Ramakrishna Mission Residential College (Autonomous)
Vivekananda Centre for Research
Ramakrishna Mission Ashrama
(A Branch Centre of Ramakrishna Mission, Belur Math, Howrah-711202)
Narendrapur, Kolkata - 700 103, West Bengal, India
A Scientific Industrial Research Organisation, Recognised by DST, Govt. of India
College with Potential for Excellence (CPE), Re-accredited by NAAC - 'A' (CGPA 3.56 out of 4)

NOTICE

Date: 07.08.2018

A meeting of the Board of Studies in Physics will be held on 25.08.2018, Saturday at 2 PM in the department.

You are requested to kindly attend the meeting.

Agenda

1. Confirmation of the proceedings of the last meeting held on 10.02.2018.

2. Preparation of the Panels of Paper Setters, Moderators, Examiners (Practical) and Reviewers related to UG & PG Examinations to be held during the months of November-December, 2018.

3. Finalization of new UG Syllabus (CBCS)

4. Miscellaneous.

Malay Purkait
Head, Dept. of Physics

Copy to:

1. Prof. Parongama Sen (C.U.)
2. Prof. Dipali Banerjee (IIEST, Shibpur)
3. Dr. Indranath Chaudhuri (St. Xavier's College)
4. Prof. Debnarayan Jana (C.U.)
5. Mr. Jyotirmay Bhowmik (DPSC Ltd., Kolkata)
6. Permanent Teaching Staff of the Dept. of Physics

PHONES : 24772201(3lines), 24772205 FAX : 033-24773597 EMAIL : rkmcnpur@vsnl.com
WEBSITE : www.rkmcnarendrapur.org

Proceedings of the Meeting of the Board of Studies in Physics held on 25-08-2018 at 2PM in the Dept. of Physics.

The following members were present :-

Members present with signature :-

1. Malay Purkait
2. Dipali Banerjee
3. Malay Purkait.
4.
5. Debnarayan Jana
6. Sourav Chattopadhyay
7. Koushik Sarkar
8. Debabrata Das
9. Swapan Bhunia
10. [signature]
11. Dhirajit Basak
12. Jagadish Ch. Mahato

HOD was on the chair. The following resolutions have been taken in the meetings.

1. The resolutions of the meeting held on 10.02.2018 were read and accepted by the members present.

2. Name of the Internal Examiners and ~~Paper~~ panel of the External paper-setters, Panel of Moderators and external Examiners (for practicals) in connection with the B.Sc 1st, 3rd and 5th Sem, M.Sc 1st and 3rd sem. Examination - 2018 were finalized after discussion, as given in the shell sheets attached.

3. The new ~~Phy~~ syllabus for CBCS (Choice Based Credit System) to the UG students (from 2018) was finalized and the Changes in the syllabus with respect to old one are highlighted.

The Meeting ended with a vote of thanks to the chair.

Malay Purkait
25.08.18

Ramakrishna Mission Residential College (Autonomous)
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Narendrapur, Kolkata - 700 103, West Bengal, India
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NOTICE

Date: 02.03.2019

A meeting of the Board of Studies in Physics will be held on 14.03.2019, Thursday at 3 PM in the department.

You are requested to kindly attend the meeting.

Agenda

1. Confirmation of the proceedings of the last meeting held on 25.08.2018.
2. Preparation of the Panels of Paper Setters, Moderators, Examiners (Practical) and Reviewers related to UG & PG Examinations to be held during the months of April - May, 2019.
3. Miscellaneous.

Malay Purkait
2.03.19
Head, Dept. of Physics

Copy to:

1. Prof. Parongama Sen (C.U.)
2. Prof. Dipali Banerjee (IIEST, Shibpur)
3. Dr. Indranath Chaudhuri (St. Xavier's College)
4. Prof. Debnarayan Jana (C.U.)
5. Mr. Jyotirmay Bhowmik (DPSC Ltd., Kolkata)
6. Permanent Teaching Staff of the Dept. of Physics

4/3/19
04/03/19
4/3/19
4/3/19

Ramakrishna Mission Residential College (Autonomous)
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NOTICE

Date: 02.08.2019

A meeting of the Board of Studies in Physics will be held on 17.08.2019, Saturday at 2 PM in the department.

You are requested to kindly attend the meeting.

Agenda

1. Confirmation of the proceedings of the last meeting held on 14.03.2019.
2. Preparation of the Panels of Paper Setters, Moderators, Examiners (Practical) and Reviewers related to UG & PG Examinations to be held during the months of November - December, 2019.
3. Introduction of CBCS syllabus of PG course w.e.f. 2019-20 session.
4. Miscellaneous.

Malay Purkait
Head, Dept. of Physics

Copy to:

1. Prof. Parongama Sen (C.U.)
2. Prof. Dipali Banerjee (IIEST, Shibpur)
3. Dr. Indranath Chaudhuri (St. Xavier's College)
4. Prof. Debnarayan Jana (C.U.)
5. Mr. Jyotirmay Bhowmik (DPSC Ltd., Kolkata)
6. Permanent Teaching Staff of the Dept. of Physics

17/03/19.

Proceedings of the Meeting of the Board of Studies in Physics held on 17.08.2019 at the Dept. of Physics at 2 PM.

Members present with signature :-

①	MALAY PURKAIT	Malay Purkait
2.	PROF. D. JANA.	Debnarayan Jana
3.	" P. SEN.	Absent.
4.	DR. I. CHAUDHURI	Indranath Chaudhuri
5.	PROF. D. BANERJEE.	Ab.
6.	Mr. J. BHOWMIK	Absent.
7.	DR. D. DAS.	Debabrata Das
8.	" K. SARKAR	K. Sarkar
9.	" J. MAHATO.	Jagadish Ch. Mahato
10.	" S. CHATTYAPADHYA.	Absent
11.	MR. S. BHUNIA.	Swapan Bhunia.
12.	" A. ROY.	Ab.
13.	" T. BISWAS.	Tanmay Biswas

HOD was on the chair. The following resolutions have been taken in the meeting.

1. The resolutions of the meeting held on 14.03.2019 were read and accepted by the members present.

2. Name of the Internal Examiners and panel of external paper-setters, moderators and the external Examiners for practical Examination in the connection with the UG 1st, 3rd and 5th Sem, and PG 1st and 3rd Sem. Examination 2019 has been finalized after discussion as given in the seperate sheets attached.

3. The CBCS for PG course (All Sem.) was finalized and the changes in the syllabus with respect to old one are highlighted. The meeting ended with a vote of thanks to the chair

HOD
Malay Purkait.
17-08-2019

Ramakrishna Mission Residential College
(Autonomous)
Narendrapur, Kolkata – 700103

Department of Physics

Syllabi for Courses offered by the Department
at Undergraduate Level

Under **CBCS**

(Program Code : BSHPHY)

2018-19

Course Structure: Semester-wise distribution of Core Courses

Semester	Course Name	Course Code / Paper Code	Credits
I	Mathematical Physics – I	HPHY1CC01L	6
	Mechanics	HPHY1CC02L	6
II	Waves and Optics	HPHY2CC03L	6
	Mathematical Physics – II	HPHY2CC04L	6
III	Electricity & Magnetism	HPHY3CC05L	6
	Elements of Modern Physics	HPHY3CC06L	6
	Analog Systems and Applications	HPHY3CC07L	6
IV	Thermal Physics	HPHY4CC08L	6
	Electromagnetic Theory	HPHY4CC09L	6
	Quantum Mechanics and Applications	HPHY4CC10L	6
V	Statistical Mechanics	HPHY5CC11L	6
	Digital Systems and Applications	HPHY5CC12L	6
	Classical Dynamics	HPHY5DSE1L	6
	Nuclear and Particle Physics	HPHY5DSE2L	6
VI	Advanced Mathematical Physics	HPHY6CC13L	6
	Solid State Physics	HPHY6CC14L	6
	Nano-materials and Applications	HPHY6DSE3L	6
	Project Work	HPHY6DSE4L	6

Course Structure: Semester-wise distribution of Generic Courses

Semester	Course Name	Course Code / Paper Code	Credits
I	Mechanics and Thermal Physics or Electronic devices, Analog and digital circuit designing	HPHY1GE01L or HELE1GE01L	6 or 6
II	Mechanics and Thermal Physics or Electronic devices, Analog and digital circuit designing	HPHY1GE01L or HELE1GE01L	6 or 6
III	Optics and Electricity-Magnetism or Applied Electronics	HPHY3GE02L or HELE3GE02L	6 or 6
IV	Optics and Electricity-Magnetism or Applied Electronics	HPHY3GE02L or HELE3GE02L	6 or 6

Ability Enhancement Compulsory Course (AECC)

1. Compulsory language to be taken in 1st Year.
    a. Subject: English
    b.
        i. Marks: 50
        ii. Credit: 2
        iii. Written Test at the Mid & End Semester
    c. Subject: Bengali
        i. Marks: 50
        ii. Credit: 2
        iii. Written Test at the Mid & End Semester
2. Environmental Studies
    i. Marks in Theory : 75
    ii. Credit: 3
    iii. Written Test at the Mid & End Semester
    iv. Marks in Project : 25
    v. Credit: 1

vi. Each Student will be required to submit a Project Report at the end of Second Semester of First Year. The Project will be an original work which may be related to the Honours Subject of the students but must be some aspect of the environmental studies. However, students may involve his own habitat while doing his Project. In the month of February students should talk to either their teacher of the Environmental Studies or the teachers of their own subject to choose the Project area. The length of the Project Report should be not less than 1500 words but not more then 3000. It may be hand written or typed. The Project must be submitted by 31st May. Students should submit their Project Report Head of the Department and must obtain a Project Completion Certificate from the HoD.

