1. Measurements of length (or diameter) using Vernier Caliper, Screw gauge and Travelling Microscope.
2. To determine the Elastic constants of a wire by Searle's method.
3. To determine g bar pendulum.
4. To determine g by Kater's Pendulum.
5. To study the Motion of a spring and calculate (a) Spring Constant. (b) g.

Reference Books:

- Advanced Practical Physics for students, B.L. Fluant and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practical, Michael Nelson and Jon M. Osborn, 4th edn., reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edn., 2011, Kitab Mahal New Delhi.

SEMESTER-II

GE-II: WAVES AND OPTICS

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

Superposition of two Collinear Harmonic oscillations:
Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **(5-Lectures)**

Superposition of two Perpendicular harmonic Oscillations:
Graphical and Analytical methods. Lissajous Figures (1.1) and their uses. **(2-Lectures)**

Waves Motion:
General Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group Velocity, Phase velocity, Plane waves. Spherical waves. Wave intensity. **(7-Lectures)**

Sound:
Simple harmonic motion-forced vibrations and resonance. Fourier theorem – Apllication to saw tooth wave and square wave. Intensity and loudness of sound. Decibels. Intensity levels. Musical notes-Musical scale. Acoustics of buildings. Reverberation and time of reverberation. Absorption coefficient. Sabine's formula. Measurement of reverberation time, Acoustic aspects of halls and auditona. **(12-Lectures)**

Wave Optics:
Electromagentic nature of light. Definition and Properties of wave front. Huygen's Principle. **(3-Lectures)**

Interference:
Interfernce. Division of amplitude and division of wavefront. Young's Double Slit experiment. Phase change on reflection. Stoke's treatement. Interference in thin flims, parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes). Fringes of equal thickness (Fieau Fringes). Newton's Rings. Measurement of wavelength and refractive index. **(12-Lectures)**

Michelson's Interferometer:
(1) Idea of form of fringes (no theory needed). (2) Determination of wavelength. (3) Wavelength difference. (4) Refractive index. (5) Visibility of freinges. **(3-Lectures)**

Diffraction:
Fraunhofer diffraction-single slit: Elementary idea of Diffarction grating. Fresnel Diffarction. Half-period zones.Zone Plate. Fresnel Diffraction pattern of a straight edge using half-period zone analysis. **(11-Lectures)**

Polarization:

Transverse nature of light waves. Plane polarized light-production and analysis. Circular and elliptical polarization. **(5-Lectures)**

Reference Books:

- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1975, McGraw-Hill.
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing.
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R.Chand Publications.
- University Physics, F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986, Addition-Wesley.

PHYSICS LAB:GE-II LAB: WAVES AND OPTICS

1. To determine the frequency of an Electrically Maintained Tunng Fork by Melde's Experiment.
2. To determine the Coefficient of Viscosity of water by Capillary Flow Method [Poiseuille's method]
3. To determine the Refractive index of the material of a Prism using Sodium Light.
4. To determine wavelength of sodium light using Newton's Rings.
5. Determine velocity of sound by Kundt's Tube.

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. Osborn, 4th Edn., Reprinted, 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, Induc Prakash and Ramanath, 11 Edn., 2011, Kitab Mahal, New Delhi.

SEMESTER-III

GE-III: ELECTRICITY AND MAGNETISM

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

Vector Analysis:
Scalar and Vector products, gradient, divergence, Curl and their significance. Vector Integration, Line, surface and volume integrals of Vector fields. Gauss-divergence theorem and Stoke's theorem of vectors (Statements only). **(12-Lectures)**

Electrostatics:
Electrostatic field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem. Electric field due to point charge. Infinite line of charge. Uniformly charged spherical shell and solid sphere. Plane charged sheet. Charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, Uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel. Plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation. Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric. **(22-Lectures)**

