Choice Based Credit System (CBCS)

NOWGONG COLLEGE
(AUTONOMOUS)

SYLLABUS

DEPARTMENT OF PHYSICS

Learning Outcomes-based Curriculum Framework (LOCF)
of
Undergraduate Programme

BACHELOR OF SCIENCE IN PHYSICS

(Effective from Academic Year 2020-21)

Syllabus as approved by Academic Council, Nowgong College (Autonomous)

1. Introduction to the Programme

B.Sc. (Honours) Physics is a three-year undergraduate program with specialization in Physics. The programme fosters interdisciplinary approach to the study of Physics, Mathematics, Statistics and Computers aiming to promote holistic education useful in handling social, economics, engineering, physical and bio-sciences problems. The curriculum is dispensed using a combination of classroom teaching, project-based learning, practical's, group discussions, presentations, home assignments, industry interactions and exposure, internships and fieldwork.

B.Sc. (Honours) Physics programme is designed in such a way that students will be exposed to the physics related issues, data, its manifestation to industries and society, capable of identifying the problems and working towards their solutions through various physical theories and analytical techniques. The course is designed in such a way that students can absorb strong foundation of physics.

2. Programme Structure

The B.Sc. Physics is a three-year programme divided into six semesters. A student is required to complete 148 credits for the completion of programme as Honours student and 132 credits for the completion of programme as Regular student.

The B.Sc. (Honours Course) in Physics programme is aligned with CBCS structure as -

Honours Course		**Credits**					
		Theory with Practical					
		Theory	**Practical**	**Total**			
Honours Core Course HCC (14 Papers)		14x4=56	14x2=28	84			
Discipline Specific Elective Course HDS (4 Papers)		4x4=16	4x2=8	24			
Honours Generic Elective Course HGE (4 Papers)		4x4=16	4x2=8	24			
Ability Enhancement Course AEC	Communication Language (1 Paper)	1x4=4	0	4			
	Environmental Studies (1 Paper)	1x4=4	0	4			
Skill Enhancement Course SEC (2 Papers)		2x2=4	2x2=4	8			
Total		100	48	148			

The B.Sc. (Regular Course) in Physics programme is aligned with CBCS structure as -

Regular Course		**Credits**					
		Theory with Practical					
		Theory	**Practical**	**Total**			
Regular Core Course RCC (12 Papers)		12x4=48	12x2=28	76			
Discipline Specific Elective Course RDS (6 Papers)		6x4=24	6x2=8	32			
Ability Enhancement Course AEC	Communication Language (1 Paper)	1x4=4	0	4			
	Environmental Studies (1 Paper)	1x4=4	0	4			
Skill Enhancement Course SEC (4 Papers)		4x2=8	4x2=8	16			
Total		88	44	132			

3. Details of Courses in the Programme

Honours Course for Science

Ability Enhancement Compulsory Course (AECC) papers

ENGL/ASSA/HIND/BENG -AEC-1014 ……. (Theory)

ENST-AEC-2014 …….. (Theory)

Honours Core Course (HCC) papers

PHYS-HCC-1016 Mathematical Physics - I (Theory+ Practical)

PHYS -HCC-1026 Mechanics (Theory+ Practical)

PHYS -HCC-2016 Electricity and Magnetism (Theory+ Practical)

PHYS -HCC-2026 Waves and Optics (Theory+ Practical)

PHYS -HCC-3016 Mathematical Physics – II (Theory+ Practical)

PHYS -HCC-3026 Thermal Physics (Theory+ Practical)

PHYS -HCC-3036 Digital Systems and Applications (Theory+ Practical)

PHYS -HCC-4016 Mathematical Physics - III (Theory+ Practical)

PHYS -HCC-4026 Elements of Modern Physics (Theory+ Practical)

PHYS -HCC-4036 Analog Systems and Applications (Theory+ Practical)

PHYS -HCC-5016 Quantum Mechanics and Applications (Theory+ Practical)

PHYS -HCC-5026 Solid State Physics (Theory+ Practical)

PHYS -HCC-6016 Electromagnetic Theory (Theory+ Practical)

PHYS -HCC-6026 Statistical Mechanics (Theory+ Practical)

Discipline Specific Elective Papers

PHYS -HDS-5016 Physics of Devices and Instruments (Theory+ Practical)

PHYS -HDS-5026 Nuclear and Particle Physics (Theory+ Practical/Tutorial)

PHYS -HDS-6016 Nano Materials and Applications (Theory+ Practical)

PHYS -HDS-6026 Dissertation (Work+ Presentation)

Skill Enhancement Course papers (2 papers to be selected as applicable from the pool table)

XXXX-SEC-3014 (Theory+ Practical/Presentation)

XXXX-SEC-4014 (Theory+ Practical/Presentation)

Honours Generic Elective Papers [HGE] (to be offered to other Departments/Disciplines)

PHYS –HGE-1016 Mechanics (Theory+ Practical)

PHYS - HGE -2016 Electricity and Magnetism (Theory+ Practical)

PHYS - HGE -3016 Thermal Physics and Statistical Mechanics (Theory+ Practical)

PHYS - HGE -4016 Waves and Optics (Theory+ Practical)

Regular Core Course (RCC) for Science

Ability Enhancement Compulsory Course (AECC) papers

ENGL/ASSA/HIND/BENG-AEC-1014 ……. (Theory)

ENST-AEC-2014 …….. (Theory)

Regular Core Papers

PHYS –RCC-1016 Mechanics (Theory+ Practical)

PHYS - RCC -2016 Electricity and Magnetism (Theory+ Practical)

PHYS - RCC -3016 Thermal Physics and Statistical Mechanics (Theory+ Practical)

PHYS - RCC -4016 Waves and Optics (Theory+ Practical)

Discipline Specific Elective Papers

PHYS -RDS-5016 Nuclear and Particle Physics (Theory+ Tutorial)

PHYS -RDS-6016 Nano Materials and Applications (Theory+ Practical)

Skill Enhancement Courses (4 papers to be selected as applicable from the pool table)

XXXX -SEC-3014 (Theory+ Practical/Presentation)

XXXX -SEC-4014 (Theory+ Practical/Presentation)

XXXX -SEC-5014 (Theory+ Practical/Presentation)

XXXX- SEC-6014 (Theory+ Practical/Presentation)

4. Semester-wise distribution of Courses

A) Semester wise distribution of honours course (Science)

SEM	Credit					
	Honours Core Course (HCC) 14X6=84 (L+P)/(L+Tu) 4+2	Ability Enhancement Course (AEC) 2X4=8 (L) 4	Skill Enhancement Course (SEC) 2x4=8 (L+P) 4+2	Honours Discipline Specific Elective (HDS) 4x6=24 ((L+P)/(L+Tu) 4+2 / (W+P) 4+2	Honours Generic Elective (HGE) 4x6=24 (L+P)/(L+Tu) 4+2	Total
I	PHYS-HCC-1016 PHYS-HCC-1026	ENGL/ASSA/ HIND/BENG-AEC-1014			XXXX-HGE-1016	22
II	PHYS-HCC-2016 PHYS-HCC-2026	ENST-AEC-2014			XXXX-HGE-2016	22
III	PHYS-HCC-3016 PHYS-HCC-3026 PHYS-HCC-3036		XXXX-SEC-3014		XXXX-HGE-3016	28
IV	PHYS-HCC-4016 PHYS-HCC-4026 PHYS-HCC-4036		XXXX-SEC-4014		XXXX-HGE-4016	28
V	PHYS-HCC-5016 PHYS-HCC-5026			PHYS-HDS 5016 PHYS-HDS-5026		24

VI	PHYS-HCC-6016 PHYS-HCC-6026			PHYS-HDS-6016 PHYS-HDS-6026		24
Total						148

B) Semester-wise distribution of Regular Course (Science)

SEM	Credit					
	Regular Core Course (RCC) 12X6=72 (L+P)/(L+Tu) 4+2	Ability Enhancement Course (AEC) 2X4=8 (L) 4	Skill Enhancement Course (SEC) 4x4=16 (L+P) 2+2	Regular Discipline Specific Elective (RDS) 6x6=36 (L+P)/(L+Tu) 4+2		Total
I	PHYS-RCC-1016	ENGL/ASSA/HIND/BENG-AEC-1014				22
II	PHYS-RCC-2016	ENST-AEC-2014				22
III	PHYS-RCC-3016		PHYS-SEC-3014			22
IV	PHYS-RCC-4016		PHYS-SEC-4014			22
V			PHYS-SEC-5014	PHYS-RDS-5016		22
VI			XXXX-SEC-6014	PHYS-RDS-6016		22
Total						132

5. Graduate Attributes

On completion of the programme students are expected to have acquired the skills of effective communication, critical thinking, research methods and social outreach. The attributes expected from the graduates of B.Sc. (Honours) Physics are:

i. A holistic knowledge and understanding of basic concepts in physics and its application with arts, science, commerce and technology.

ii. The capacity to identify, understand and solve the problems of society.

iii. Team building and leadership skills, communication, creative and critical thinking skills, and innovative problem-solving skills.

iv. To enable the students to understand basic concepts and aspects related to research, various techniques to collect the data to analyse the data and interpret the results thereafter.

vi. Learning the basic programming languages and various softwares (Mathematica, MATLAB, SciLab, Origin etc.) will help the students.

6. Programme Objectives

i. To imbibe strong foundation of physics in students.

ii. To make acquainted students with basic to high-level physics concepts.

iii. To update students with mathematical tools that aid in physics theory.

iv. To teach/strengthen students' knowledge of programming languages and mathematical physics packages.

v. To promote application-oriented pedagogy by exposing students to real world data.

vi. To make students do projects, which prepares them for jobs/markets.

7. Programme Learning Outcomes

This program exposes students to the beautiful world of physics and how it affects all aspects of daily life. This course aims to provide students with all major physics concepts and the necessary theory to implement them. The facts of nature and the ability to link the facts by observation and to discover the laws of nature by developing an understanding and knowledge of the basic physics. The ability to implement this knowledge for analyzing new facts and learning skills and tools like mathematics, engineering and technology, to find the solution, interpreting results and make predictions for the future progress. Also, various computational software would help to analyze data as well as optimizing the use of time and resources. These software provide the necessary support and advantages for their careers. Exposure to a large amount of real-life data helps to improve their analytical skills. To a large extent, this teaching method provides them with the motivation and confidence to start working as a learned physicist in the near future. The course structure also motivates / assists students to pursue careers in related disciplines.

8. Teaching Learning Process

The Department of Physics at Nowgong College (Autonomous) is primarily responsible for organizing the Bachelor of Science course (Honours) Physics. Tutorial and practice related instructions are provided under the general guidance of Department of Physics of Nowgong College (Autonomous).

There shall be 90 instructional days excluding examination in a semester.

9. Teaching Pedagogy

Teaching Pedagogy involves classroom interaction, discussion, lectures, course-based practical work, viva-voce, mock test, demonstration, presentation, classroom tests, and assignments. The achievement of course is described in each course papers as learning outcomes in detail.

10. Assessment Methods/Evaluation System

The students registered for academic programmes will study semester I to VI at the Nowgong College (Autonomous) and during these semesters Core, AECC, HDS, RDS and SEC courses are offered.

(i) English shall be the medium of instruction and examination for Honours course and English/Assamese for Generic Elective course and Regular course.

(ii) Examinations shall be conducted at the end of each Semester as per the Academic calendar notified by the Nowgong College (Autonomous).

(iii) The assessment broadly comprises of Internal Assessment (Sessional Examination, Attendance, Assignments) and End Semester Examination.

(iv) Theory papers without practical/presentation i.e. only Ability Enhancement Compulsory Course (AEC) Papers consist of total 100 marks divided into 80 marks for theory, 20 marks for internal assessment.

(v) Theory papers with practical/presentation i.e Core Courses (CCC- EN; CCC-ASSA, HIND, BENG and ALEN; HCC; RCC). Discipline Specific Electives (HDS & RDS), Generic Electives (HGE & RGE), Skill Enhancement Courses (SEC) consist of total 100 marks divided into 60 marks for theory, 20 marks for internal assessment and 20 marks for Practical/Presentation.

(vi) Internal assessment of 20 marks is comprises with 06 marks from assignment, 10 marks from sessional examination and 4 marks from attendance.

(vii) Each practical paper will carry 20 marks including 15 marks for continuous evaluation and 2 marks for practical note book and 3 marks for the oral test or *viva voce*.

Hardcopy of practical file has to be maintained by the students for each practical paper and has to be submitted in the concerned department at the time of examination.