SYLLABUS FOR
UG PHYSICS *C__ORE__ COURSE* (CBCS)

B.Sc. Physics Honours

(Program Code : BSHPHY)

RAMAKRISHNA MISSION RESIDENTIAL COLLEGE (AUTONOMOUS) NARENDRAPUR

2018-19

CORE COURSE (PHYSICS)

FIRST YEAR

Semester – I

Course Name: Mathematical Physics-I

Course Code / Paper Code : HPHY1CC01L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical :LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment :Class Test, Mid Sem. Exam., Attendance]

Course Outcome :

After completion of the course student will

- Learn different methods of solving first and second order differential equations.
- Get introduced to Special functions like Gamma function, Beta function, delta function.
- Learn about vector algebra, vector calculus and their typical applications in physics.
- Learn about matrices and vector spaces for the application in different area of physics.
- Learn about Fourier series expansion of various types of functions.
- Learn about basics of Python language.

(a) Theory (TH) Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Calculus Lectures: 16

Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series for functions of single and double variables.

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Initial value problems. Particular Integral.

Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials.

Special Method: Singular Point of Second Order Linear Differential Equations and their importance. Forbenius Method and it's application (simple examples).

Special Integrals: Introduction to Beta Function and Gamma Function, their integral forms, relationship between them, simple properties.

Vector Algebra and Vector Calculus — Lectures: 16

Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.

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

Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

Orthogonal Curvilinear Coordinates — Lectures: 6

Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.

Matrices — Lectures: 16

Eigen values and Eigenvectors: Introduction to Eigen values and Eigenvectors of a Normal Matrix; Hermitian and Anti-Hermitian Matrix; Orthogonal Matrix; Unitary Matrix; Rotation Matrices; General square matrix, Degenerate eigen values. Cayley-Hamilton Theorem. **Linear Transformations**: The matrix of a Linear Transformation, Orthogonal and Unitary Transformations, Similarity Transformations; Diagonalization of a matrix; Trace of a matrix. **Complex Vectors and Matrices**: Complex Numbers, Hermitian and Unitary Matrices, Inner product of vectors in Complex vector spaces, Elementary idea about Hilbert space. Function space.

Introduction to Fourier Series — Lectures: 6

Periodic functions, Summation of Fourier series, Convergence of Fourier series and Dirichlet conditions, Half- range Fourier series, Change of interval, Parseval's identity, Integration and differentiation of Fourier series. Orthogonal functions, Multiple Fourier series.

Reference Books

Mathematical Methods for Physicists by Tai L. Chow

Mathematical Methods for Physicists by Arfken and Weber

Mathematical Methods for Physics and Engineering by K F Riley M. P. Hobson, S. J.Bence (3rd Ed).

Introduction to Linear Algebra by Gilbert Strang (4th Ed.)

Vector analysis by M.R. Spiegel.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

Introduction and Overview **Lectures: 3**

Computer architecture and organization, memory and Input/output devices , Binary and Decimal arithmetic, concept of Algorithms.

Introduction to programming in python **Lectures: 10**

Introduction to programming, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, iteration, compound statements, indentation in python, the if-else-elseif block, for and while loops, nested compound statements.

Programs **Lectures: 10**

Elementary calculations with different types of data e.g., area and volume of regular shapes using formulae. Small programs utilising basic conditional statements and loops.Simple calculations of matrices e.g., addition, subtraction, multiplication. Sorting.

Introduction to plotting graphs **Lectures: 4**

Basic idea of plotting using Gnuplot/Labplot/Veusz. Plotting functions and datafiles.Fitting data using suitable fit function.

Errors and error Analysis **Lectures: 3**

Truncation and round off errors, Absolute and relative errors, Floating point computations.

Reference Books

Learning with Python-how to think like a computer scientist, J. Elkner, C. Meyer, and A. Downey, 2015, Dreamtech Press.

Introduction to computation and programming using Python, J. Guttag, 2013, Prentice Hall India.

"This is an entirely new course added vide the BOS meeting dated 25/08/2018".

Course Name: Mechanics

Course Code / Paper Code : HPHY1CC02L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

Students will be able to articulate and describe:

- Relative motion, inertial and non inertial reference frames.
- Parameters defining the motion of mechanical systems and their degrees of freedom.
- Centre of mass and inertia tensor of mechanical systems.
- Introduction to analytical mechanics as a systematic tool for problem solving.
- Elastic properties of matter and fluid dynamics.

(a) Theory (TH) **Credits: 4**

Total Lectures: 60 (+ 5 Tutorials)

Fundamentals of Dynamics Lectures: 12

Review of Newton's Laws: Mechanistic view of the Universe. Concepts of Inertial frames, force and mass.

Solution of the equations of motion (E.O.M.) in simple force fields in one, two and three dimensions using cartesian, cylindrical polar and spherical polar coordinate systems.

Dynamics of systems of particles: Difficulty of solving the E.O.M. for systems of particles. Newton's third Law. External and Internal forces. Momentum and Angular Momentum of a system. Torque acting on a system. Conservation of Linear and Angular Momentum. Centre of mass and its properties. Two-body problem.

Variable- mass system: motion of rocket.

Work and Energy Lectures: 6

Work and Kinetic Energy Theorem. Conservative Forces: Force as the gradient of a scalar field - concept of Potential Energy. Other equivalent definitions of a Conservative Force. Conservation of Energy; Qualitative study of one dimensional motion from potential energy curves. Stable and unstable equilibrium. Energy of a system of particles.

Gravitation and Central Force Motion **Lectures: 10**

Central Force. Reduction of the two body central force problem to a one-body problem. Setting up the E.O.M. in plane polar coordinates. Differential equation for the path. Motion under an Inverse- square force. Newton's Law of Gravitation. Inertial and gravitational mass. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Gravitational potential energy. Potential and field due to spherical shell and solid sphere.

Rotational Dynamics **Lectures: 12**

The Rigid Body: Constraints defining the rigid body. Degrees of freedom for a rigid body; Relation between Angular momentum and Angular Velocity - Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. E.O.M for rotation about a fixed axis. Principal Axes transformation. Transformation to a body fixed frame. E.O.M for the rigid body with one point fixed (Euler's equations of motion). General motion of a rigid body - translation plus rotation. Kinetic energy of rotation.

Elasticity **Lectures: 6**

Relation between Elastic constants. Twisting torque on a Cylinder or Wire. Bending of a beam –Internal bending moment. Cantilever, Elastic potential energy.

Fluid Motion **Lectures: 6**

Kinematics of Moving Fluids: Equation of continuity; Idea of streamline and turbulent flow,Reynold's number. Poiseuille's equation for Flow of a viscous Liquid through a capillary tube.

Non-Inertial systems **Lectures: 8**

Galilean transformations and Galilean invariance. Non-inertial frames and idea of fictitious forces. E.O.M with respect to a uniformly accelerating frame. E.O.M with respect to a uniformly rotating frame - Centrifugal and Coriolis forces. Laws of Physics in a laboratory on the surface of the earth.

Reference Books

An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.

Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education

Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000

Classical Dynamics of Particles and Systems,S.T.Thornton,J.B.Marion,(Fifthed.), Thompson & Brooks.

(b) Practical (PR) Credits: 2

Total Lectures: 30

1. Measurements of length (or diameter) using Slide Callipers, Screw Gauge and Travelling Microscope.

2. To determine the Moment of Inertia of a metallic cylinder / rectangular bar about an axis passing through the C.G. and to determine the Modulus of Rigidity of the suspension wire.