Magnetism: Magnetic induction, $\bar{B} = \mu_0.(\bar{H} + \bar{M})$ relation [by Rowland ring method]. Energy density of magnetic field (by simple solenoid method). Hysteresis and hysteresis loss. Dia-magnetic, Para-magnetic and Ferro-magnetic substances. Magnetic circuits. Design of permanent magnets by the concept of magnetic circuits. Susceptibility and permeability and their measurements for Dia-magentic, Para-magentic and Fero-magnetic materials. **(10-Lectures)**

Electricity:
Faraday's law of electromagnetic induction, Lenz's law. Theory of moving coil galvanometer, its figure of merit. Theory of generation of AC Power and Power factor of AC circuits. Wattless current and Choke coil. Analytic treatement of LR, RC and LCR series and parallel circuits using vector diagram and operation method. Resonace and Quality factor. Transformer and its principles for no load and with load, using vector diagram.
Three phase AC generation and distribution, star and delta distribution system, Rotating Magnetic Field and Induction motor. Thermoelectricity. Seebeck effect. **(16-Lectures)**

Reference Books:

- Electricity and magnetism, Edward M. Purcell, 1986, McGraw-Hill Education.
- Electricity and magnetism, J.H. Fewkes & J. Yarwood. Vol.I, 1991, Oxford Univ. Press.
- Electricity and Magenitism, D.C. Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction of Electrodynamics, 3rd Edn., 1998, Benjamin Cummings.

PHYSICS LAB: GE-III LAB:ELECTRICITY AND MAGENTISM

1. To use a multimeter for measuring (a) Resistances (b) A.C. and D.C. voltages (c) D.C. current (d) Checking electrical fuses.
2. To find the value of an unknown resistances using a PO box.
3. To compare capacitances using de-Sauty's bridge.
4. To determine the figure of merit of a moving coil galvanometer.
5. To measure the given high resistance.
6. To measure the given low resistance.

Reference Books:

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

SEMESTER-IV

GE-IV: THERMAL PHYSICS AND STATISTICAL MECHANICS

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

Laws of Thermodynamics:
Thermodynamic Description of system. Zeroth Law of thermodynamics and temperature. First law and internal energy. conservation of heat into work, Various Thermodynamical Process. Applications of First Law. General Relation between C_P and C_V. Work done during isothermal and Adiabatic Process. Compressibility and Expansion Coefficient. Reversible and irrerversible processes, Second Law and Entropy, Carnot's cycle & theorem. Entropy changes in reversible & irreversible processes. Entropy-temperature diagrams. **(22-Lectures)**

Thermodynamical Potentials:
Enthalpy, Gibbs. Helmholtz and internal energy Functions. Maxwell's relations and applications. Joule-Thomson effect. Clasius-Clapeyron equation. Expression for (C_P-C_V). C_P/C_V. TdS equations. **(10-Lectures)**

Kinetic Theory of Gases:
Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean Free path (Zeroth order). Transport Phenomena. Viscosity, Conduction and Diffusion (for vertical case). Law of equipartition of energy (no derivation) and its applications to specific heat of gases, mono-atomic and diatomic gases. **(10-Lectures)**

Theory of Radiation:
Blackbody radiation, Spectral distribution. Concept of Energy Density. Derivation of Planck's law. Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan-Boltzmann Law and Wien's displacement law from Planck's law. **(6-Lectures)**

Statistical Mechanics:
Maxwell-Boltzmann law- distribution of velocity- Quantum statistics-Phase space, Fermi-Dirac distribution law, Electron gas, Bose-Einstein distribution law, Photon gas, comparison of three statistics. **(12-Lectures)**

Reference Books:

- Thermal Physics, S.Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, F.W. Sears and G.L. Salinger, 1988, Narosa.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

PHYSICS LAB:GE-IV LAB:THERMAL PHYSICS AND STATISTICAL MECHANICS

1. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
2. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
3. To use copper-iron thermocouple as thermometer to find melting point of wax.
4. To calibrate Resistance Temperature Device (RTD) using Null Method.
5. To find specific heat of liquid by method of cooling.
6. To find the temperature dependence of resistance of a Thermistor and determine an unknown temperature.

Reference Books:

- Advanced Practical Physics for Students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edn., 201., Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.