(viii) Each presentation will carry 20 marks including 15 marks for continuous evaluation and 2 marks for presented report and 3 marks for the oral test or *viva voce*. The departments will decide the process of continuous evaluation for the task carried-out against the presentation.

Hardcopy of the report has to be maintained by the students for each presented paper and has to be submitted in the concerned department at the time of examination.

(ix) The dissertation paper in 6^{th} semester (Paper Code: PHYS-HDS-6026) consists of 100 marks where 70 marks for the work and 30 marks for presentation.

B.SC. (HONOURS) IN PHYSICS
HONOURS CORE COURSE (HCC) PAPERS

SEMESTER I

PAPER CODE: PHYS-HCC-1016

Mathematical Physics I

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of course is on applications in solving problems of interest to physicists.
2. The objective of the practical in this subject is emphasized on nurturing the computational skills of the students.
3. To be able to solve physical problems and as well as to construct the computational problems to be solved.

Learning outcome: -

1. Successful students would be able to understand vector and its applications in various fields, differential equations and its applications, different coordinate systems, concept of probability and error.
2. The students would be able to understand the physical problems by solving it computationally and make them familiar with various software, which will be helpful in their higher education and in various jobs as well.

CONTENTS:

THEORY:

UNIT 1:VECTOR CALCULUS (LECTURES 24)

Revision: 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 derivatives. 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).

UNIT 2: FIRST AND SECOND ORDER DIFFERENTIAL EQUATIONS (LECTURES 14)

First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration

UNIT 3: ORTHOGONAL CURVILINEAR COORDINATES (LECTURES 8)

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

UNIT 4: DIRAC DELTA FUNCTION AND ITS PROPERTIES (LECTURES 6)

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

UNIT 5: INTRODUCTION TO PROBABILITY (LECTURES 4)

Independent random variables: Probability distribution functions; binomial, Gaussian and Poisson, with examples. Mean and variance.

UNIT 6: THEORY OF ERRORS (LECTURES 4)

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error.

PRACTICAL:

1. **Introduction and Overview:** Computer architecture and organization, memory and Input/output devices
2. **Basics of scientific computing:** Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow & overflow- emphasize the importance of making equations in terms of dimensionless variables, Iterative methods.
3. **Review of C & C++/Python/ Matlab/ Mathematica Programming fundamentals:** Introduction to Programming, constants, variables and data types, operators and Expressions I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (if statement. if-else Statement. Nested if Structure. else-if Statement. Ternary Operator. Goto Statement. switch Statement. Unconditional and Conditional Looping. while Loop. do-while Loop. for Loop. break and continue Statements. Nested Loops), Arrays (1D & 2D) and strings, user defined functions, Structures and Unions, Idea of classes and objects.

4. **Programs:** Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search.
5. **Random number generation:** Area of circle, area of square, volume of sphere, value of pi (π).
6. **Solution of Algebraic and Transcendental equations by Newton Raphson methods:** Solution of linear and quadratic equation, solving $\alpha = \tan \alpha$, $I = I_0(\sin \alpha/\alpha)^2$ in optics.
7. **Interpolation by Newton Gregory Forward and Backward difference formula:** Evaluation of trigonometric functions e.g. $\sin \theta$, $\cos \theta$, $\tan \theta$ etc.
8. **Numerical Integration (Trapezoidal and Simpson rules), Monte Carlo method:** Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop.
9. **Solution of Ordinary Differential Equations (ODE):** First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods: First order differential equation (a) Radioactive decay (b) Newton's law of cooling**.**

SUGGESTED READINGS:

Text Books

- Mathematical Physics, H.K. Das and Dr. Rama Verma, 7th Edition, 2014, S Chand.
- Principles of Mathematical Physics, SP Kuila, 2015, NCBA.
- Mathematical Physics, BD Gupta, 4th Edition, Vikas Publishing House Pvt. Ltd.
- Mathematical methods in Physics, D Biswas, 2nd Edn, 2015, NCBA
- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
- Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.

References

- Advanced Engineering Mathematics, Erwin Kreyszig, 10th Edition, 2011, Wiley India.
- Differential Equations with Applications and Hostorical Notes, George Simmons,2nd Edition, 2017, McGraw Hill Education.
- An introduction to ordinary differential equations, E. A. Coddington, 2009, PHI.
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn.2007, Cambridge University Press.
- A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn . , 2007 , Wiley India Edition.
- Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.

PAPER CODE: PHYS-HCC-1026

Mechanics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To get acquaintance with the dynamics of the system of particles, motion, elasticity.
2. To understand the concept of gravitation and special theory of relativity.

Learning outcome: -

1. The successful students would be able to develop the knowledge on the mechanics and dynamics of the particles and special theory of relativity and can apply its concept on various physical phenomena.
2. The students would be able to understand the basics of material properties like, elasticity, elastic constants and their relation, torsion of a cylinder, bending of a beam, cantilever, beam supported at its ends and loaded in the middle.

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CONTENTS:

THEORY:

UNIT 1: FUNDAMENTALS OF DYNAMICS (LECTURES 6)

Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.

UNIT 2: WORK AND ENERGY (LECTURES 4)

Work and Kinetic Energy Theorem. Conservative and non-conservative forces. Potential Energy. Energy diagram. Stable and unstable equilibrium. Elastic potential energy. Force as gradient of potential energy. Work & Potential energy. Work done by non-conservative forces. Law of conservation of Energy.

UNIT 3: COLLISIONS (LECTURES 3)

Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames

UNIT 4: ROTATIONAL DYNAMICS (LECTURES 12)

Angular momentum of a particle and system of particles. Torque. Principle of conservation of

angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

UNIT 5: ELASTICITY (LECTURES 3)

Relation between Elastic constants. Twisting torque on a Cylinder or Wire. Cantilever

UNIT 6: FLUID MOTION (LECTURES 2)

Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

UNIT 7: GRAVITATION AND CENTRAL FORCE MOTION (LECTURES 9)

Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere. Motion of a particle under a central force field. Two-body problem and its reduction to one body problem and its solution. The energy equation and energy diagram. Kepler's Laws.

UNIT 8: OSCILLATIONS (LECTURES 7)

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

UNIT 9: NON-INERTIAL SYSTEMS (LECTURES 4)

Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications.

UNIT 10: SPECIAL THEORY OF RELATIVITY (LECTURES 10)

Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.

PRACTICAL:
A minimum of seven experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge, Spherometer and travelling micro- scope.
2. To study the Motion of Spring and calculate (a) Spring constant and (b) Rigidity modulus.
3. To determine the Moment of Inertia of a cylinder about two different axes of symmetry by torsional oscillation method.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Young's Modulus of the material of a wire by Searle's apparatus.

6. To determine the Modulus of Rigidity of a Wire Static method.
7. To determine the value of g using Bar Pendulum.
8. To determine the value of g using Kater's Pendulum.
9. To determine the height of a building using a Sextant.
10. To determine g and velocity for a freely falling body using Digital Timing Technique.

SUGGESTED READINGS:

Textbooks

- Mechanics, Prof. D.S.Mathur and Dr. P. S. Hemne, First Edition, Reprint 2014, S Chand.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley
- BSc Practical Physics, N N Ghosh, 2017, Bharati Pawan Publishers.
- A Text Book of Practical Physics, Dr. Samir Kumar Ghosh, 2005, New Central Book Agency.

References

- An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley.
- Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.

SEMESTER II

PAPER CODE: PHYS-HCC-2016

Electricity and Magnetism

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of the course is to provide better perspective and understanding on electric and magnetic fields and their interactions with the matter and various circuit theories.
2. The practical are designed in such a way that the students can have implications with the prescribed theories.

Learning outcome: -

1. After successful completion of this course, students would be able to understand electric and magnetic fields in matter.
2. The students would be able to understand the Dielectric properties of matter, magnetic properties of matter, electromagnetic induction and also would be able to apply Kirchoff's law and various network theorem in different circuits.
3. The hands on experiment will provide the better understanding of electricity and magnetism and various parameters of the circuit.

CONTENTS:

THEORY:

UNIT 1: ELECTRIC FIELD AND ELECTRIC POTENTIAL (LECTURES 20)

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. 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 a system of charged

conductors. Parallel-plate capacitor. Capacitance of an isolated conductor.

UNIT 2: DIELECTRIC PROPERTIES OF MATTER (LECTURES 10)

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.

UNIT 3: MAGNETIC FIELD (LECTURES 9)

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

UNIT 4: MAGNETIC PROPERTIES OF MATTER (LECTURES 4)

Magnetization vector (M). Magnetic Intensity(H). Magnetic Susceptibility and permeability. Relation between B, H, M**.**

UNIT 5: 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.

UNIT 6: ELECTRICAL CIRCUITS (LECTURES 4)

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.

UNIT 7: NETWORK THEOREMS (LECTURES 4)

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.

UNIT 8: BALLISTIC GALVANOMETER (LECTURES 3)

Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR.

PRACTICAL

A minimum of seven experiments to be done

1. Use a Multimeter for measuring - (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and checking - (d) Capacitances, and (e) Electrical fuses.
2. To study the characteristics of a series RC Circuit.

3. To determine an unknown Low Resistance using Potentiometer.
4. To determine an unknown Low Resistance using Carey Foster's Bridge.
5. To verify the Thevenin and Norton theorems.
6. To determine self-inductance of a coil by Anderson's bridge.
7. 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
8. To study the response curve of a parallel LCR circuit and determine its (a) Anti- resonant frequency and (b) Quality factor Q.

SUGGESTED READINGS:

Textbooks

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.
- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw.
- Electricity and Magnetism, R. Murugeshan, S Chand
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.
- BSc Practical Physics, N N Ghosh, 2017, Bharati Pawan Publishers.

References

- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.
- 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.
- A Text Book of Practical Physics, Dr. Samir Kumar Ghosh, 2005, New Central Book Agency

PAPER CODE: PHYS-HCC-2026

Waves and Optics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To develop the knowledge on wave motion, interference, diffraction and various optical

phenomena.
2. To provide better understanding of the basic underlying physics of interferometer and holography.
3. To provide physical insight of various optical devices through experiments.

Learning outcome: -

1. Successful students would be able to get a clear concept on superposition of harmonic oscillations, different types of wave motions, superposition of harmonic waves, interference,
2. The interferometer, diffraction, the idea behind holography.
3. The students would be able to understand and capable of handling various optical instruments.

CONTENTS:

THEORY:

UNIT 1: SUPERPOSITION OF COLLINEAR HARMONIC OSCILLATIONS (LECTURES 5)

Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats).

UNIT 2: SUPERPOSITION OF TWO PERPENDICULAR HARMONIC OSCILLATIONS (LECTURES 2)

Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

UNIT 3: WAVE MOTION (LECTURES 4)

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

UNIT 4: VELOCITY OF WAVES (LECTURES 6)

Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.

UNIT 5: SUPERPOSITION OF TWO HARMONIC WAVES (LECTURES 7)

Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. 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.

UNIT 6: WAVE OPTICS (LECTURES 3)

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

UNIT 7: INTERFERENCE (LECTURES 9)

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

UNIT 8: INTERFEROMETER (LECTURES 4)

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.

UNIT 9: DIFFRACTION (LECTURES 15)

Fraunhofer diffraction in Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. Rayleigh's criterion.

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 diffraction pattern of a straight edge, a slit and a wire.

UNIT 10: HOLOGRAPHY (LECTURES 5)

Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

PRACTICAL

A minimum of seven experiments to be done

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To study Lissajous Figures.
3. Familiarization with: Schuster`s focusing; determination of angle of prism.
4. To determine refractive index of the Material of a prism using sodium source.
5. To determine the wavelength of sodium source using Michelson's interferometer.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.

SUGGESTED READINGS

Textbooks

- Textbook of Vibration and Waves, S P Puri, 2nd Edn, 2004, Macmillan India Ltd.
- A Textbook on Oscillations, Waves and Acoustics, M Ghosh, D Bhattacharya, 3rd Edn, 2006, S Chand & Company Ltd.
- Wave and Acoustics, P K Chakrabarti, S Chowdhury, 4th Edn, 2002, NCBA.
- A Textbook on Light for Advanced Degree Students, K G Mazumdar

- A Textbook of Optics, N Subrahmanyam, Brij Lal, M N Avadhanulu, 2016, 25th Edn, S Chand & Company Pvt. Ltd.
- Textbook of Physical Optics, K Ghosh, A Manna, 1st Edn, 2007, Macmillan India Ltd.