3. Determination of the pressure coefficient of air.

4. Determination of Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

5. Determination of Young's modulus of the material of a beam by the method of flexure.

6. Determination of the resistance of a suspended coil galvanometer by the method of half deflection and to calculate the figure of merit of the galvanometer (using the same data).

7. To determine the value of g using bar pendulum/Kater's pendulum.

Reference Books

Advanced Practical Physics, B.Ghosh, K.G.Mazumder, Sreedhar Publisher.

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

Practical Physics by D. Chattapadhyay and P.C. Rakshit.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Semester – II

Course Name: Waves and Optics

Course Code / Paper Code : HPHY2CC03L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome :

On successful completion of this course, students will:

- Understand the basics of acoustics.
- Understand physical characteristics of harmonic motion, forced vibration and resonance.
- Use Lissajous figures to understand the superposition of harmonic waves.
- Understand the properties of light, namely reflection, refraction, interference, diffraction and polarization theoretically and can verify those experimentally.
- Understand the applications of interference, diffraction and polarization phenomena, design and working of interferometers,optical instruments and their practical use.

(a) Theory (TH) Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Superposition of periodic motion Lectures: 2

SHO, Superposition principle, Lissajous figure

Forced Vibrations and Resonance Lectures: 6

Undamped oscillator with harmonic forcing, The complex exponential method for forced oscillations, Forced oscillations with damping, Effect of varying the resistive term, Transient phenomena, The power absorbed by a driven oscillator, Examples of resonance: Electrical resonance; Optical resonance; Anharmonic oscillators.

Progressive waves Lectures: 6

Normal modes and travelling waves, Progressive waves in one direction, Wave speeds in specific media, Superpositions, Wave pulses, Motion of wave pulses of constant shape, Superposition of wave pulses, *Dispersion*: Phase and group velocities, The energy of a mechanical wave, The transport of energy by a wave, Momentum flow and mechanical radiation pressure, Waves in two and three dimensions.

Superposition of Two Harmonic Waves Lectures: 8

Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Superposition of N Harmonic Waves.

Wave Optics **Lectures: 3**

Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.

Interference **Lectures: 10**

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

Interferometer **Lectures: 5**

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.

Diffraction **Lectures: 10**

Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

Polarization **Lectures: 10**

Different states of polarization; double refraction, Huygen's construction for uniaxial crystals; Polaroids and their uses. Production and analysis of plane, circularly and elliptically polarized light by retardation plates. Optical activity; Modern explanation of optical activity; Biquartz and half shade polarimeter.

Reference Books

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.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

1. Familiarization with: Schuster`s focusing; determination of angle of prism and refractive index of the Material of a prism using sodium source.

2. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.

3. Measurement of the slit width and the separation between the slits of a double slit by observing the diffraction and interference fringes.

4. To determine wavelength of sodium light using Fresnel Bi-prism.

5. To determine wavelength of sodium light using Newton's Rings.

6. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.

7. To calibrate a polarimeter and hence to determine the concentration of unknown sugar solution.

8. To study Lissajous figures using RC lead-lag circuit.

Reference Books

Advanced Practical Physics, B.Ghosh ,K.G.Mazumder, Sreedhar Publisher

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, KitabMahal.

Practical Physics by D Chattopadhyay and P.C. Rakshit by New Central Book Agency.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Course Name: Mathematical Physics - II

Course Code / Paper Code : HPHY2CC04L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After completing the course, student will be able to

- Learn about various special functions, partial differential equations commonly used in various theorems in physical sciences.
- Use the orthogonal polynomials and other special functions in various theories of physics and in numerical analysis.
- Use the calculus of variations.
- Get skill to simulate different mathematical problems with python programming.

(a) Theory (TH) **Credits: 4**

Total Lectures: 60 (+ 5 Tutorials)

Special Functions **Lectures: 20**

Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and $J_1(x)$)and Orthogonality.

Variational Calculus in Physics **Lectures: 20**

Functionals. Basic ideas of functionals. Determination of the path that gives extremum solutions, Euler equation, Use of calculus of variation to solve problems: shortest distance between two points in a plane, area of the surface of revolution is a minimum-Catenary; soap film problem: minimize the surface area of revolution etc., The second form of Euler equations, function with several variables, equation of constraints, Lagrange undetermined multiplier Lagrange's equation of motion, generalised coordinates, cyclic coordinates, applications to simple problems.

Partial Differential Equations **Lectures: 16**

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

Dirac Delta Functions and Its properties **Lectures: 4**

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Reference Books

Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.

Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.

Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.

Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.

Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.

Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press

Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books
Mathematical Physics, P. K. Chattopadhyay, 2014, New Academic Science.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

Introduction to Numerical Analysis **Lectures: 15**

Curve fitting, Least square fit , Solution of Linear system of equations by Gauss Elimination and Gauss-Seidel Method , Solution of First Order ODE using Euler and Runge-Kutta2nd Order/ 4th Order Method, Integration by Trapezoidal Method, Simpson 1/3 Method ,Finding roots of a function using Bisection Method and Newton-Rhapson Method, Lagrange Interpolation Formula.

Programs **Lectures: 15**

Execution of specific problems discussed in Numerical Analysis using Python Programming.

Reference Books

Numerical Methods for Engineers by Raymond P Canale, Steven C Chapra

Numerical Analysis by Rainer Kress.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

CORE COURSE (PHYSICS)

SECOND YEAR

Semester – III

Course Name: Electricity & Magnetism

Course Code / Paper Code : HPHY3CC05L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

On successful completion of this course students will:

- Gain knowledge on the basic concepts of electric and magnetic fields.
- Understand the concept of conductors, dielectrics, inductance and capacitance
- Gain knowledge on the nature of magnetic materials.
- Understand the concept of static and time varying fields.
- Able to solve different electrical circuits for electrical and electronics applications both theoretically and experimentally.

(a) Theory (TH) Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Electric Field & Electric Potential Lectures: 18

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

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Multipole expansion: Multipole expansion of scalar potential-monopole, dipole, quadrupole terms, Potential and Electric Field of a dipole. Force and Torque on a dipole.

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor. Method of Electrical Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

Dielectric Properties of Matter Lectures: 6

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

Magnetic Field — Lectures: 12

Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole).

Ampere's Circuital Law and its application to (1) infinite straight wire, (2) Infinite planar surface current, and (3) Solenoid. Properties of B: curl and divergence. Axial vector property of B and its consequences. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

Magnetic Properties of Matter — Lectures: 4

Magnetization vector (M). Magnetic Intensity (H). Magnetic Susceptibility and permeability. Relation between B, H, M. Ferromagnetism. B-H curve and hysteresis.

Electromagnetic Induction — Lectures: 6

Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.

Electrical Circuits — Lectures: 6

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.

Network Theorem — Lectures: 8

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

Reference Books

Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw Hill.

Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.

Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education.
Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.

Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

List of Practical

1. To determine an unknown Low Resistance using Potentiometer.

2. To determine an unknown Low Resistance using Carey Foster's Bridge.

3. To verify the Thevenin and Norton theorems.

4. To verify the Superposition, and Maximum power transfer theorems.

5. To determine self-inductance of a coil by Anderson's bridge.

6. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.

7. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.

Reference Books

Advanced Practical Physics (Vol. I & Vol. II), B.Ghosh, K.G.Mazumder, Sreedhar Publisher.

An Advanced Course in Practical Physics, D. Chattopadhyay, P.C.Rakshit, New Central Book Agency.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Course Name: Elements of Modern Physics

Course Code / Paper Code : HPHY3CC06L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

On successful completion of the course, the students will:

- Understand the intuitive ideas of the Quantum physics and Nuclear physics.
- Be able to understand dual nature of particle.
- Gain a comprehensive knowledge in Modern physics.

(a) Theory (TH) **Credits: 4**

Total Lectures: 60 (+ 5 Tutorials)

Quantum Theory Lectures: 10

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; 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.

Introduction to Quantum Mechanics Lectures: 20

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg's Uncertainty Principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- applications.

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension.

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

Basic Concept of Nuclear Physics Lectures: 20

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.

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.

Fission and fusion- mass deficit, relativity and generation of energy; 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).

Laser Lectures: 10

Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Calculations of population inversion for Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser.

Reference Books

Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.

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 and Serway, 2010, Cengage Learning.

Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill.

Quantum Mechanics: Theory & Applications, A.K.Ghatak &S.Lokanathan, 2004, Macmillan.

Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.

Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, (2nd Ed), 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 behaves like Waves, T.A.Moore, 2003, McGraw Hill.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

List of Practical

1. Verification of Stefan's law using torch bulb.
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.
3. To determine the Planck's constant using LEDs of at least 4 different colours.
4. To determine the absorption lines in the rotational spectrum of Iodine vapour.
5. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
6. To determine the wavelength of laser source using diffraction of single slit. 7. To determine the wavelength of laser source using diffraction of double slits.

Reference Books

Advanced Practical Physics, B.Ghosh, K.G.Mazumder, Sreedhar Publisher

An Advanced Course In Practical Physics, D. Chattopadhyay, P.C.Rakshit, New Central Book Agency

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.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Course Name: Analog Systems and Applications

Course Code / Paper Code : HPHY3CC07L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

This course will

- Prepare the students to have a basic knowledge in the analysis of Electric Networks.
- Develop the ability to design and understand Analog circuits using discrete components as well as various applications of circuits.
- Understand the working principles of different electronic devices.
- Analyse the basics of transistor biasing and stability, and further understand the concept of multistage amplifiers and its frequency response.
- Design, develop and analyse the various applications using operational amplifiers and timer.

(a) Theory (TH) Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Semiconductor Diodes Lectures: 12

P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). 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. Current Flow Mechanism in Forward and Reverse Biased Diode.

Two-terminal Devices and their Applications Lectures: 8

Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter, pi-filter.Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.

Bipolar Junction transistors Lectures: 5

n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

Field Effect Transistors and Amplifiers — Lectures: 35

Basic principle of operations of FET.

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Frequency response of a CE amplifier. Coupled Amplifier: Two stage RC-coupled amplifier.

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise.

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

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.

Applications of Op-Amps: Linear - (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator.

Non- linear – (1) inverting and non-inverting comparators, (2) Schmidt triggers.

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation).

555 Timer: Astable multivibrator.

Reference Books

Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.

Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.

Solid State Electronic Devices, B.G.Streetman &S.K.Banerjee, 6th Edn.,2009, PHI Learning.

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

OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.

Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Ed, Oxford University Press.

Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer.

Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.

Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning.

Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

List of Practical

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 study the frequency response of voltage gain of a CE- amplifier.

6. To design a Wien bridge oscillator for given frequency using an op-amp.

7. To design a digital to analog converter (DAC) of given specifications and to study the analog to digital convertor (ADC).

8. To add two dc voltages using Op-amp in inverting and non-inverting mode.

9. To design a precision Differential amplifier of given I/O specification using Op-amp.

10. To investigate the use of an op-amp as an Integrator.

11. To investigate the use of an op-amp as a Differentiator.

Reference Books

Advanced Practical Physics (Vol II), B.Ghosh, K.G.Mazumder, Sreedhar Publisher.

OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.

Basic Electronics: A text lab manual, P.B.Zbar, A.P. Malvino, M.A.Miller, 1994, Mc-Gr Hill.

Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

CORE COURSE (PHYSICS)

SECOND YEAR

Semester – IV

Course Name: Thermal Physics

Course Code / Paper Code : HPHY4CC08L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After completion of the course, students will be able to

- Apply the knowledge in science and engineering to model the energy conversion phenomenon in various thermodynamic processes.
- Investigate the effectiveness of energy conversion process in mechanical power generation for the benefit of mankind.
- Appreciate the concepts learnt in fundamental laws of thermodynamics, from which get ideas how to sustain in energy crisis and think beyond curriculum in the field of alternative and renewable sources of energy.

(a) Theory (TH) **Credits: 4**

Total Lectures: 60 (+ 5 Tutorials)

Thermodynamics Lectures: 22

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, 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, Compressibility and Expansion Co-efficient.

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

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Entropy Changes in Reversible and Irreversible processes with examples. Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot Cycle. Entropy of the Universe. Physical significance of entropy.

Third Law of Thermodynamics : Magnetic work, Cooling due to Adiabatic Demagnetization. Unattainability of absolute zero temperature.

Maxwell's Thermodynamics Relations — Lectures: 8

Derivation and Applications of Maxwell's Relations, Expressions for$C_p - C_v$, TdS Equations, Energy equations, Joule-Thomson coefficient for Ideal and Van der Waal Gases, Change of temperature during adiabatic process.

Thermodynamics Potentials — Lectures: 10

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Theirdefinition andproperties.Equilibrium between phases, Gibb's phase rule and simple applications. First and Second Order Phase Transitions with variousexamples, Clausius - Clapeyron equation and Ehrenfest equations.

Kinetic Theory of Gases — Lectures: 20

Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.

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. Brownian Motionand its Significance.

Real Gases: Behavior of Real Gases, Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO_2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapor and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

Reference Books

Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.

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.

Thermodynamics and an introduction to thermostatistics, H. B. Callen, 1985, Wiley**.**

Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

List of Practical

1. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
2. . To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
3. . To study the variation of Thermo-Emf of a Thermocouple with difference of temperature of its two Junctions.
4. To calibrate a thermocouple to measure the melting temperature of naphthalene.
5. To determine the linear expansion coefficient of a metal by optical lever.

Reference Books

Advanced Practical Physics(Vol I & Vol II), B.Ghosh ,K.G.Mazumder, Sreedhar Publisher.

An Advanced Course In Practical Physics, D. Chattopadhyay, P.C.Rakshit, New Central Book Agency.

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.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Course Name: Electromagnetic Theory

Course Code / Paper Code : HPHY4CC09L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After the completion of the course student will

- Understand the basic of electromagnetic vector fields.
- Apply the principles of electrostatics to solve the problems related to electric field and electric potential, boundary conditions and electric energy density.
- Understand the concepts related to Faraday's law, induced emf and Maxwell's equations.
- Apply Maxwell's equations to solve the problems related to transmission lines and uniform plane wave propagation.

(a) Theory (TH) **Credits: 4**

Total Lectures: 60 (+ 5 Tutorials)

Maxwell's Equations Lectures: 20

Maxwell's equations. Displacement Current. Vector and Scalar Potentials. Gauge Transformations: Lorentz and Coulomb Gauge. Boundary Conditions at Interface between Different Media. Wave Equations. Plane Waves in Dielectric Media. Poynting Theorem and Poynting Vector. Electromagnetic (EM) Energy Density. Physical Concept of Electromagnetic Field Energy Density, Momentum Density and Angular Momentum Density.

EM Waves in an isotropic dielectric Lectures: 10

Wave equation, polarization of EM waves, reflection and refraction at plane boundary, reflection and transmission coefficients, Fresnel's formula, change of phase on reflection, polarization on reflection and Brewster's law, total internal reflection.

EM waves in conducting medium Lectures: 16

Wave equation in conducting medium, reflection and transmission at metallic surface – skin effect and skin depth, Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, application to propagation through ionosphere. propagation of E-M waves between parallel and conducting plates – wave guides (rectangular only).

Potential and Fields Lectures: 05

Scalar and Vector potentials, Coulomb and Lorentz Gauge, Retarded potentials, Lienard-Wiechert potentials.

Dispersion **Lectures: 05**

Equation of motion of an electron in a radiation field: Lorentz theory of dispersion – normal and anomalous; Sellmeier's and Cauchy's formulae, absorptive and dispersive mode, half power frequency, band width.

Scattering **Lectures: 04**

Rayleigh's scattering (qualitative ideas), blue colour of the sky, absorption, Electric dipole radiation.

Reference Books

Introduction to Electrodynamics, D.J. Griffiths, 4th Ed, PHI.

Classical Electrodynamics, J D Jackson, 3rd Ed, Wiley.

Optics, E. Hecht, 2016, Pearson.

Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.

Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

List of Practical

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of various optically active substances using Polarimeter.
3. To analyse elliptically polarized Light by using a Babinet's compensator.
4. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene etc.).
5. To verify Fresnel's equation of electromagnetic waves with the help of prism and polaroids.
6. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

Reference Books

Advanced Practical Physics(Vol I), B.Ghosh ,K.G.Mazumder, Sreedhar Publisher

An Advanced Course In Practical Physics, D. Chattopadhyay, P.C.Rakshit, New Central Book Agency.

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.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Course Name: Quantum Mechanics and Applications

Course Code / Paper Code : HPHY4CC10L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

- After the completion of this course:
- Students will gain basic understanding of quantum mechanics. They will learn different types of representations of operators and various ways of applying them in different problems.
- Students will learn how to solve Scroidinger's equation for various types of potentials and finally the hydrogen atom problem.
- Students will learn perturbative process and it's physical applications.
- Students will be able to apply quantum mechanics to understand the atomic spectra, splitting of spectral lines in electric and magnetic fields.