References

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.
- A Text Book of Practical Physics, Dr. Samir Kumar Ghosh, 2005, New Central Book Agency
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

SEMESTER III

PAPER CODE: PHYS- HCC-3016

Mathematical Physics-II

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of the course is to enhance the ability to acquire the knowledge on applications in solving problems of interest to physicists.
2. To make the students aware of various computational techniques through computational lab.

Learning outcome:

1. The students would be able to solve differential equation using power series solution method, solve differential equation using separation of variables method, special integrals, different properties of matrix, Fourier series.
2. The computational methods would help them to sole the physics problems and also prepare them to construct the problem.

CONTENTS:

THEORY:

UNIT 1: FOURIER SERIES (LECTURES 14)

Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Applications.

UNIT 2: FROBENIUS METHOD AND SPECIAL FUNCTIONS (LECTURES 22)

Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating

Function, Orthogonality. Simple recurrence relations. Bessel Functions of the First Kind: Generating Function, simple recurrence relations**.**

UNIT 3: SOME SPECIAL INTEGRALS (LECTURES 6)

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions.

UNIT 4: PARTIAL DIFFERENTIAL EQUATIONS (LECTURES 14)

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. Diffusion Equation**.**

UNIT 5: METHOD OF LEAST SQUARES (4 LECTURES)

Fitting of straight lines and quadratic curves. Goodness of fit. Chi square test.

PRACTICAL:

Topics	**Description with Applications**
Introduction to Numerical computationsoftware Scilab/Mathematica/Matlab	Introduction to Scilab/Mathematica/Matlab, Advantages and disadvantages, Scilab/Mathematica/Matlab environment, Command window, Figurewindow, Edit window, Variables and arrays, Initialising variables in Scilab/Mathematica/Matlab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab/Mathematica/Matlab/Python functions, Introduction to plotting, 2D and 3D plotting Numerical methods and developing the skills of writing a program.
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohm's law to calculate R, Hooke's law to calculate spring constant
Solution of Linear system of equations by Gauss elimination method and GaussSeidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen value problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)

Generation of Special functions using User defined functions in Scilab/Mathematica/Matlab	Generating and plotting Legendre Polynomials Generating and plotting Bessel function
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation Fixed difference method Partial differential equations	First order differential equation □ Radioactive decay □ Current in RC, LC circuits with DC source □ Classical equations of motion Second order Differential Equation □ Harmonic oscillator (no friction) □ Damped Harmonic oscillator Partial Differential Equation: □Wave equation □Heat Equation

SUGGESTED READINGS:

Textbooks

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Mathematical Physics, H.K. Das and Dr. Rama Verma, 7th Edition, 2014, S Chand.
- Principles of Mathematical Physics, SP Kuila, 2015, NCBA.
- Mathematical methods in Physics, D Biswas, 2nd Edn, 2015, NCBA
- Mathematical Physics, BD Gupta, 4th Edition, Vikas Publishing House Pvt. Ltd.
- Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.

References

- 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 Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press

- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
- Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
- www.**scilab**.in/textbook_companion/generate_book/291

PAPER CODE: PHYS-HCC-3026

Thermal Physics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To introduce the basic knowledge on thermodynamics, relations, entropy and kinetic behavior of gases.
2. To provide basic understanding of the physics of various techniques to determine thermal conductivity, working of thermo couple through practical.

Learning outcome: -

1. The students would gain the knowledge and skills to identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, Thermodynamics potentials, Free energies, Maxwell's relations in thermodynamics, behaviour of real gases.
2. The students would be able to understand the Searl's method, Angstrom's method, Charlton's method to determine the thermal conductivity of the given material, would be able to understand Callendar and Barne's method to determine mechanical equivalent of heat.

CONTENTS:

THEORY:

INTRODUCTION TO THERMODYNAMICS

UNIT 1: ZEROTH AND FIRST LAW OF THERMODYNAMICS (LECTURES 8)

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 CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

UNIT 2: SECOND LAW OF THERMODYNAMICS (LECTURES 10)

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.

UNIT 3: ENTROPY (LECTURES 7)

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

UNIT 4: THERMODYNAMIC POTENTIALS (LECTURES 7)

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations.

UNIT 5: MAXWELL'S THERMODYNAMIC RELATIONS (LECTURES 7)

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of C_p-C_v, (3) TdS Equations, (4) Energy equations, (5) Change of Temperature during Adiabatic Process.

KINETIC THEORY OF GASES

UNIT 6: DISTRIBUTION OF VELOCITIES (LECTURES 7)

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.

UNIT 7: MOLECULAR COLLISIONS (4 LECTURES)

Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance.

UNIT 8: REAL GASES (LECTURES 10)

Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour 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. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule- Thomson Effect for Real and Van der Waal Gases. Temperature of Inversion. Joule- Thomson Cooling.

PRACTICAL

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

SUGGESTED READINGS:

Textbooks

- Advanced Heat & Thermodynamics, K D Krori, 2004, NCBA.
- Thermodynamics and Statistical Physics, Sharma and Sarkar, 2014, Himalaya Publishing House.
- Advanced Text Book on Heat, PK Chakrabarti, 2005, Shreedhar Prakashani
- Heat Thermodynamics and Statistical Physics, Brij Lal, N. Subrahmanyam, P. S. Hemne, 2018, S Chand and Company Ltd.

References

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press

- Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
- Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.
- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, Vani Pub
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013.

PAPER CODE: PHYS-HCC-3036

Digital Systems and Applications

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of the course is to develop the concepts of electronics designing, digital systems and its applications .
2. To provide the students the practical understanding of underlying physics of various electronic circuits.

Learning outcome:-

1. After successful completion of the course student would be able to understand the working principle of CRO, develop a digital logic and apply it to solve real life problems, analyse, design and implement combinational logic circuits.
2. The students would be able to classify different semiconductor memories, analyse, design and implement sequential logic circuits, analyse digital system design using PLD, Simulate and implement combinational and sequential circuits.

CONTENTS:

THEORY:

UNIT 1: INTRODUCTION TO CRO (LECTURES 3)

Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.

UNIT 2: INTEGRATED CIRCUITS (Qualitative treatment only) (LECTURES 3)

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.

UNIT 3: DIGITAL CIRCUITS (LECTURES 6)

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.

UNIT 4: BOOLEAN ALGEBRA (LECTURES 6)

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.

UNIT 5: DATA PROCESSING CIRCUITS (LECTURES 4)

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

UNIT 6: ARITHMETIC CIRCUITS (LECTURES 5)

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

UNIT 7: SEQUENTIAL CIRCUITS (LECTURES 6)

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

UNIT 8: TIMERS (LECTURES 3)

IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

UNIT 9: SHIFT REGISTERS (LECTURES 2)

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

UNIT 10: COUNTERS (4 BITS) (LECTURES 4)

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

UNIT 11: COMPUTER ORGANIZATION (LECTURES 6)

Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing**.**

UNIT 12: INTEL 8085 MICROPROCESSOR ARCHITECTURE (LECTURES 8)

Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry.

UNIT 13: INTRODUCTION TO ASSEMBLY LANGUAGE (LECTURES 4)

1 byte, 2 byte & 3 byte instructions.

PRACTICAL:
A minimum of seven experiments to be done

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To design a switch (NOT gate) using a transistor.
3. To verify and design AND, OR, NOT and XOR gates using NAND gates.
4. To design a combinational logic system for a specified Truth Table.
5. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
6. Half Adder, Full Adder and 4-bit binary Adder.
7. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
8. To build JK Master-slave flip-flop using Flip-Flop ICs
9. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
10. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
11. To design an astable multivibrator of given specifications using 555 Timer.
12. Write the following programs using 8085 Microprocessor
    a) Addition and subtraction of numbers using direct addressing mode
    b) Addition and subtraction of numbers using indirect addressing mode
    c) Multiplication by repeated addition.
    d) Division by repeated subtraction.
    e) Handling of 16-bit Numbers.
    f) Use of CALL and RETURN Instruction.
    g) Block data handling.
    h) Other programs (e.g. Parity Check, using interrupts, etc.).

SUGGESTED READINGS:
Textbooks

- Principles of Electronics, V.K. Mehta & Rohit Mehta, 2009, 11th edition, S Chand.
- A Textbook for Electronics, Santanu Chattopadhyay, 2nd edition, 2016, NCBA.

- Fundamental Principles of Electronics, B. Ghosh, Books & Allied (P) Ltd.
- Electronics Fundamentals and Applications, D Chattopadhyay & P C Rakshit, 14th Edition, New Age International Publisher.
- Fundamental of Microprocessors and Microcontrollers, 2012, Dhanpat Rai Publications

References

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw Hill.
- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- Microprocessor Architecture Programming and applications with 8085, R.S. Goankar, 2002, Prentice Hall.
- Microprocessor 8085:Architecture, Programming and interfacing, A. Wadhwa, 2010, PHI.

SEMESTER IV

PAPER CODE: PHYS- HCC-4016

Mathematical Physics-III

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To enhance the mathematical knowledge on complex analysis, integration, transforms (Fourier, Laplace),tensor algebra and its applications to different physical phenomena, electrical networks and cosmology.
2. To make the students familiar with various computational tools, to solve and construct the physical problems.

Learning outcome: -

1. Successful students would be able to utilize the course in developing concepts and its applications in various theoretical fields with concept of probability and error.
2. The students would be able to develop their computational skills by solving problem and as well as would be able to construct physical problem.

CONTENTS:

THEORY:

UNIT 1: COMPLEX ANALYSIS (LECTURES 30)

Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles 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 with numerical applications.

UNIT 2: INTEGRAL TRANSFORMS (LECTURES 10)

Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.).

UNIT 3: LAPLACE TRANSFORMS (LECTURES 10)

Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem (Statement only). Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator.

UNIT 4: TENSOR ALGEBRA (LECTURES 10)

Introduction to tensor, Transformation of co-ordinates, Einsteins summation convention. contravariant and co- variant tensor, tensorial character of physical quantities, symmetric and antisymmetric tensors, kronecker delta, Levi-Civita tensor. Quotient law of tensors, Raising and lowering of indices Rules for combination of tensors- addition, subtraction, outer multiplication, contraction and inner multiplications.

PRACTICAL

Mathematica /Scilab/C++ /C based simulations experiments based on Mathematical Physics problems like

1. Solve differential equations:
   $dy/dx = e^{-x}$ with $y = 0$ for $x = 0$
   $dy/dx + e^{-xy} = x^2$
   $d^2y/dt^2 + 2\, dy/dt = -y$
   $d^2y/dt^2 + e^{-t} dy/dt = -y$
2. **Dirac delta function**
   Evaluate $\frac{1}{\sqrt{2n\sigma^2}} \int (x+3) e^{\frac{-(x-2)^2}{2\sigma^2}} dx$ for $\sigma = 1, 0.1, 0.01$ and show it tends to 5.
3. **Fourier Series:**
   Program to sum $\sum_{n=1}^{\infty} 0.2^n$.
   Evaluate the Fourier coefficients of a given periodic function (square wave).
4. **Frobenius method and Special functions:**
   $\int_{-1}^{1} P_n(\mu) P_m(\mu)\, d\mu = \delta_{n,m}$
   Plot $P_n(x), j_y(x)$.
   Show recursion relation.
5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.

7. Evaluation of trigonometric functions e.g. sin θ, Given Bessel's function at N points find its value at an intermediate point.
8. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.
9. Compute the n^{th} roots of unity for n = 2, 3, and 4.
10. Find the two square roots of −5+12j.
11. Integral transform: FFT of e^{-x^2}
12. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.
13. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.
14. Perform circuit analysis of a general LCR circuit using Laplace's transform.

SUGGESTED READINGS:

Textbooks

- Mathematical Physics, H.K. Das and Dr. Rama Verma, 7th Edition, 2014, S Chand.
- Principles of Mathematical Physics, SP Kuila, 2015, NCBA.
- Mathematical Physics, BD Gupta, 4th Edition, Vikas Publishing House Pvt. Ltd.
- Mathematical methods in Physics, D Biswas, 2nd Edn, 2015, NCBA
- Complex Variables and Applications, J. W. Brown & R.V. Churchill,7th Ed. 2003, Tata McGraw Hill
- Matrices and Tensor in Physics, A W Joshi, 4th Edition, 2017, NAIP.
- Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011, S.Chand & Company

References

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Schaum's outlines for Complex Variables, Murray R. Spiegel, Seymour Lipschutz, John Schiller, Dennis Spellman, 2017, 2nd edition, McGraw Hill.
- Schaum's outlines for Vector Analysis, Murray R. Spiegel, Seymour Lipschutz, John Schiller, Dennis Spellman, 2018, 2nd edition, McGraw Hill.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- https://web.stanford.edu/~boyd/ee102/laplace_ckts.pdf
- www.**scilab**.in/textbook_companion/generate_book/291

PAPER CODE: PHYS-HCC-4026

Elements of Modern Physics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To reveal a scientific journey with the laws of nature as companion with the inception of quantum mechanical aspects, nuclear phenomena, as well as to understand the fundamental concepts of laser physics and its implications.
2. To provide the practical knowledge on various techniques of determining Planck's Constant, photoelectric effect, determine the charge of electron, determination of wavelength of laser using single slit and double slit.