(a) Theory (TH) Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Schrodinger Equation Lectures: 20

Time dependent Schrodinger equation: Time dependent Schrodinger equation and dynamical evolution of a quantum state; Properties of Wave Function. Interpretation of Wave Function Probability and probability current densities in three dimensions; Conditions for Physical Acceptability of Wave Functions. Normalization. Linearity and Superposition Principles. Eigenvalues and Eigenfunctions. Position, momentum and Energy operators; commutator of position and momentum operators; Expectation values of position and momentum. Wave Function of a Free Particle.

Time independent Schrodinger equation-Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; 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, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle.

General Discussion of Bound States in an Arbitrary Potential Lectures: 10

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.

Quantum Theory of Hydrogen-like Atoms Lectures: 10

Time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers. s, p, d shells.

Atoms in Electromagnetic Field — Lectures: 10

Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.

Normal and Anomalous Zeeman Effect. Paschen-Back and Stark Effect (Qualitative Discussion only).

Many Electron Atoms — Lectures: 10

Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin- orbit coupling in atoms- L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

Reference Books

Principles of Quantum Mechanics, R.Shankar, 2nd Ed., Springer.

A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill.

Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.

Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.

Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer.

Quantum Mechanics, Eugen Merzbacher, 2004, John Wiley and Sons, Inc.

Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education.

(b) Practical (PR) — Credits: 2

Total Lectures: 30

List of Practical

1. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom. Obtain the energy eigenvalues and plot the corresponding wave-function. Ground state energy of the Hydrogen atom is 13.6 eV. Take e = 3.795 (eVÅ)1/2, ħc = 1973 (eVÅ) and m (reduced mass) = 0.511x106 eV/c^2.

2. Solve the s-wave radial Schrodinger equation for an atom:wherem is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential.

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 (eVÅ)1/2, m = 0.511x106 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12eV in all three cases.

3. Plot the probability density of ns, np, nd orbitals and interpret the results.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule system taking the Morse potential. Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: m = 940x106eV/C2, D = 0.755501 eV, α = 1.44, ro = 0.131349 Å.

Laboratory Based Experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency.

6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting.

7. To study the tunnelling effect in tunnel diode using I-V characteristics.

"This is an entirely new course added vide the BOS meeting dated 25/08/2018".

CORE COURSE (PHYSICS)

THIRD YEAR

Semester – V

Course Name: Statistical Mechanics

Course Code / Paper Code : HPHY5CC11L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

On completion of this course a student should be able to

- define and discuss the concepts of microstate and macro state of a model system, roles of entropy and free energy from the view point of statistical mechanics.
- apply the machinery of statistical mechanics to the calculation of macroscopic properties resulting from microscopic models of magnetic and crystalline systems .
- understand the Fermi-Dirac and Bose-Einstein distributions, state where they are applicable, learn how they differ and show when they reduce to the Boltzmann distribution .
- apply Fermi-Dirac distribution to the calculation of thermal properties of electrons in metals.

(a) Theory (TH) **Credits: 4**

Total Lectures: 60 (+ 5 Tutorials)

Classical Statistical Mechanics Lectures: 20

Macrostate& Microstate, Elementary Concept of Ensemble, Microcanonical ensemble, Phase Space, Entropy and Thermodynamic Probability, Canonical ensemble, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two- Energy Levels System, Grand canonical ensemble and chemical potential.

Classical Theory of Radiation Lectures: 12

Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law.

Bose-Einstein Statistics Lectures: 8

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

Quantum Theory of Radiation — Lectures: 12

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

Fermi-Dirac Statistics — Lectures: 8

Fermi-Dirac Distribution Law, Thermodynamic functions of a completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Thermionic equation: Richardson's equation.

Reference Books

Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed.,1996, Oxford University Press.

Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill

Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall

Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.

Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press.

Statistical Mechanics – an elementary outline, A. Lahiri, 2008, Universities Press.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

(b) Practical (PR) — Credits: 2

Total Lectures: 30

List of Practical

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:

a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations

b) Study of transient behavior of the system (approach to equilibrium)

c) Relationship of large N and the arrow of time

d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution

e) Computation and study of mean molecular speed and its dependence on particle mass

f) Computation of fraction of molecules in an ideal gas having speed nearthemost probable speed

2. Computation of the partition function Z for systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics:

a) Study of how Z, Average Energy, Energy Fluctuation, Specific Heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.

b) Ratios of occupation numbers of various states for the systems considered above

c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at hightemperature and low temperature.

4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.

5. Plot the following functions with energy at different temperatures:

a) Maxwell-Boltzmann distribution b) Fermi-Dirac distributionc) Bose-Einstein distribution.

Reference Books

Advanced Practical Physics (Vol I & Vol II), B.Ghosh, K.G.Mazumder, Sreedhar Publisher.

An Advanced Course in Practical Physics, D. Chattopadhyay, P.C.Rakshit, New Central Book Agency.

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.

"This is an entirely new course added vide the BOS meeting dated 25/08/2018".

Course Name: Digital Systems &Applications

Course Code / Paper Code : HPHY5CC12L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After this course student will :

- Have a thorough understanding of the fundamentals and techniques used in digital electronics.
- Understand and study the formation of combinational and sequential circuits and its applications in digital system.
- Identify, create and design the complex logical circuits problems with appropriate solutions individually or in a team.
- Operate and understand standard electronic equipment such as breadboard, pulse generator, digital multi-meters, power supplies and digital ICs to analyse, test and implement the digital circuits.
- Illustrate the basic logic gates and their realization using universal gates.
- Analyse different sequential circuits and compare its theoretical performance to actual performance.

(a) Theory (TH) Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Boolean Algebra Lectures: 10

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

Digital Circuits Lectures: 25

Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.

Sequential Circuits: SR, D, 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.

Data Processing Circuits **Lectures: 5**

Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.

Shift Registers **Lectures: 5**

Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).

Counters (4 bits) **Lectures: 5**

Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Integrated Circuits **Lectures: 10**

Active & Passive components. Discrete components. Wafer. Chip. Advantages and drawbacks of ICs. Scale of integration: SSI, MSI, LSI and VLSI (basic idea and definitions only). Classification of ICs. Examples of Linear and Digital lCs.

Reference Books

Digital Principles and Applications, A.P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw.

Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.

Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

Digital Electronics G K Kharate ,2010, Oxford University Press.

Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning

Logic circuit design, Shimon P. Vingron, 2012, Springer.

Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.

Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill.

Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

List of Practical

1. To design a switch (NOT gate) using a transistor.
2. To verify and design AND, OR, NOT and XOR gates using NAND gates.
3. To design a combinational logic system for a specified Truth Table.
4. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
5. To minimize a given logic circuit.
6. To construct Half Adder, Full Adder circuits.
7. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
8. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
9. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
10. To design an astable multivibrator of given specifications using 555 Timer.

Reference Books

Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.

Advanced Practical Physics(Vol II), B.Ghosh ,K.G.Mazumder, Sreedhar Publisher.

An Advanced Course in Practical Physics, D. Chattopadhyay, P.C.Rakshit, New Central Book Agency.

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.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Course Name: Classical Dynamics

Course Code / Paper Code : HPHY5DSE1L

Full Marks : 100 (Theory-80, Internal Assessment-20)

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After the course completion, student will be able to

- define and understand basic mechanical concepts related to discrete and continuous mechanical systems.
- describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism.
- learn the basic of Special Theory of Relativity.
- Comprehend properties of fluid in motion.

Theory (TH) Credits: 6

Total Lectures: 90 (+ 5 Tutorials)

Advanced Classical Mechanics Lectures: 30

Brief recap of Lagrangian mechanics and assorted problems.

Hamiltonian Dynamics : Legendre Transformation, Hamilton's equation of motion, Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for particle in a central force field- conservation of angular momentum and energy, Hamiltonian dynamics in an accelerated system, Hamiltonian of a charge particle moving in EM Field, Larmor's frequency , Phase space and Liouville's Theorem.

Canonical Transformations: Theory of canonical transformation, generating functions, condition for a transformation to be canonical, benefit of such transformation with specific examples. Concept of Poisson's Bracket and its relevance. Assorted problems.

Introduction to Hamilton-Jacobi Theory (basic discussions).

Small Amplitude Oscillation Lectures: 15

Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

Special Theory of Relativity Lectures: 30

Historical development. Mathematical Prerequisite: Non Orthogonal Co-ordinate Systems, Covariant and Contravariant Vectors, Introduction to Tensor Analysis.

Postulates of Special Theory of Relativity. Lorentz Transformations. Minkowski space. The invariant interval, light cone and world lines. Time-dilation, length contraction and twin paradox. Space-Time diagrams and Invariant Hyperbolae. Solving simple problems using S-T diagrams. Four-vectors: space-like, time-like and 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.

Fluid Dynamics Lectures: 15

Density and pressure in a fluid, continuum hypothesis, an element of fluid and its velocity, continuity equation, Fluid properties- viscosity, thermal conductivity, mass diffusivity, other fluid properties and equation of state, Navier-Stokes equation, incompressible and compressible flows, laminar and turbulent flows, rotational and irrotational flows, qualitative description of turbulence, experimental fluid dynamics.

Reference Books

Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.

Introduction to Classical Mechanics: With Problems and Solutions, David Morin,Cambridge University Press.

Classical Dynamics of Particles and Systems, S.T.Thornton&J.B.Marion, Cengage Learning.

Introduction to Special Relativity, Wolfgang Rindler, Oxford Science Publications.

Spacetime Physics: Introduction to Special Relativity, E.F.Taylor&J.A.Wheeler, W.H.Freeman Publication.

An Illustrated Guide to Relativity, Tatsu Takeuchi, Cambridge University Press.

An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge University Press.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Course Name: Nuclear and Particle Physics

Course Code / Paper Code : HPHY5DSE2L

Full Marks : 100 (Theory-80, Internal Assessment-20)

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After the completion of the course, Students will be able to

- Learn about the properties of nuclei, the nuclear structure and decay mechanisms.
- Signify various interaction mechanisms of nuclear radiations with matter.
- Understand the principle of nuclear radiation detectors and how to produce high energy particles required for various nuclear reactions.
- Learn about the properties of fundamental particles and their interactions.

Theory (TH) **Credits: 6**

Total Lectures: 90 (+ 5 Tutorials)

General Properties of Nuclei Lectures: 15

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

Nuclear Models Lectures: 15

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, 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.

Radioactivity Decay Lectures: 15

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

Nuclear Reactions Lectures: 10

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

Interaction of Nuclear Radiation with matter **Lectures: 7**

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

Detectors of Nuclear Radiations **Lectures: 8**

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

Particle Accelerators **Lectures: 5**

Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons. Fermi lab accelerator.

Particle Physics **Lectures: 15**

Particle interactions; basic features, types of particles and its families. The neutrinos, Symmetries and Conservation laws: angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness, Time reversal, charge conjugation, CPT theorem, Eightfold way, Quark model, quark content of mesons and baryons,color quantum number and gluons, gauge bosons, dynamics of gauge particles, Higgs boson, Symmetry breaking. Application to Astrophysics: nucleo-synthesis, CNO cylcle.

Reference Books

Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).

Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).

Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).

Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press.

Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.

Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi.

Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).

Theoretical Nuclear Physics, J.M. Blatt &V.F.Weisskopf (Dover Pub.Inc., 1991).

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

CORE COURSE (PHYSICS)

THIRD YEAR

Semester – VI

Course Name: Advanced Mathematical Physics

Course Code / Paper Code : HPHY6CC13L

Full Marks : 100 (Theory-80, Internal Assessment-20)

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome: Student will acquire

- Knowledge of linear vector space and associated mappings to solve different physical problems.
- Advanced knowledge in complex analysis and complex integral.
- Basic of integral transformation.
- Introductory knowledge in group theory and the tensor analysis as well as their applications in modern theoretical physics.

(a) Theory (TH) **Credits: 6**

Total Lectures: 90 (+ 5 Tutorials)

Complex Analysis Lectures: 25

Brief Revision of Complex Numbers, triangular inequalities, Schwarz inequalityand their Graphical Representation, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy’s Integral formula. Simply and multiply connected region. Laurent and Taylor’s expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Integral Transform Lectures: 10

Fourier and Laplace transforms and their inverse transforms, Bromwich integral [use of partial fractions in calculating inverse Laplace transforms]; Transform of derivative and integral of a function; Solution of differential equations using integral transforms.

Linear Vector Spaces Lectures: 15

Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space.Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of Linear Transformations. Non-singular Transformations. Representation of Linear

Transformations by Matrices.Inner products. Gram-Schmidt orthogonalization. Orthogonal and unitary transformations and their matrix representation.

Group Theory Lectures: 10

Review of sets, Mapping and Binary Operations, Relation, Types of Relations.

Groups: Elementary properties of groups, uniqueness of solution, Subgroup, Centre of a group, Co-sets of a subgroup, cyclic group, Permutation/Transformation. Homomorphism and Isomorphism of group. Normal and conjugate subgroups, Completeness and Kernel. Some special groups with operators. Matrix Representations: Reducible and Irreducible representations. Schur's lemma. Orthogonality theorems. Character tables and their uses. Application to small vibrations.

Cartesian Tensors Lectures: 30

Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti- symmetric Tensors. Invariant Tensors: Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors: Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities. Tensorial Formulation of Analytical Solid Geometry: Equation of a Line. Angle Between Lines. Projection of a Line on another Line. Condition for Two Lines to be Coplanar. Foot of the Perpendicular from a Point on a Line. Rotation Tensor (No Derivation). Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors: Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law.

Reference Books :

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

Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press

Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press

Complex Variables and Applications, J.W.Brown & R.V.Churchill, 7th Ed. 2003, Tata McGraw-Hill.

Mathematical Tools for Physics, James Nearing, 2010, Dover Publications

Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, Elsevier.

Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press.

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

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

Course Name: Solid State Physics

Course Code / Paper Code : HPHY6CC14L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After completion of the course:

- student will be able to analyse the crystal structures by applying crystallographic parameters.
- Students will be able to determine the crystal structure by analysis of XRD data.
- Students will be able to evaluate and analyse the electrical and optical properties of solids.
- Students will be able to analyse electron transport and energy related problems by applying quantum mechanical principles.
- Students will be able to analyse the lattice vibration phenomenon in the solids
- Student will able to understand and analyse the properties of semiconductors.

(a) Theory (TH) — Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Crystal Structure — Lectures: 10

Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.

Elementary Lattice Dynamics — Lectures: 10

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.

Magnetic Properties of Matter — Lectures: 15

Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and energy loss.

Dielectric Properties of Matter — Lectures: 10

Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. ClausiusMosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes.

Ferroelectric Properties of Materials — Lectures: 5

Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Elementary Band Theory — Lectures: 5

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.

Superconductivity — Lectures: 5

Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London’s Equation and Penetration Depth. Isotope effect. Idea of BCS theory (no derivation).

Reference Books

Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.

Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India

Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill

Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning

Solid State Physics, Rita John, 2014, McGraw Hill

Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India

Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

List of Practical

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

Reference Books

Advanced Practical Physics, B.Ghosh, K.G.Mazumder, Sreedhar Publisher

An Advanced Course In Practical Physics, D. Chattopadhyay, P.C.Rakshit.

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.

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Course Name: Nano-materials and Applications

Course Code / Paper Code : HPHY6DSE3L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After the completion of course student will

- Learn about the background on Nanoscience and broad outline of Nanoscience and Nanotechnology.
- Understand the synthesis and characterization techniques of nanomaterials, their applications and the impact of nanomaterials on environment.
- The different physical and chemical properties of nanomaterials and how they differ from the bulk one.
- Apply their learned knowledge to develop small scale devices.
- How to synthesis semiconducting nanocrystals and form nanodevices using chemical route.

(a) Theory (TH) — Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Nano-scale Systems — Lectures: 10

Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods), Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

Synthesis of Nanostructure Materials — Lectures: 10

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

Characterization — Lectures: 5

X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

Optical Properties Lectures: 15

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

Electron Transport Lectures: 5

Carrier transport in nano-structures. Coulomb blockade effect, thermionic emission, tunnelling and hoping conductivity. Defects and impurities: Deep level and surface defects.

Applications Lectures: 15

Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots -magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

Reference Books

C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).

S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)

K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).

Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).

Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.

Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

"This is an entirely new course added vide the BOS meeting dated 25/08/2018".

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

List of Practical

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

Reference Books

C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).

S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)

K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).

Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

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Course Name: Project Work

Course Code / Paper Code : HPHY6DSE4L

Full Marks : 100 (Supervisor-30, Project Report-20, Project Dissertation-50)

Course outcome

The outcomes of project-based learning are :

- Students learn project management.
- They grow more empathetic.
- They become systems thinkers.
- They become explorers.
- They become problem-solvers.
- They become wildly and unabashedly different.
- They are more engaged in the learning process.
- They are ready for the creative.
- They engage in iterative thinking.
- They make deep connections between ideas.
- They learn to take creative risks.
- They apply fundamental and disciplinary concepts and methods in ways appropriate to their principal areas of study.
- They demonstrate skill and knowledge of current information and technological tools and techniques specific to the professional field of study.
- Use effectively oral, written and visual communication.
- Identify, analyse, and solve problems creatively through sustained critical investigation.
- Integrate information from multiple sources.
- Demonstrate an awareness and application of appropriate personal, societal, and professional ethical standards.
- Practice the skills, diligence, and commitment to excellence needed to engage in lifelong learning.