Learning outcome: -

1. The successful completion of the course by the students would help them to understand the scientific method of the evolution of physics from classical to modern era.
2. The student would be able to understand underlying principles of lasing action.
3. The practical would provide deep insight to various topics in atomic and laser physics.

CONTENTS:

THEORY:

UNIT 1: QUANTUM THEORY OF LIGHT (LECTURES 14)

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.

UNIT 2: POSITION MEASUREMENT AND UNCERTAINTY PRINCIPLE (LECTURES 5)

Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction.

UNIT 3: SCHRÖDINGER EQUATION AND ITS APPLICATIONS (NON-RELATIVISTIC) (LECTURES 20)

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 dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

UNIT 4:ATOMIC NUCLEI AND NUCLEAR MODELS (LECTURES 6)

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

UNIT 5: RADIOACTIVITY, NUCLEAR DECAY AND NUCLEAR REACTIONS (LECTURES 11)

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).

UNIT 6: LASERS (LECTURES 4)

Einstein’s A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

PRACTICAL

A minimum of seven experiments to be done

1. Measurement of Planck’s constant using black body radiation and photo-detector
2. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
3. To determine work function of material of filament of directly heated vacuum diode.
4. To determine the Planck’s constant using LEDs of at least 4 different colours.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine the ionization potential of mercury.
7. To determine the absorption lines in the rotational spectrum of Iodine vapour.
8. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
9. To setup the Millikan oil drop apparatus and determine the charge of an electron.
10. To show the tunneling effect in tunnel diode using I-V characteristics.

11. To determine the wavelength of laser source using diffraction of single slit.
12. To determine the wavelength of laser source using diffraction of double slits.
13. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating.

SUGGESTED READINGS:

Textbooks

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Atomic Physics, J B Rajam, 2008, S Chand & Company Ltd.
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
- Nuclear Physics, S N Ghoshal, 2019, Revised Edition, S Chand
- Nuclear Physics, D C Tayal, Himalaya Publishing House.
- Nuclear Physics, Irving Kaplan, 2002, Narosa

References

- Quantum Physics, H C Verma, 2nd Edition, 2012, TBS.
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- 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
- A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal,1985, Vani Pub.
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013,

PAPER CODE: PHYS-HCC-4036

Analog Systems and Applications

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of the course is to develop the concepts of electronics designing , devices, analog systems, such as, amplifiers, oscillators, OPAMPs and their applications.
2. To provide the physics involved in various electronic circuit and the component used in it through experiments.

Learning outcome: -

1. Students would be able to learn about electronic circuits such as Amplifiers and Oscillator, their types , their working and applications in domestic, industrial and as well as scientific devices/instrumentations.
2. The students would be able to design various circuits and also would be able to understand the physics of various devices.

CONTENTS:

THEORY:

UNIT 1: SEMICONDUCTOR DIODES (LECTURES 10)

P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. Drift Current and Diffusion Current , Einstein Relationship, PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current flow Mechanism in Forward and Reverse Biased Diode. Derivation for Barrier Potential, Barrier Width and Current for Step Junction.

UNIT 2: TWO-TERMINAL DEVICES AND THEIR APPLICATIONS (LECTURES 7)

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

UNIT 3: BIPOLAR JUNCTION TRANSISTORS (LECTURES 6)

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.

UNIT 4: AMPLIFIERS (LECTURES 15)

Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Two stage RC-coupled amplifier and its voltage and current gain in low, mid and high frequency, frequency response curve.

UNIT 5: FEEDBACK IN AMPLIFIERS (LECTURES 4)

Concept of feedback, different types of feedback (qualitative only), advantages of negative feedback in amplifier. Effects of Positive and Negative Feedback on Input Impedance,

Output Impedance, Gain, Stability, Distortion and Noise.

UNIT 6: OSCILLATORS (LECTURES 5)

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

UNIT 7: OPERATIONAL AMPLIFIERS (BLACK BOX APPROACH) (LECTURES 13)

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. Op-Amps as: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator.

PRACTICAL

A minimum of seven experiments to be done

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 various biasing configurations of BJT for normal class A operation.
6. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
7. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
8. To design a Wien bridge oscillator for given frequency using an op-amp.
9. To design a phase shift oscillator of given specifications using BJT.
10. To study the Colpitt`s oscillator.
11. To design a digital to analog converter (DAC) of given specifications.
12. To study the analog to digital convertor (ADC) IC.
13. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
14. To design inverting amplifier using Op-amp (741,351) and study its frequency response
15. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response
16. To study the zero-crossing detector and comparator
17. To add two dc voltages using Op-amp in inverting and non-inverting mode
18. To design a precision Differential amplifier of given I/O specification using Op-amp.
19. To investigate the use of an op-amp as an Integrator.
20. To investigate the use of an op-amp as a Differentiator.
21. To design a circuit to simulate the solution of a 1st/2nd order differential equation.

SUGGESTED READINGS:

Textbooks

- Fundamentals Principles of Electronics, B Ghosh,2010, Books and Allied Ltd.

- Principles of Electronics, V.K. Mehta & Rohit Mehta, 2009, 11th edition, S Chand.
- A Textbook for Electronics, Santanu Chattopadhyay, 2nd edition, 2016, NCBA.
- Electronics and Fundamentals and Applications, P C Rakshit and D Chattopadhyay, 16th edition, 2020, New Age International Pvt. Ltd.
- Basic Electronics, D. C. Tayal, 2018, Hiamlaya Publishing House Pvt. Ltd.
- An Advanced course in Practical physics, P C Rakshit and D Chattopadhyay.

References

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronic Principles, Albert Malvino and David Bates, 8th Edition, 2016, Tata McGraw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer

SEMESTER V

PAPER CODE: PHYS-HCC-5016

Quantum Mechanics and Applications

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of the course is to understand the principles of quantum mechanics, its physical concepts related to Schrödinger equations, wave functions, uncertainty principle and its applications to Hydrogen and Hydrogen-like atoms and in many electron atomic systems.
2. The computational practical is framed for solving various problems based on the quantum mechanical systems.

Learning outcome: -

1. The students would be able to understand the principles in quantum mechanics, such as the Schrödinger equation, the wave function, the uncertainty principle, stationary and non-stationary states, time evolution of solutions, as well as the relation between quantum mechanics and linear algebra.
2. The students would be able to solve the Schrödinger equation for hydrogen atom. Students would understand the concepts of angular momentum and spin, as well as the rules for quantization and addition of these, spin-orbit coupling and Zeeman Effect.
3. The student would be able to solve various quantum mechanical system using the various computational tool and would be able to understand the nature of the particular system.

CONTENTS:

THEORY:

UNIT 1: TIME DEPENDENT SCHRÖDINGER EQUATION (LECTURES 6)

Time dependent Schrödinger 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.

UNIT 2: TIME INDEPENDENT SCHRÖDINGER EQUATION (LECTURES 10)

Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigen functions; General solution of the time dependent Schrödinger 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 wave function; Position-momentum uncertainty principle.

UNIT 3: GENERAL DISCUSSION OF BOUND STATES IN AN ARBITRARY POTENTIAL (LECTURES 12)

Continuity of wave function, boundary condition and emergence of discrete energy levels; application to one-dimensional problem-square well potential; Quantum mechanics of simple harmonic oscillator-energy levels and energy eigen functions using Frobenius method; Hermite polynomials; ground state, zero point energy.

UNIT 4: QUANTUM THEORY OF HYDROGEN-LIKE ATOMS (LECTURES 10)

Time independent Schrödinger 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.

UNIT 5: ATOMS IN ELECTRIC & MAGNETIC FIELDS (LECTURES 12)

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).

UNIT 6: 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.).

PRACTICAL:

A minimum of seven experiments to be done
Use C/C++/Mathematica/Scilab for solving the following problems based on quantum mechanics like

1. Solve the s-wave (l=0) Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

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

Here m is the reduced mas of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen

atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511x10^6 eV/c^2.

2. Solve the s-wave (l=0) radial Schrodinger equation for an atom:

$$\frac{d^2u}{dr^2} = \frac{2m}{\hbar^2}[V(r) - E]u(r), \text{ where } V(r) = \frac{-e}{r}e^{\frac{-r}{a}}$$

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

3. Solve the radial Schrödinger equation for a particle of mass m,

$$\frac{d^2u}{dr^2} = \frac{2m}{\hbar^2}[V(r) - E]u(r)$$

For the anharmonic potential $V(r) = \frac{1}{2}kr^2 + \frac{1}{3}br^3$

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

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

$$\frac{d^2u}{dr^2} = \frac{2\mu}{\hbar^2}[V(r) - E]u(r)$$

where μ is the reduced mass of the two-atom system for the Morse Potential

$$V(r) = D(e^{-2\alpha rF} - e^{-\alpha rF}), \quad r' = \frac{r - r_o}{r}$$

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: m = 940x106eV/c^2, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

Laboratory Based Experiments

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

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

7. To show the tunneling effect in tunnel diode using I-V characteristics.

8. Quantum efficiency of CCDs.

SUGGESTED READINGS:

Textbooks

- Quantum Mechanics: Concepts and Applications, Nouredine Zettli, 2nd Edition, Wiley
- Lectures on Quantum Mechanics, Ashok Das, 2nd edition , 2012, World Scientific.
- Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
- Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.

References

- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan
- Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
- Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer

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

PAPER CODE: PHYS-HCC-5026

Solid State Physics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. The course is designed through the inception of a theoretical and experimental approach to provide the fundamental insights and knowledge into solid state physics. It aims to relate the physical concepts to material science, chemistry, biochemistry, engineering.
2. To impart practical knowledge of magnetic susceptibility, working of piezoelectric crystal, surface plasmon resonance, Hall effect through experiments.

Learning outcome: -

1. Students after the course completion would be able to understand the physics behind crystal structures, crystal types, symmetries, X-ray diffraction, and phonon interactions and can acquire the knowledge of various physical phenomena such as magnetism, dielectrics, ferroelectrics and semiconductors.
2. The students would be able to understand the underlying physics about the macroscopic properties of the solid by doing experiments.

CONTENTS:

THEORY:

UNIT 1: CRYSTAL STRUCTURE (LECTURES 12)

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.

UNIT 2: 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.

UNIT 3: MAGNETIC PROPERTIES OF MATTER (LECTURES 8)

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.

UNIT 4: DIELECTRIC PROPERTIES OF MATERIALS (LECTURES 8)

Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability.

UNIT 5: FERROELECTRIC PROPERTIES OF MATERIALS (LECTURES 6)

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

UNIT 6: ELEMENTARY BAND THEORY (LECTURES 10)

Review of Free Electron theory of metals, its failure. Bloch Function**.** 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.

UNIT 7: SUPERCONDUCTIVITY (LECTURES 6)

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).

PRACTICAL

A minimum of seven experiments to be done

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)

6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

SUGGESTED READINGS:

Textbook

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Solid State Electronic Devices, Beng G. Streetman, S K Banerjee, 6th Edition,PHI
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications.

References

- 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, H. Ibach and H. Luth, 2009, Springer
- Solid State Physics, Rita John, 2014, McGraw Hill
- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

SEMESTER VI

PAPER CODE: PHYS-HCC-6016

Electromagnetic Theory

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To provide proper understanding of the basic properties of electromagnetic waves and its interaction with bounded and unbounded media and its polarization.
2. To impart knowledge on underlying principles of optical fibres and its implications to communication system.

Learning outcome:-

1. On successful completion of the course students would acquire the concepts of Maxwell's equations, propagation of electromagnetic (EM) waves in different homogeneous-isotropic as well as anisotropic unbounded and bounded media, production and detection of different types of polarized EM waves, general information as waveguides and fibre optics.

CONTENTS:

THEORY:

UNIT 1: MAXWELL EQUATIONS (LECTURES 10)

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.

UNIT 2: EM WAVE PROPAGATION IN UNBOUNDED MEDIA (LECTURES 7)

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth.

UNIT 3: WAVE IN BOUNDED MEDIA (LECTURES 10)

Boundary conditions at a plane interface between two media. Reflection & Refraction of

plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence).

UNIT 4: POLARIZATION OF ELECTROMAGNETIC WAVES (LECTURES 15)

Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses.

UNIT 5: ROTATORY POLARIZATION (LECTURES 7)

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

UNIT 6: WAVE GUIDES (LECTURES 8)

Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.

UNIT 7: OPTICAL FIBRES (LECTURES 3)

Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only

PRACTICAL

A minimum of seven experiments to be done

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized Light by using a Babinet's compensator.
4. To study dependence of radiation on angle for a simple Dipole antenna.
5. To determine the wavelength and velocity of ultrasonic waves in a liquid (Kerosene Oil, Xylene, etc.) by studying the diffraction through ultrasonic grating.
6. To study the reflection, refraction of microwaves
7. To study Polarization and double slit interference in microwaves.
8. To determine the refractive index of liquid by total internal reflection using Wollaston's air-film.
9. To determine the refractive Index of (1) glass and (2) a liquid by total internal reflection using a Gaussian eyepiece.
10. To study the polarization of light by reflection and determine the polarizing angle for air-glass interface.

11. To verify the Stefan`s law of radiation and to determine Stefan's constant.

12. To determine the Boltzmann constant using V-I characteristics of PN junction diode.

SUGGESTED READINGS:

Textbook

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Electromagnetism, Ashutosh Pramanik, 2009, 2nd Edition, PHI.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning

References

- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
- Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill..
- Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2004, Cambridge University Press
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013

PAPER CODE: PHYS-HCC-6026

Classical and Statistical Mechanics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of course is to make familiar with the statistical errors and the variation of thermodynamic parameters. Further, it would provide the concept of the classical mechanics and thermodynamical laws for the macroscopic systems by understanding properties in atomic scale.
2. To provide the basics of BE Statistics and FD statistics for understanding the macroscopic properties of different particles.

Learning outcome: -

1. On successful completion of the course students would learn the techniques of Statistical Mechanics to apply in various fields including Astrophysics, Semiconductors, Plasma Physics, Bio-Physics, Chemistry and in many other directions.
2. The students would be able to understand the physical problems solving it computationally and make them familiar with various software, which will be helpful in their higher education and in various jobs as well.

CONTENTS:

THEORY:

UNIT 1: CLASSICAL MECHANICS (LECTURES 14)

Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion.

Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy.

UNIT 2: CLASSICAL STATISTICS (LECTURES 14)

Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox.

UNIT 3: CLASSICAL THEORY OF RADIATION (LECTURES 8)

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. Rayleigh-Jean's Law. Ultraviolet Catastrophe.

UNIT 4: QUANTUM THEORY OF RADIATION (LECTURES 8)

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.

UNIT 5: BOSE-EINSTEIN STATISTICS (LECTURES 8)

B-E distribution law, Bose Einstein condensation, properties of liquid He (qualitative description), Bose derivation of Planck's law.

UNIT 6: FERMI-DIRAC STATISTICS (LECTURES 8)

Fermi-Dirac Distribution Law, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals.

PRACTICAL

A minimum of seven experiments to be done

Use C/C++/Scilab/other numerical simulations for solving the problems based on Statistical Mechanics like

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 near the most probable speed

2. Computation of the partition function $Z(\beta)$ for examples of 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 $Z(\beta)$, average energy $<E>$, energy fluctuation ΔE, 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 high temperature 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 distribution
    c. Bose-Einstein distribution

SUGGESTED READINGS:

Textbooks

- A Textbook of Statistical Mechanics, S. Chandra, 2nd edition, 30 November 2016 CBS Publishers & Distributors.
- Heat Thermodynamics and Statistical Physics, Brijlal, N Subhramanyam, P Hemne, 2017, S Chand.
- 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

References

- 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
- Elementary Numerical Analysis, K.E.Atkinson, 3rd Edn . 20 07 , Wiley India Edition
- Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
- Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
- Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
- Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274

DISCIPLINE SPECIFIC ELECTIVE (DSE) PAPERS

SEMESTER V

PAPER CODE: PHYS-HDS-5016

Physics Of Devices and Instruments

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. To build the theoretical and experimental knowledge of various electronic devices and the instruments.
2. This course would provide the physics of various electronic components, the fabrication technique and basic knowledge on communication systems.

Learning outcome:

1. Upon completion of this course, students will be able to gain knowledge on advanced electronics devices such as UJT, JFET, MOSFET, CMOS etc.
2. The students would acquire detailed process of IC fabrication, Digital Data serial and parallel Communication Standards along with the understanding of communication systems.

CONTENTS:

THEORY:

UNIT 1: DEVICES (LECTURES 14)

Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO_2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode.

UNIT 2 : **POWER SUPPLY AND FILTERS (LECTURES 3)**

Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection

UNIT 3 : ACTIVE AND PASSIVE FILTERS (LECTURES 3)

Low Pass, High Pass, Band Pass and band Reject Filters.

UNIT 4 : MULTIVIBRATORS (LECTURES 3)

Astable and Monostable Multivibrators using transistors.

UNIT 5 : PROCESSING OF DEVICES (LECTURES 14)

Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation.

UNIT 6 : DIGITAL DATA COMMUNICATION STANDARDS (LECTURES 8)

Serial Communications: RS232, Handshaking, Implementation of RS232 on PC. Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART). Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port.

UNIT 7 : INTRODUCTION TO COMMUNICATION SYSTEMS (LECTURES 15)

Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK.

PRACTICAL:
A minimum of seven experiments to be done

1. To design a power supply using bridge rectifier and study effect of C-filter.
2. To design the active Low pass and High pass filters of given specification.
3. To design the active filter (wide band pass and band reject) of given specification.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To design an Amplitude Modulator using Transistor.
9. To design PWM, PPM, PAM and Pulse code modulation using ICs.
10. To design an Astable multivibrator of given specifications using transistor.

11. To study a PLL IC (Lock and capture range).
12. To study envelope detector for demodulation of AM signal.
13. Study of ASK and FSK modulator.
14. Glow an LED via USB port of PC.
15. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

SUGGESTED READINGS:

Textbooks

- Principles of Communication Engineering, Anokh Singh, 3rd Edn, 1999, S Chand & Co Ltd.
- Electronic Instrumentation, H S Kalsi, 2017, 3rd Edn, Tata McGraw Hill Education.
- Electronics Fundamentals and Applications, D Chattopadhyay & P C Rakshit, 14th Edn, 2017, NAIP.
- Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons

References

- Principles of Communication Systems, H Taub and D L Schilling, 2nd Edn, 1986, Tata McGraw Hill.
- Electronic Devices and Circuit Theory, R L Boylestad & Louis Nashelsky, 10th Edn, 2013, Pearson.
- Electronic
- Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd.
- Op-Amps & Linear Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd
- Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India
- Basic Electronics:A text lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller,1994, Mc-Graw Hill
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

PAPER CODE: PHYS-HDS-5026

Nuclear and Particle Physics

PAPER CREDIT: 06 (5T+1Tu)

T: Theory Tu: Tutorial

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Presentation T: Theory, IA: Internal Assessment, P: Presentation

Objectives:-

1. The course emphasizes to impart knowledge on properties of Nucleus, the involved nuclear reactions.
2. To provide awareness of particle accelerators, different nuclear radiation by understanding their underlying physics and its applications.
3. To familiarize with the broad spectrum of particle physics.

Learning outcome:

1. Upon completion of this course, students would have the understanding of the sub atomic particles and their properties.
2. They would gain knowledge about the different nuclear techniques and their applications indifferent branches of Physics and societal application.
3. The course will develop problem based skills and the acquire knowledge could be applied in the areas of nuclear, medical, archeology, geology and other interdisciplinary fields of Physics and Chemistry.

CONTENTS:

THEORY:

UNIT 1: GENERAL PROPERTIES OF NUCLEI (LECTURES 12)

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.

UNIT 2: NUCLEAR MODELS (LECTURES 10)

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model.

UNIT 3: RADIOACTIVITY DECAY (LECTURES 12)

(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.

UNIT 4: NUCLEAR REACTIONS (LECTURES 8)

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).

UNIT 5: INTERACTION OF NUCLEAR RADIATION WITH MATTER (LECTURES 6)

Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

UNIT 6: DETECTOR FOR NUCLEAR RADIATIONS (LECTURES 6)

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter.

UNIT 7: PARTICLE ACCELERATORS (LECTURES 5)

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

UNIT 8: PARTICLE PHYSICS (LECTURES 16)

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.

SUGGESTED READINGS:

Textbooks

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Nuclear Physics, D C Tayal, 2011, Himalaya Publishing House
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Atomic and Nuclear Physics, Shatendra Sharma, 2008, 1st Edn, Pearson Education.
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).

References

- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
- 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)

SEMESTER VI

PAPER CODE: PHYS-HDS-6016

Nano Materials and Applications

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, T: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. The objective of this course is to imbibe a foundational knowledge on nanoscience, such as the influence of dimensionality of the object at nanoscale on their properties.
2. To provide basics knowledge of the fabrication techniques and their future application in the industry.

Learning outcome: -

1. Successful students would be able to understand the physics of particles in nano scale, such as the quantum confinement on the electronic structure, corresponding chemical and physical properties.
2. They would learn the basics of various fabrication techniques, correlate properties of nanostructures with their shape, size and surface charateristics and various technical perspectives of the nanoscale devices.

CONTENTS:

THEORY:

UNIT 1: NANOSCALE 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.

UNIT 2: SYNTHESIS OF NANOSTRUCTURE MATERIALS (LECTURES 8)

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.

UNIT 3: CHARACTERIZATION (LECTURES 8)

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

UNIT 4: OPTICAL PROPERTIES (LECTURES 14)

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 heterostrctures and nanostructures.

UNIT 5: ELECTRON TRANSPORT (LECTURES 6)

Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

UNIT 6: APPLICATIONS (LECTURES 14)

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).

PRACTICALS:

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 prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

SUGGESTED READINGS:

Textbooks

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- An Introduction to synthesis, properties and applications of Nanomaterials, Thomas Varghese, K M Balakrishna, 1st Edn, 2017, Atlantic publishers and Distributors Pvt. Ltd.
- Nanophysics and Nanotechnology, Edward L. Wolf, 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).

References

- 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).
- 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 & Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

PAPER CODE: PHYS-HDS-6026

Dissertation

PAPER CREDIT: 06(4W+2P)

W: Work (Field/Laboratory/Library etc.) P: Presentation

Total no. of period: 90 Total Marks: 100 (W80+P20)

W: Work (Field/Laboratory/Library etc.) P: Presentation

Objectives:

1. To develop the spirit of research and innovative work
2. To get familiar with the research methodologies
3. To enhance the ability of research analysis in a holistic approach.
4. To provide a capacity to learn continually and interact with multidisciplinary groups.
5. To craft an extensive and comprehensive piece of written work so as to convey research in the most efficient and effective way and therefore confirm to the reader that the thesis, as a minimum, of a worthy standard and quality.

Learning outcome:

1. On successful completion of the course, the student would be exposed to design a research investigation that incorporates appropriate theoretical approaches, conceptual models and a review of the existing literature.
2. They would be able to design their roadmap with a discussion of the methodology to be used, write a comprehensive of the literature, draw valid conclusions, relating them to the research topic.

The outline of the dissertation may contain as follows –

a) TITLE
b) INTRODUCTION
c) REVIEW OF LITERATURE
d) METHODOLOGY
e) RESULTS/FINDINGS
f) DISCUSSION
g) SUMMARY/CONCLUSION
h) ACKNOWLWDGEMENT
i) REFERENCES/BIBLIOGRAPGY

(Each candidate is required to complete any one project work related to any area of the syllabus, which is to be evaluated by the internal examiners through the viva-voice test.)

SKILL ENHANCEMENT COURSE (SEC) PAPERS

SEMESTER – III

PAPER CODE: PHYS-SEC-3014

Weather Forecasting

Paper Credits: 04 (2T+2P)

Total no. of Lectures: 30+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To impart theoretical knowledge on weather forecasting to the students.
2. To enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques.

Learning outcome: -

1. On successful completion of the course students would be able to understand concepts and various techniques of weather phenomenon and basic forecasting.

CONTENTS:

THEORY:

UNIT 1: INTRODUCTION TO ATMOSPHERE (LECTURES 9)

Elementary idea of atmosphere: physical structure and composition; compositional layering of the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones andanticyclones: its characteristics.

UNIT 2: MEASURING THE WEATHER (LECTURES 4)

Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

UNIT 3: WEATHER SYSTEMS (LECTURES 3)

Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms;

tropical cyclones: classification; tornadoes; hurricanes

.