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SYLLABUS FOR CBCS UG PHYSICS
GENERIC ELECTIVE COURSE

RAMAKRISHNA MISSION RESIDENTIAL COLLEGE (AUTONOMOUS) NARENDRAPUR

2018-19

GENERIC ELECTIVE COURSE (PHYSICS)

Course Name: Mechanics and Thermal Physics

Course Code / Paper Code : HPHYGE01L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

- This section enables students to think the modelling of physical problem as well as experiments and limitation of experiments. It develops the application level thinking and makes the students understand the reality of physical phenomena.
- The knowledge of heat is very important in our daily life, such as warming the house, cooking, heating the water and drying the washed clothes. Here basic laws of physics are taught. They will learn about many usages in the industry. The other knowledge the students will acquire is about the internal energy and thermodynamic potentials, which are useful for determining conditions for equilibrium and spontaneous processes.

(a) Theory (TH) **Credits: 4**

Total Lectures: 60 (+ 5 Tutorials)

UNIT-1 :Mechanics Lectures: 30

Vector Analysis Lectures: 4

Review of vector algebra (Scalar and Vector product), 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 (statement only).

Ordinary Differential Equation Lectures: 4

1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.

Laws of Motion Lectures: 3

Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.

Rotational Motion Lectures: 3

Angular velocity and angular momentum. Torque. Conservation of angular momentum.

Gravitation **Lectures: 6**

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. Physiological effects on astronauts.

Oscillations **Lectures: 3**

Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations.

Elasticity **Lectures: 7**

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.

UNIT-2 : Thermal Physics Lectures: 30

Laws of Thermodynamics **Lectures: 12**

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P and C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams.

Thermo-dynamical Potential **Lectures: 6**

Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications, General expressions for $(C_P – C_V)$, C_P/C_V ,TdS equations, Joule-Thomson Effect, Clausius- Clapeyron Equation.

Kinetics Theory of Gases **Lectures: 6**

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.

Theory of Radiation **Lectures: 6**

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.

Reference Books

Mechanics Berkeley Physics, v.1: Charles Kittel, et.al. 2007, Tata McGraw-Hill.

Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.

Heat and Thermodynamics, M.W.Zemansky and R. Dittman, 1981, McGraw Hill.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

1. Measurements of length (or diameter) using slide callipers, screw gauge and travelling microscope.

2. Determination of moment of inertia of a metallic cylinder/rectangular bar about an axis passing through its c.g.

3. Determination of modulus of rigidity of the material of a wire by dynamical method.

4. Determination of Young's modulus of the material of a beam by the method of flexure (single length only).

5. To determine the value of g using bar pendulum.

6. To determine the coefficient of linear expansion of a metallic rod using an optical lever.

7. Determination of the pressure coefficient of air.

8. To estimate the temperature of a torch bulb filament from resistance measurement and to verify Stefan's law.

9. To determine the thermal conductivity of a bad conductor of heat by Lee's and Chorlton's method.

Reference Books

Practical Physics, B.Ghosh, K.G.Mazumder, Sreedhar Publisher

An Advanced Course in Practical Physics, D. Chattopadhyay, P.C.Rakshit, New Central Book Agency.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

GENERIC ELECTIVE COURSE (PHYSICS)

Course Name: Optics and Electricity-Magnetism

Course Code / Paper Code : HPHYGE02L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

- Learn the various properties of light, applications of interferometry in industry, such as the measurement of small displacements, refractive index changes.
- Electricity and magnetism are two very important topics in the science of physics. They give the information about the natural laws and to control the machine. We use these facts to build motors and generators.

(a) Theory (TH) **Credits: 4**

Total Lectures: 60 (+ 5 Tutorials)

UNIT-1 : Optics Lectures: 30

Wave Nature Lectures: 2

Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

Interference Lectures: 12

Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Fresnel's Bi-prism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.

Diffraction Lectures: 10

Fresnel Diffraction: Half-period zones, Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. Fraunhofer diffraction - Single slit; Double Slit, Multiple slits and Diffraction grating.

Polarization Lectures: 6

Transverse nature of light waves, Plane polarized light – production and analysis,Brewster's law, Double refraction, Circular and Elliptical polarization, Optical activity, Fresnel's theory of optical activity, Polarimeters.

UNIT-2 : Electricity - Magnetism   Lectures: 30

Electrostatics	**Lectures: 15**

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.

Magnetism	**Lectures: 8**

Magnetostatics: Biot-Savart law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law.

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro- magnetic materials.

Basic Electronics	**Lectures: 7**

P-N junction diode, Various opto-electronic devices-Photo-diode, LED, semiconductor laser, bridge rectifier, filter circuits, Zener diode, voltage regulator, Transistors.

Boolean algebra, Boolean identities, De Morgan’s theorems, study of different logic gates.

Reference Books

Principles of Optics, B.K. Mathur, 1995, Gopal Printing

Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications

Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill

Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education

Electricity & Magnetism, J.H. Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press

D.J.Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

(b) Practical (PR) **Credits: 2**

Total Lectures: 30

1. To determine the wavelength of a monochromatic light by Newton's ring method.

2. To calibrate a polarimeter and hence to determine the concentration of sugar solution.

3. Determination of the focal length of a concave lens by auxiliary lens method or by combination method.

4. Determination of horizontal component of earth's magnetic field by using magnetometer.

5. To draw the I-V characteristic of i) resistor and ii) a P-N junction diode in forward bias condition. (Plot both the characteristic curves on the same graph paper.) Estimate from the graphs i) the resistance of the resistor and ii) the dynamic resistance of the diode for three different currents. One current should correspond to the intersecting point of the two curves.

6. To draw the I-V characteristics of a bridge rectifier: (i) without using any filter and (ii) using a capacitive filter. (Percentage voltage regulation to be calculated for each case at a specified load current).

7. To draw the reverse characteristics of a Zener diode & to study its voltage regulation characteristics using a variable load. (Breakdown region to be identified on the graph and Percentage voltage regulation to be calculated for two load currents.)

8. To draw the output characteristics of a transistor in C-E configuration (for at least 5 base currents) and hence to determine the A.C. current gain from the active region of the characteristics.

9. To verify the truth tables of OR, AND logic gates using diodes and construction of AND, OR and NOT gates using NOR / NAND IC gates on breadboard.

Reference Books

Advanced Practical Physics (Vol. I & II), B.Ghosh,K.G.Mazumder, Sreedhar Publisher.

An Advanced Course in Practical Physics, D. Chattopadhyay, P.C.Rakshit, New Central Book Agency.

"Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018".

GENERIC ELECTIVE COURSE (ELECTRONICS)

Course Name: Electronic devices, Analog and Digital circuit designing

Course Code / Paper Code : HELEGE01L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

After the course student will acquire

- fundamental knowledge on the electrical circuit designing, Analog and digital circuit design methods for proper understanding of various modern technologies.
- very important knowledge on different semiconductor devices and their properties that will help the students to understand the applications and modern development of the field.

(a) Theory (TH) Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Unit-1 Network theorem (09 Lectures)

Thevenin's theorem, Norton's theorem and interconversion, superposition theorem, maximum power transfer theorem. Concept of 3 phase network, T-Pi transform

Unit 2 Semiconductor devices and circuits (20 Lectures)

Semiconductor Diode and its applications: PN junction diode and characteristics. HWR, FWR- center tapped and bridge FWRs. Circuit diagrams, working and waveforms, ripple factor &efficiency(no derivations).Filters: circuit diagram and explanation of shunt capacitor filter with waveforms. Wave shaper circuits.

Zener diode regulator: circuit diagram and explanation for load and line regulation, disadvantages of Zener diode regulator.

BJT and Small Signal amplifier: Bipolar Junction Transistor: Construction, principle & working of NPN transistor, terminology. Configuration: CE, CB. Definition of α, β and γ and their interrelations, leakage currents. Study of CE Characteristics, Hybrid parameters.

Transistor biasing: need for biasing, DC load line, operating point, thermal runaway, stability and stability factor. Voltage divider bias: circuit diagrams and their working, Q point expressions for voltage divider biasing. Small signal CE amplifier

Field effect transistor: concept of FET and MOSFET, CMOS circuits.

Unit-3 Digital System Design (25 Lectures)

Boolean algebra and Logic gates: K-map-3 and 4 variable expressions. Characteristics of logic families: Fan In and Fan out, power dissipation and noise Immunity, propagation delay, comparison of TTL and CMOS families.