UNIT 4: CLIMATE AND CLIMATE CHANGE (LECTURES 6)

Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

UNIT 5: BASICS OF WEATHER FORECASTING (LECTURES 8)

Weather forecasting and its types; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

DEMONSTRATIONS AND EXPERIMENTS:

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:
   (a) To calculate the sunniest time of the year.
   (b) To study the variation of rainfall amount and intensity by wind direction.
   (c) To observe the sunniest/driest day of the week.
   (d) To examine the maximum and minimum temperature throughout the year.
   (e) To evaluate the relative humidity of the day.
   (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upperwind charts and its analysis.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non-aviation)

SUGGESTED READINGS:

Textbooks and References

- Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
- The weather Observers Hand book, Stephen Burt, 2012, CambridgeUniversity Press.
- Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
- Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers,Nagpur.
- Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
- Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

SEMESTER – IV

PAPER CODE: PHYS-SEC-4014

Research & Technical Writing

Paper Credits: 04(2T+2P)

Total no. of Lectures: 30+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. To aware the students about importance of research and technical writing.
2. To provide students with an introduction to technical writing, graphing and data analysis, LaTeX and its uses, familiarization of Origin and Microsoft excel.

Learning outcome: -

1. On successful completion of the course students would be able to write reports, articles, thesis, in latex, create chart in Microsoft excel, use different format of chartbased on need, plot data from different sources using Origin.

CONTENTS:

THEORY:

UNIT 1: INTRODUCTION (LECTURES 4)

Structure and components of scientific reports - Types of report – Technical reports and thesis– Different steps in the preparation – Layout – Illustrations and tables - Bibliography, referencing and footnotes. Need of scientific word processor, examples of scientific word processors.

UNIT 2: TECHNICAL WRITING IN LATEX (LECTURES 12)

Introduction to LaTeX, advantages of using LaTex, TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation

representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. Applications of LaTex in article, thesis, slide preparation.

UNIT 3: SCIENTIFIC GRAPHING AND DATA ANALYSIS (LECTURES 14)

Creating chart in Microsoft excel, Types of chart- Column chart, line chart, Pie chart, Doughnut chart, bar chart, area chart, scatter chart, surface chart; Chart elements- Chart style, Chart filter, fine tune of chart; Chart design tools- Design and format.

The Origin Workspace, Multi-sheet Workbooks, Managing Data and Metadata, Importing Data from different sources, Working with Excel and Origin, Basic Data Manipulation, Creating and Customizing Graphs, Custom Graph Templates and Themes, Publishing Graphs, Basic Data Analysis, Customizing Data Import, Post Processing of Imported Data, Creating and Customizing Multi-layer Graphs, Data Exploration and Pre-selection, Advanced Nonlinear Fitting, including Creating Custom Fitting Functions, Analysis Themes, Customizing Reports and Creating Custom Tables in Graphs, Recalculating/Updating Results, Analysis Templates and Custom Reports, Peaks and Baseline.

SUGGESTED READINGS:

Textbooks and References

- Kothari, C. R., Garg, G., Research Methodology: Methods and Techniques. New Age International (P) Limited, Publishers.
- Griffiths, D. F., Higham, D. J., Learning LaTeX. United States: Society for Industrialand Applied Mathematics.
- Lamport, s., Bibby, D. Lamport L., LATEX: a document preparation system : user'sguide and reference manual. Germany: Addison-Wesley.
- Lalwani, L., Excel All-in-One: Master the New Features of Excel 2019 / Office 365. India: BPB Publications.
- Origin 9: The Data Analysis and Graphing Workspace. (2011). UnitedStates: OriginLab.

SEMESTER – V

PAPER CODE: PHYS-SEC-5014

Renewable Energy and Energy Harvesting

Paper Credits: 04 (2T+2P)

Total no. of Lectures: 30+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. To impart theoretical knowledge of renewable energy and itsharvesting to the students.
2. To provide them with exposure and hands-on learning.

Learning outcome: -

1. On successful completion of the course students would be able to understand theoretical knowledge and practical implementation of methods of energy harvesting.

CONTENTS:

THEORY:

UNIT 1: FOSSIL FUELS AND ALTERNATE SOURCES OF ENERGY (LECTURES 6)

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

UNIT 2: SOLAR ENERGY (LECTURES 8)

Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, solar cooker, solar green houses, solar cell. Need and characteristics of photovoltaic (PV) systems, PV models.

UNIT 3: WIND ENERGY HARVESTING (LECTURES 4)

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

UNIT 4: OCEAN ENERGY (LECTURES 5)

Ocean Energy Potential against Wind and Solar, Wave Characteristics, Wave Energy Devices. Tide characteristics, Tide Energy Technologies, Ocean Thermal Energy, Ocean Bio-mass.

UNIT 5: GEOTHERMAL ENERGY (LECTURES 3)

Geothermal Resources, Geothermal Technologies.

UNIT 6: HYDRO ENERGY (LECTURES 4)

Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

DEMONSTRATIONS AND EXPERIMENTS

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

SUGGESTED READINGS:

Textbooks and References

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

SEMESTER – VI

PAPER CODE: XXXX-SEC-6014

Paper Credits: 04(2T+2P)

Total no. of Lectures: 30+30(L+P)

Total Marks: 100 (T60+IA20+P20)

(**Note:** The regular students may select their choice of paper from the pool of SEC papers)

HONOURS GENERIC ELECTIVE PAPERS [HGE]
(to be offered to other Departments/Disciplines)

SEMESTER I

PAPER CODE: PHYS- HGE- 1016

Mechanics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To get acquaintance with the dynamics of the system of particles, motion, elasticity.
2. To understand the concept of gravitation and special theory of relativity.

Learning outcome: -

1. The successful students would be able to develop the knowledge on the mechanics and dynamics of the particles and special theory of relativity and can apply its concept on various physical phenomena.
2. The students would be able to understand the basics of material properties like, elasticity, elastic constants and their relation, torsion of a cylinder, bending of a beam, cantilever, beam supported at its ends and loaded in the middle.

CONTENTS:

THEORY:

UNIT 1: VECTORS (LECTURES 4)

Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

UNIT 2: ORDINARY DIFFERENTIAL EQUATIONS (LECTURES 6)

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

UNIT 3: LAWS OF MOTION (LECTURES 10)

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

UNIT 4: MOMENTUM AND ENERGY (LECTURES 6)

Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

UNIT V: ROTATIONAL MOTION (LECTURES 5)

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

UNIT 6: GRAVITATION (LECTURES 8)

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).

UNIT 7: OSCILLATIONS (LECTURES 6)

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

UNIT 8: ELASTICITY (LECTURES 8)

Hooke's law - Stress-strain diagram – Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants – Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder – Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia – q, η and σ by Searles method.

UNIT 9: SPECIAL THEORY OF RELATIVITY (LECTURES 7)

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

PRACTICALS:

A minimum of five experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge and Spherometer.
2. To determine the Moment of Inertia of a Symmetrical body about an axis by torsional oscillation method.
3. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
4. To determine the Modulus of Rigidity of a Wire Static method.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum.
8. To study the Motion of Spring and calculate (a) Spring constant and (b) value of g.

SUGGESTED READINGS:

Textbooks

- Mechanics, Prof. D.S.Mathur and Dr. P. S. Hemne, First Edition, Reprint 2014, S Chand.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley
- BSc Practical Physics, N N Ghosh, 2017, Bharati Pawan Publishers.

- A Text Book of Practical Physics, Dr. Samir Kumar Ghosh, 2005, New Central Book Agency.

References

- An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley.
- Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.

SEMESTER II

PAPER CODE: PHYS-HGE-2016

Electricity And Magnetism

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of the course is to provide better perspective and understanding on electric and magnetic fields and their interactions with the matter and various circuit theories.
2. The practical are designed in such a way that the students can have implications with the prescribed theories.

Learning outcome: -

1. After successful completion of this course, students would be able to understand electric and magnetic fields in matter.
2. The students would be able to understand the Dielectric properties of matter, magnetic properties of matter, electromagnetic induction and also would be able to apply Kirchoff's law and various network theorem in different circuits.
3. The hands on experiment will provide the better understanding of electricity and magnetism and various parameters of the circuit.

CONTENTS:

THEORY:

UNIT 1: ELECTROSTATICS (LECTURES 34)

Review of Vector Analysis: Gradient, Divergence, Curl of a vector and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.

Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

UNIT 2: MAGNETISM (LECTURES 10)

Magnetostatics: Biot-Savart's law & 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.

UNIT 3: ELECTROMAGNETIC INDUCTION (LECTURES 6)

Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

UNIT 4: MAXWELL`S EQUATIONS AND ELECTROMAGNETIC WAVE PROPAGATION (LECTURES 10)

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves

PRACTICALS:

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. To study the Characteristics of a Series RC Circuit.
3. To study a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
4. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and
5. (b) Quality factor Q
6. To determine a Low Resistance by Carey Foster's Bridge.
7. To verify the Thevenin and Norton theorem
8. To verify the Superposition, and Maximum Power Transfer Theorem

SUGGESTED READINGS:

Textbooks

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

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw.
- Electricity and Magnetism, R. Murugeshan, S Chand
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.
- BSc Practical Physics, N N Ghosh, 2017, Bharati Pawan Publishers.

References

- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.
- 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.
- A Text Book of Practical Physics, Dr. Samir Kumar Ghosh, 2005, New Central Book Agency

SEMESTER III

PAPER CODE: PHYS-HGE-3016

Thermal Physics and Statistical Mechanics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. The course is developed to introduce the basic knowledge on thermodynamics,kinetic behavior of gases and statistical mechanics.
2. To provide basic understanding of the physics of various techniques to determine thermal conductivity, working of thermo couple through practical.

Learning outcome: -

1. Upon successful completion, students would have the knowledge and skills to identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, Thermodynamics potentials, Free energies, Maxwell's relations in thermodynamics, behaviour of real gases.
2. To provide the basics of BE Statistics and FD statistics for understanding the macroscopic properties of different particles.

CONTENTS:

THEORY:

UNIT 1: THERMODYNAMIC DESCRIPTION OF SYSTEM (LECTURES 22)

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 & C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

UNIT 2: THERMODYNAMIC POTENTIALS (LECTURES 10)

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

UNIT 3: KINETIC THEORY OF GASES (LECTURES 10)

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.

UNIT 4: 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.

UNIT 5: STATISTICAL MECHANICS (LECTURES 12)

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Three types of statistics: Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein, comparison of three statistics. Maxwell-Boltzmann distribution law of velocity, application of Quantum statistics in electron gas and photon gas.

PRACTICALS:

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the coefficient of thermal conductivity of a bad conductor by Leeand Charlton's disc method.
6. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
7. To study the variation of thermo emf across two junctions of a thermocouplewith temperature.
8. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

SUGGESTED READINGS:

Textbooks

- A Textbook of Statistical Mechanics, S. Chandra, 2nd edition, 30 November 2016 CBS Publishers & Distributors.
- Heat Thermodynamics and Statistical Physics, Brijlal, N Subhramanyam, P Hemne, 2017, S Chand.
- Thermodynamics and Statistical Physics, Sharma and Sarkar, 2014, Himalaya Publishing House.
- Advanced Text Book on Heat, PK Chakrabarti, 2005, Shreedhar Prakashani

References

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- 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

SEMESTER IV

PAPER CODE: PHYS-HGE-4016

Waves & Optics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To develop the knowledge on wave motion, interference, diffraction and various optical phenomena.
2. To provide better understanding of the basic underlying physics of interferometer and holography.
3. To provide physical insight of various optical devices through experiments.

Learning outcome: -

1. Successful students would be able to get a clear concept on superposition of harmonic oscillations, different types of wave motions, superposition of harmonic waves, interference,
2. The interferometer, diffraction, the idea behind holography.
3. The students would be able to understand and capable of handling various optical instruments.

CONTENTS:

THEORY:

UNIT 1: SUPERPOSITION OF TWO COLLINEAR HARMONIC OSCILLATIONS (LECTURES 4)

Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).

UNIT 2: SUPERPOSITION OF TWO PERPENDICULAR HARMONIC OSCILLATIONS (LECTURES 2)

Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

UNIT 3: WAVES MOTION (LECTURES 7)

General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

UNIT 4: FLUIDS (LECTURES 7)

Surface Tension: Synclastic and anticlastic surface – Excess of pressure – Application to spherical and cylindrical drops and bubbles – variation of surface tension with temperature – Jaegar's method. Viscosity – Rate flow of liquid in a capillary tube – Poiseuille's formula – Determination of coefficient of viscosity of a liquid – Variations of viscosity of liquid with temperature – lubrication.