Combinational logic analysis and design: Multiplexers and Demultiplexers, Adder (half and full) and their use as subtractor, Encoder and Decoder, Multiplexer and De-multiplexer

Sequential logic design: Latch, Flip flop, S-R FF , J-K FF, T and D type FFs, clocked FFs, registers, Counters (ripple, synchronous and asynchronous, ring, modulus).

Unit-4 Introduction to VHDL programming (06 Lectures)

VHDL: A Brief History of HDL, Structure of HDL Module, Comparison of VHDL and Verilog, Introduction to Simulation and Synthesis Tools, Test Benches.

VHDL: Module, Delays, brief description - data flow style, behavioral style, structural style, mixed design style, simulating design. Language Elements, Introduction, Keywords, Identifiers, White Space Characters, Comments, format, Integers, reals and strings. Logic Values, Data Types-net types, undeclared nets, scalars and vector nets, Register type, Parameters. Operands, Operators, types of Expressions.

(b) Practical (PR) Credits: 2

Total Lectures: 30

Experiments:

1. Verification of Thevenin's and Norton's theorem and Verification of Maximum power transfer theorem.
2. Half wave and Full wave rectifier Rectifier – without and with shunt capacitance filter.
3. Zener diode as voltage regulator – load regulation.
4. Transistor characteristics in CE mode – determination of r_i, r_o and β.
5. To verify and design AND, OR, NOT and XOR gates using NAND gates.
6. Design a Half and Full Adder.
7. Design a 4 X 1 Multiplexer using gates.
8. To build a Flip- Flop Circuits using elementary gates. (RS, Clocked RS, D-type).
9. Design a counter using JK Flip-Flop.

Computer simulations (VHDL)

1. Write code to realize basic and derived logic gates.
2. Half adder, Full Adder using basic and derived gates.
3. Half subtractor and Full Subtractor using basic and derived gates.
4. Clocked D FF, T FF and JK FF (with Reset inputs).
5. Multiplexer (4x1, 8x1) and Demultiplexer using logic gates.

6. Decoder (2x4, 3x8), Encoders and Priority Encoders.

7. Design and simulation of a 4 bit Adder.

Suggested Books:

1. Electronic Devices and circuit theory, Robert Boylstead and Louis Nashelsky, 9th Edition, 2013, PHI

2. Electronics text lab manual, Paul B. Zbar.

3. Electric circuits, JoesephEdminister, Schaum series.

4. Basic Electronics and Linear circuits, N.N. Bhargava, D.C. Kulshresta and D.C Gupta -TMH.

5. Electronic devices, David A Bell, Reston Publishing Company/DB Tarapurwala Publ.

8. Solid state electronic devices, Ben. G. Streetman and Sanjay Kumar Banerjee, PHI (7^{th} Ed)

9. Electronics fundamentals and applications, D. Chattopadhyay and P. C. Rakshit, New Age International Publishers, 12^{th} Ed.

10. Electronic Devices and circuits, Jacob Millman and Halkias

11. M. Morris Mano Digital System Design, Pearson Education Asia,(Fourth Edition)

12. Thomas L. Flyod, Digital Fundamentals, Pearson Education Asia (1994)

13. W. H. Gothmann, Digital Electronics: An Introduction To Theory And Practice, Prentice Hall of India(2000)

14. R. L. Tokheim, Digital Principles, Schaum’s Outline Series, Tata McGraw- Hill (1994)

15. A Verilog HDL Primer – J. Bhasker, BSP, 2003 II Edition.

16. Verilog HDL-A guide to digital design and synthesis-Samir Palnitkar, Pearson, 2nd edition.

“Highlighted portion has been revised/added vide the BOS meeting dated 25/08/2018”.

Course Name: Applied Electronics

Course Code / Paper Code : HELEGE02L

Full Marks : 100 (Theory-50, Practical-30, Internal Assessment-20)

[Practical : LNB-05, VIVA-05, Experiemnt-20]

[Internal Assessment : Class Test, Mid Sem. Exam., Attendance]

Course outcome:

- will acquire fundamental knowledge and problem-solving skills on practical field of electronics in multidisciplinary applications and could be able to forward the knowledge towards new technological goals.
- will acquire very important knowledge on instrumentation and sensing methods that will help the students to understand the applications of automation in present days technology.
- will acquire rudimentary knowledge and problem-solving skill on one of the most recent and advanced technology named communication technology for multidisciplinary applications.

(a) Theory (TH) Credits: 4

Total Lectures: 60 (+ 5 Tutorials)

Unit-1 Operational Amplifier and Timer circuits (20 Lectures)

Operational Amplifier: Inverting and non-inverting amplifier, Op-amp parameters, Summing Amplifier, Difference Amplifier, Integrator, Differentiator, Instrumentation Amplifier, Audio Amplifier(LM386), Voltage to current converter, Current to Voltage converter, Sample and Hold circuits. First order active filters (Circuit diagram and formula only): low pass, high pass, band pass, band reject and all pass filters. Phase-shift & Wein bridge oscillator using op-amp.
Timer: Functional block diagram of 555 timer, Monostable operation and its Application, Astable operation and its Applications.

Unit 2 *Instrumentations* (10 Lectures)

A-D and D-A Conversion: Circuit of R-2R ladder- Basic concept. A-D conversion characteristics, successive approximation ADC.
Transducers (Basic Working): Hall effect sensors, magneto-strictive transducers, Microphone, Touch Switch, Piezoelectric sensors, light(photo-conductive, photo emissive, photo voltaic, semiconductor, LDR), Temperature (electrical and non-electrical), Pressure sensor.
Oscilloscopes: Working principle of CRT, wave form display and electrostatic focusing, time base and sweep synchronisation, measurement of voltage, frequency and phase by CRO.
Signal Generators: Pulse Generator, Function generators.

Unit-3 Analog Communications (15 Lectures)

Diagram of electronic communication system. Modulation-need and types of modulation.

Amplitude modulation – representation, modulation index, expression for instantaneous voltage, power relations, frequency spectrum, DSBFC, DSBSC and SSBSC (mention only). Limitations of AM. Demodulation- AM detection: principles of detection, linear diode, principle of working and waveforms. Block diagram of AM transmitter and Receiver.

Frequency Modulation/demodulation techniques: Frequency Modulation: definition, modulation index, FM frequency spectrum diagram, bandwidth requirements, frequency deviation and carrier swing, FM generator-varactor diode modulator. FM detector – principle, slope detector-circuit, principle of working and waveforms. Block diagram of FM transmitter and Receiver. Comparison of AM and FM.

Phase Modulation/ demodulation: Phase Modulation: definition, modulation index, PM frequency spectrum diagram.

Unit-4 Digital communication systems (15 Lectures)

Digital communication: Introduction to pulse and digital communications, sampling theorem, types- PAM, PWM, PPM, PCM – quantization, advantages and applications, digital modulations (FSK, PSK, and ASK). Advantage and disadvantages of digital transmission, characteristics of data transmission circuits – Shannon limit for information capacity, bandwidth requirements, data transmission speed, noise, cross talk, echo suppressors, distortion and equalizer, TDMA, FDMA, CDMA concepts, architecture (block diagram) of cellular mobile communication network, Comparative study of GSM and CDMA, 2G, 3G and 4G concepts.

Suggested Books:

1. Electronic Communication, George Kennedy, 3rd edition, TMH.
2. Electronic Communication, Roddy and Coolen, 4th edition, PHI.
3. Electronic Communication systems, Kennedy & Davis, IV edition-TATA McGraw Hill.
4. Advanced Electronic Communication systems, Wayne Tomasi- 6th edition, Low priced edition-Pearson education.

Credits: 2

(b) Practical (PR)

Total Lectures: 30

Experiment

1. Study of basic monostable multivibrator
2. Study of basic astable multivibrator
3. Study of basic inverting and non-inverting amplifier
4. Study of basic integrator and differentiator circuit
5. Design of first order LPF, HPS, BPF

Computer simulations

1. Amplitude modulator and Amplitude demodulator
2. Study of FM modulator
3. Study of VCO using IC 566

Suggested Books:

1. Measurement Systems, 4/e, Doeblin McGraw Hill, New York, 1992.
2. Electrical Measurements & Electronic Measurements by A.K. Sawhney
3. Instrumentation- Devices and Systems ByRangan, Sarma, and Mani, Tata-McGraw Hill
4. Electronic Instrumentation by H.S Kalsi, McGraw Hill
5. Instrumentation measurements and analysis by Nakra& Choudhary
6. Measurement & Instrumentation- DVS Murthy
7. R. A. Gayakwad, Op-Amps and Linear IC's, Pearson Education (2003)
8. Electronic Sensor Circuits and Projects, III Volume, Forrest M Mims, Master Publishing Inc.

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