UNIT 5: SOUND (LECTURES 6)

Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem -Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

UNIT 6: WAVE OPTICS (LECTURES 3)

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

UNIT 7: INTERFERENCE (LECTURES 11)

Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclinationand Fringes of equal thickness. Newton's Rings: measurement of wavelength. Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index Visibility of fringes.

UNIT 8: DIFFRACTION (LECTURES 15)

Fresnel and Fraunhofer diffraction. 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 diffraction pattern of a straight edge and at a circular aperture. Resolving Power of a telescope. Fraunhofer diffraction due to a Single slit, Diffraction grating. Resolving power of grating.

UNIT 9: POLARIZATION (LECTURES 5)

Transverse nature of light waves. Double Refraction, Plane, circular and elliptically polarized light, Production and analysis of polarized light. Retarding plates.

PRACTICALS:

A minimum of five experiments to be done.

1. To study the variation in liquid column height with diameter of capillary tube and determine the surface tension of the liquid.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment.
3. To determine the coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method)
4. To determine the focal length of a convex mirror with the help of convex lens .
5. To determine the refractive index of a liquid by using plane mirror and convex lens.
6. To determine the focal length of two lenses and their combination by displacement method .
7. Familiarization with Schuster's focussing; determination of angle of prism.
8. To determine the Refractive Index of the Material of a Prism using Sodium Light.
9. To determine wavelength of sodium light using Newton's Rings.

SUGGESTED READINGS:

Textbooks

- Textbook of Vibration and Waves, S P Puri, 2nd Edn, 2004, Macmillan India Ltd.
- A Textbook on Oscillations, Waves and Acoustics, M Ghosh, D Bhattacharya, 3rd Edn, 2006, S Chand & Company Ltd.
- Wave and Acoustics, P K Chakrabarti, S Chowdhury, 4th Edn, 2002, NCBA.
- A Textbook on Light for Advanced Degree Students, K G Mazumdar
- A Textbook of Optics, N Subrahmanyam, Brij Lal, M N Avadhanulu, 2016, 25th Edn, S Chand & Company Pvt. Ltd.
- Textbook of Physical Optics, K Ghosh, A Manna, 1st Edn, 2007, Macmillan India Ltd.

References

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.

B.SC. (REGULAR) IN PHYSICS
REGULAR CORE COURSE (RCC) PAPERS

SEMESTER I

PAPER CODE: PHYS- RCC- 1016

Mechanics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To get acquaintance with the dynamics of the system of particles, motion, elasticity.
2. To understand the concept of gravitation and special theory of relativity.

Learning outcome: -

1. The successful students would be able to develop the knowledge on the mechanics and dynamics of the particles and special theory of relativity and can apply its concept on various physical phenomena.
2. The students would be able to understand the basics of material properties like, elasticity, elastic constants and their relation, torsion of a cylinder, bending of a beam, cantilever, beam supported at its ends and loaded in the middle.

CONTENTS:

THEORY:

UNIT 1: VECTORS (LECTURES 4)

Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.

UNIT 2: ORDINARY DIFFERENTIAL EQUATIONS (LECTURES 6)

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

UNIT 3: LAWS OF MOTION (LECTURES 10)

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

Mass.

UNIT 4: MOMENTUM AND ENERGY (LECTURES 6)

Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.

UNIT V: ROTATIONAL MOTION (LECTURES 5)

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

UNIT 6: GRAVITATION (LECTURES 8)

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).

UNIT 7: OSCILLATIONS (LECTURES 6)

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

UNIT 8: ELASTICITY (LECTURES 8)

Hooke's law - Stress-strain diagram – Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants – Work done in stretching and work done in twisting a wire – Twisting couple on a cylinder – Determination of Rigidity modulus by static torsion - Torsional pendulum-Determination of Rigidity modulus and moment of inertia – q, η and σ by Searles method.

UNIT 9: SPECIAL THEORY OF RELATIVITY (LECTURES 7)

Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

PRACTICALS:

A minimum of five experiments to be done.

1. Measurements of length (or diameter) using vernier caliper, screw gauge and Spherometer.
2. To determine the Moment of Inertia of a Symmetrical body about an axis by torsional oscillation method.
3. To determine the Young's Modulus of the material of a wire by Searle's apparatus.
4. To determine the Modulus of Rigidity of a Wire Static method.
5. To determine the elastic Constants of a wire by Searle's method.
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum.
8. To study the Motion of Spring and calculate (a) Spring constant and (b) value of g.

SUGGESTED READINGS:

Textbooks

- Mechanics, Prof. D.S.Mathur and Dr. P. S. Hemne, First Edition, Reprint 2014, S Chand.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley

- BSc Practical Physics, N N Ghosh, 2017, Bharati Pawan Publishers.
- A Text Book of Practical Physics, Dr. Samir Kumar Ghosh, 2005, New Central Book Agency.

References

- An Introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw-Hill.
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, F. W. Sears, M. W. Zemansky, H.D Young 13/e, 1986, Addison Wesley.
- Feynman Lectures, Vol. I, R. P. Feynman, R. B. Leighton, M. Sands, 2008, Pearson Education.
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.

SEMESTER II

PAPER CODE: PHYS-RCC-2016

Electricity And Magnetism

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. The emphasis of the course is to provide better perspective and understanding on electric and magnetic fields and their interactions with the matter and various circuit theories.
2. The practical are designed in such a way that the students can have implications with the prescribed theories.

Learning outcome: -

1. After successful completion of this course, students would be able to understand electric and magnetic fields in matter.
2. The students would be able to understand the Dielectric properties of matter, magnetic properties of matter, electromagnetic induction and also would be able to apply Kirchoff's law and various network theorem in different circuits.
3. The hands on experiment will provide the better understanding of electricity and magnetism and various parameters of the circuit.

CONTENTS:

THEORY:

UNIT 1: ELECTROSTATICS (LECTURES 34)

Review of Vector Analysis: Gradient, Divergence, Curl of a vector and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential.

Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.

UNIT 2: MAGNETISM (LECTURES 10)

Magnetostatics: Biot-Savart's law & 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.

UNIT 3: ELECTROMAGNETIC INDUCTION (LECTURES 6)

Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic field.

UNIT 4: MAXWELL`S EQUATIONS AND ELECTROMAGNETIC WAVE PROPAGATION (LECTURES 10)

Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves.

PRACTICALS:

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c)DC Current, and (d) checking electrical fuses.
2. To study the Characteristics of a Series RC Circuit.
3. To study a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
4. To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and
5. (b) Quality factor Q
6. To determine a Low Resistance by Carey Foster's Bridge.
7. To verify the Thevenin and Norton theorem
8. To verify the Superposition, and Maximum Power Transfer Theorem

SUGGESTED READINGS:

Textbooks

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

- Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw.
- Electricity and Magnetism, R. Murugeshan, S Chand
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.
- BSc Practical Physics, N N Ghosh, 2017, Bharati Pawan Publishers.

References

- Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.
- 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.
- A Text Book of Practical Physics, Dr. Samir Kumar Ghosh, 2005, New Central Book Agency

SEMESTER III

PAPER CODE: PHYS-RCC-3016

Thermal Physics and Statistical Mechanics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. The course is developed to introduce the basic knowledge on thermodynamics,kinetic behavior of gases and statistical mechanics.
2. To provide basic understanding of the physics of various techniques to determine thermal conductivity, working of thermo couple through practical.

Learning outcome: -

1. Upon successful completion, students would have the knowledge and skills to identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, Thermodynamics potentials, Free energies, Maxwell's relations in thermodynamics, behaviour of real gases.
2. To provide the basics of BE Statistics and FD statistics for understanding the macroscopic properties of different particles.

CONTENTS:

THEORY:

UNIT 1: THERMODYNAMIC DESCRIPTION OF SYSTEM (LECTURES 22)

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 & C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero.

UNIT 2: THERMODYNAMIC POTENTIALS (LECTURES 10)

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

UNIT 3: KINETIC THEORY OF GASES (LECTURES 10)

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.

UNIT 4: 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.

UNIT 5: STATISTICAL MECHANICS (LECTURES 12)

Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Three types of statistics: Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein, comparison of three statistics. Maxwell-Boltzmann distribution law of velocity, application of Quantum statistics in electron gas and photon gas.

PRACTICALS:

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine Stefan's Constant.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the coefficient of thermal conductivity of a bad conductor by Leeand Charlton's disc method.
6. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
7. To study the variation of thermo emf across two junctions of a thermocouplewith temperature.
8. To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge

SUGGESTED READINGS:

Textbooks

- A Textbook of Statistical Mechanics, S. Chandra, 2nd edition, 30 November 2016 CBS Publishers & Distributors.
- Heat Thermodynamics and Statistical Physics, Brijlal, N Subhramanyam, P Hemne, 2017, S Chand.
- Thermodynamics and Statistical Physics, Sharma and Sarkar, 2014, Himalaya Publishing House.
- Advanced Text Book on Heat, PK Chakrabarti, 2005, Shreedhar Prakashani

References

- Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
- 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

SEMESTER IV

PAPER CODE: PHYS-RCC-4016

Waves & Optics

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To develop the knowledge on wave motion, interference, diffraction and various optical phenomena.
2. To provide better understanding of the basic underlying physics of interferometer and holography.
3. To provide physical insight of various optical devices through experiments.

Learning outcome: -

1. Successful students would be able to get a clear concept on superposition of harmonic oscillations, different types of wave motions, superposition of harmonic waves, interference.
2. The interferometer, diffraction, the idea behind holography.
3. The students would be able to understand and capable of handling various optical instruments.

CONTENTS:

THEORY:

UNIT 1: SUPERPOSITION OF TWO COLLINEAR HARMONIC OSCILLATIONS (LECTURES 4)

Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).

UNIT 2: SUPERPOSITION OF TWO PERPENDICULAR HARMONIC OSCILLATIONS (LECTURES 2)

Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

UNIT 3: WAVES MOTION (LECTURES 7)

General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.

UNIT 4: FLUIDS (LECTURES 7)

Surface Tension: Synclastic and anticlastic surface – Excess of pressure – Application to spherical and cylindrical drops and bubbles – variation of surface tension with temperature – Jaegar's method. Viscosity – Rate flow of liquid in a capillary tube – Poiseuille's formula – Determination of coefficient of viscosity of a liquid – Variations of viscosity of liquid with temperature – lubrication.

UNIT 5: SOUND (LECTURES 6)

Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem -Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.

UNIT 6: WAVE OPTICS (LECTURES 3)

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

UNIT 7: INTERFERENCE (LECTURES 11)

Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclinationand Fringes of equal thickness. Newton's Rings: measurement of wavelength. Michelson's Interferometer: Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index Visibility of fringes.

UNIT 8: DIFFRACTION (LECTURES 15)

Fresnel and Fraunhofer diffraction. 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 diffraction pattern of a straight edge and at a circular aperture. Resolving Power of a telescope. Fraunhofer diffraction due to a Single slit, Diffraction grating. Resolving power of grating.

UNIT 9: POLARIZATION (LECTURES 5)

Transverse nature of light waves. Double Refraction, Plane, circular and elliptically polarized light, Production and analysis of polarized light. Retarding plates.

PRACTICALS:

A minimum of five experiments to be done.

1. To study the variation in liquid column height with diameter of capillary tube and determine the surface tension of the liquid.
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment.
3. To determine the coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method)
4. To determine the focal length of a convex mirror with the help of convex lens .
5. To determine the refractive index of a liquid by using plane mirror and convex lens.
6. To determine the focal length of two lenses and their combination by displacement method .
7. Familiarization with Schuster's focussing; determination of angle of prism.
8. To determine the Refractive Index of the Material of a Prism using Sodium Light.
9. To determine wavelength of sodium light using Newton's Rings.

SUGGESTED READINGS:

Textbooks

- Textbook of Vibration and Waves, S P Puri, 2nd Edn, 2004, Macmillan India Ltd.
- A Textbook on Oscillations, Waves and Acoustics, M Ghosh, D Bhattacharya, 3rd Edn, 2006, S Chand & Company Ltd.
- Wave and Acoustics, P K Chakrabarti, S Chowdhury, 4th Edn, 2002, NCBA.
- A Textbook on Light for Advanced Degree Students, K G Mazumdar
- A Textbook of Optics, N Subrahmanyam, Brij Lal, M N Avadhanulu, 2016, 25th Edn, S Chand & Company Pvt. Ltd.
- Textbook of Physical Optics, K Ghosh, A Manna, 1st Edn, 2007, Macmillan India Ltd.

References

- Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
- Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
- Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
- Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
- The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
- The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
- An Advance course in Practical Physics, D Chattopadhyay and P C Rakshit, 2013, New Central Book Agency.

DISCIPLINE SPECIFIC ELECTIVE PAPERS

SEMESTER V

PAPER CODE: PHYS-RDS-5016

Nuclear and Particle Physics

PAPER CREDIT: 06 (5T+1Tu)

T: Theory Tu: Tutorial

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Presentation T: Theory, IA: Internal Assessment, P: Presentation

Objectives:-

1. The course emphasizes to impart knowledge on properties of Nucleus, the involved nuclear reactions.
2. To provide awareness of particle accelerators, different nuclear radiation by understanding their underlying physics and its applications.
3. To familiarize with the broad spectrum of particle physics.

Learning outcome:

1. Upon completion of this course, students would have the understanding of the sub atomic particles and their properties.
2. They would gain knowledge about the different nuclear techniques and their applications indifferent branches of Physics and societal application.
3. The course will develop problem based skills and the acquire knowledge could be applied in the areas of nuclear, medical, archeology, geology and other interdisciplinary fields of Physics and Chemistry.

CONTENTS:

THEORY:

UNIT 1: GENERAL PROPERTIES OF NUCLEI (LECTURES 12)

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.

UNIT 2: NUCLEAR MODELS (LECTURES 10)

Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model.

UNIT 3: RADIOACTIVITY DECAY (LECTURES 12)

(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.

UNIT 4: NUCLEAR REACTIONS (LECTURES 8)

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).

UNIT 5: INTERACTION OF NUCLEAR RADIATION WITH MATTER (LECTURES 6)

Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron interaction with matter.

UNIT 6: DETECTOR FOR NUCLEAR RADIATIONS (LECTURES 6)

Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter.

UNIT 7: PARTICLE ACCELERATORS (LECTURES 5)

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

UNIT 8: PARTICLE PHYSICS (LECTURES 16)

Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons.

SUGGESTED READINGS:

Textbooks

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Nuclear Physics, D C Tayal, 2011, Himalaya Publishing House
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Atomic and Nuclear Physics, Shatendra Sharma, 2008, 1st Edn, Pearson Education.

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

References

- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
- Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP- Institute of Physics Publishing, 2004).
- 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)

SEMESTER VI

PAPER CODE: PHYS-RDS-6016

Nano Materials and Applications

PAPER CREDIT: 06 (4T+2P)

T: Theory P: Practical

Total no. of Lectures: 60+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. The objective of this course is to imbibe a foundational knowledge on nanoscience, such as the influence of dimensionality of the object at nanoscale on their properties.
2. To provide basics knowledge of the fabrication techniques and their future application in the industry.

Learning outcome: -

1. Successful students would be able to understand the physics of particles in nano scale, such as the quantum confinement on the electronic structure, corresponding chemical and physical properties.
2. They would learn the basics of various fabrication techniques, correlate properties of nanostructures with their shape, size and surface characteristics and various technical perspectives of the nanoscale devices.

CONTENTS:

THEORY:

UNIT 1: NANOSCALE 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.

UNIT 2: SYNTHESIS OF NANOSTRUCTURE MATERIALS (LECTURES 8)

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.

UNIT 3: CHARACTERIZATION (LECTURES 8)

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

UNIT 4: OPTICAL PROPERTIES (LECTURES 14)

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 heterostrctures and nanostructures.

UNIT 5: ELECTRON TRANSPORT (LECTURES 6)

Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

UNIT 6: APPLICATIONS (LECTURES 14)

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).

PRACTICALS:

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 prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

SUGGESTED READINGS:

Textbooks

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- An Introduction to synthesis, properties and applications of Nanomaterials, Thomas Varghese, K M Balakrishna, 1st Edn, 2017, Atlantic publishers and Distributors Pvt. Ltd.

- Nanophysics and Nanotechnology, Edward L. Wolf, 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).

References

- 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).
- 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 & Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

SKILL ENHANCEMENT COURSE (SEC) PAPERS

(**Note:** 4 papers to be selected as applicable from the pool table)

SEMESTER – III

PAPER CODE: PHYS-SEC-3014

Weather Forecasting

Paper Credits: 04 (2T+2P)

Total no. of Lectures: 30+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives:-

1. To impart theoretical knowledge on weather forecasting to the students.
2. To enable them to develop an awareness and understanding regarding the causes and effects of different weather phenomenon and basic forecasting techniques.

Learning outcome: -

1. On successful completion of the course students would be able to understand concepts and various techniques of weather phenomenon and basic forecasting.

CONTENTS:

THEORY:

UNIT 1: INTRODUCTION TO ATMOSPHERE (LECTURES 9)

Elementary idea of atmosphere: physical structure and composition; compositional layeringof the atmosphere; variation of pressure and temperature with height; air temperature; requirements to measure air temperature; temperature sensors: types; atmospheric pressure: its measurement; cyclones andanticyclones: its characteristics.

UNIT 2: MEASURING THE WEATHER (LECTURES 4)

Wind; forces acting to produce wind; wind speed direction: units, its direction; measuring wind

speed and direction; humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.

UNIT 3: WEATHER SYSTEMS (LECTURES 3)

Global wind systems; air masses and fronts: classifications; jet streams; local thunderstorms; tropical cyclones: classification; tornadoes; hurricanes

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UNIT 4: CLIMATE AND CLIMATE CHANGE (LECTURES 6)

Climate: its classification; causes of climate change; global warming and its outcomes; air pollution; aerosols, ozone depletion, acid rain, environmental issues related to climate.

UNIT 5: BASICS OF WEATHER FORECASTING (LECTURES 8)

Weather forecasting and its types; weather forecasting methods; criteria of choosing weather station; basics of choosing site and exposure; satellites observations in weather forecasting; weather maps; uncertainty and predictability; probability forecasts.

DEMONSTRATIONS AND EXPERIMENTS:

1. Study of synoptic charts & weather reports, working principle of weather station.
2. Processing and analysis of weather data:
    (a) To calculate the sunniest time of the year.
    (b) To study the variation of rainfall amount and intensity by wind direction.
    (c) To observe the sunniest/driest day of the week.
    (d) To examine the maximum and minimum temperature throughout the year.
    (e) To evaluate the relative humidity of the day.
    (f) To examine the rainfall amount month wise.
3. Exercises in chart reading: Plotting of constant pressure charts, surfaces charts, upper wind charts and its analysis.
4. Formats and elements in different types of weather forecasts/ warning (both aviation and non-aviation)

SUGGESTED READINGS:

Textbooks and References

- Aviation Meteorology, I.C. Joshi, 3rd edition 2014, Himalayan Books
- The weather Observers Hand book, Stephen Burt, 2012, CambridgeUniversity Press.
- Meteorology, S.R. Ghadekar, 2001, Agromet Publishers, Nagpur.
- Text Book of Agrometeorology, S.R. Ghadekar, 2005, Agromet Publishers,Nagpur.
- Why the weather, Charls Franklin Brooks, 1924, Chpraman & Hall, London.
- Atmosphere and Ocean, John G. Harvey, 1995, The Artemis Press.

SEMESTER – IV

PAPER CODE: PHYS-SEC-4014

Research & Technical Writing

Paper Credits: 04(2T+2P)

Total no. of Lectures: 30+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. To aware the students about importance of research and technical writing.
2. To provide students with an introduction to technical writing, graphing and data analysis, LaTeX and its uses, familiarization of Origin and Microsoft excel.

Learning outcome: -

1. On successful completion of the course students would be able to write reports, articles, thesis, in latex, create chart in Microsoft excel, use different format of chartbased on need, plot data from different sources using Origin.

CONTENTS:

THEORY:

UNIT 1: INTRODUCTION (LECTURES 4)

Structure and components of scientific reports - Types of report – Technical reports and thesis– Different steps in the preparation – Layout – Illustrations and tables - Bibliography, referencing and footnotes. Need of scientific word processor, examples of scientific word processors.

UNIT 2: TECHNICAL WRITING IN LATEX (LECTURES 12)

Introduction to LaTeX, advantages of using LaTex, TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX

File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. Equation representation: Formulae and equations, Figures and other floatingbodies, Lining in columns-Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors. Applications of LaTex in article, thesis, slide preparation.

UNIT 3: SCIENTIFIC GRAPHING AND DATA ANALYSIS (LECTURES 14)

Creating chart in Microsoft excel, Types of chart- Column chart, line chart, Pie chart, Doughnut chart, bar chart, area chart, scatter chart, surface chart; Chart elements- Chartstyle, Chart filter, fine tune of chart; Chart design tools- Design and format.

The Origin Workspace, Multi-sheet Workbooks, Managing Data and Metadata, Importing Data from different sources, Working with Excel and Origin, Basic Data Manipulation, Creating and Customizing Graphs, Custom Graph Templates and Themes, Publishing Graphs, Basic Data Analysis, Customizing Data Import, Post Processing of Imported Data, Creating and Customizing Multi-layer Graphs, Data Exploration and Pre-selection, Advanced Nonlinear Fitting, including Creating Custom Fitting Functions, Analysis Themes, Customizing Reports and Creating Custom Tables in Graphs, Recalculating/Updating Results, Analysis Templates and Custom Reports, Peaks and Baseline.

SUGGESTED READINGS:

Textbooks and References

- Kothari, C. R., Garg, G., Research Methodology: Methods and Techniques. New Age International (P) Limited, Publishers.
- Griffiths, D. F., Higham, D. J., Learning LaTeX. United States: Society for Industrialand Applied Mathematics.
- Lamport, s., Bibby, D. Lamport L., LATEX: a document preparation system : user'sguide and reference manual. Germany: Addison-Wesley.
- Lalwani, L., Excel All-in-One: Master the New Features of Excel 2019 / Office 365. India: BPB Publications.
- Origin 9: The Data Analysis and Graphing Workspace. (2011). UnitedStates: OriginLab.

SEMESTER – V

PAPER CODE: PHYS-SEC-5014

Renewable Energy and Energy Harvesting

Paper Credits: 04 (2T+2P)

Total no. of Lectures: 30+30(L+P)

Total Marks: 100 (T60+IA20+P20)

L: Lecture, Tu: Tutorial, P: Practical T: Theory, IA: Internal Assessment, P: Practical

Objectives: -

1. To impart theoretical knowledge of renewable energy and its harvesting to the students.
2. To provide them with exposure and hands-on learning.

Learning outcome: -

1. On successful completion of the course students would be able to understand theoretical knowledge and practical implementation of methods of energy harvesting.

CONTENTS:

THEORY:

UNIT 1: FOSSIL FUELS AND ALTERNATE SOURCES OF ENERGY (LECTURES 6)

Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventionalenergy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity.

UNIT 2: SOLAR ENERGY (LECTURES 8)

Solar energy, its importance, storage of solar energy, solar pond, non-convective solar pond, applications of solar pond and solar energy, solar water heater, solar cooker, solar green houses, solar cell. Need and characteristics of photovoltaic (PV) systems, PV models.

UNIT 3: WIND ENERGY HARVESTING (LECTURES 4)

Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

UNIT 4: OCEAN ENERGY (LECTURES 5)

Ocean Energy Potential against Wind and Solar, Wave Characteristics, Wave Energy Devices. Tide characteristics, Tide Energy Technologies, Ocean Thermal Energy, Ocean Bio-mass.

UNIT 5: GEOTHERMAL ENERGY (LECTURES 3)

Geothermal Resources, Geothermal Technologies.

UNIT 6: HYDRO ENERGY (LECTURES 4)

Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

DEMONSTRATIONS AND EXPERIMENTS

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

SUGGESTED READINGS:

Textbooks and References

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

SEMESTER – VI

PAPER CODE: XXXX-SEC-6014

Paper Credits: 04(2T+2P)

Total no. of Lectures: 30+30(L+P)

Total Marks: 100 (T60+IA20+P20)

(**Note:** The regular students may select their choice of paper from the pool of SEC papers)

SAMPLE PAPER SETTING

FOR HONOURS CORE COURSE

FOR HGE/RCC

SAMPLE DISSERTATION SETTING

The outline of the dissertation may contain as follows –

a) **TITLE**
b) **INTRODUCTION**
c) **REVIEW OF LITERATURE**
d) **METHODOLOGY**
e) **RESULTS/FINDINGS**
f) **DISCUSSION**
g) **SUMMARY/CONCLUSION**
h) **ACKNOWLWDGEMENT**
i) **REFERENCES/BIBLIOGRAPGY**

(Note: Students can search for the various format of writing dissertation**)**