PHYSICS

Vision, Mission and Core Values of the Vidyapeeth

VISION OF VIDYAPEETH

Traditionally believing that God is the Source of all Truth, Goodness and Beauty, Lingaya's Vidyapeeth, wishes to develop in students a wisdom that translates academic achievements into responsible citizenship, sincere professional service and a deep respect for life and beauty in God's Creation and Recreation.

MISSION OF VIDYAPEETH

- To impart knowledge and skills in the field of Engineering/ Technology, Management, Education, Science & Arts and related areas;
- To dedicate itself for improvement of social and economic status and enhancement of the quality of life for all;
- To strive for maximizing human welfare through education;
- To produce effective knowledge workers, practitioners and educators who will be guided by vision, compassion, knowledge, discipline, discovery with deep respect for human values;
- To provide an individual engineering and other professional COURSE experience for each student;
- To develop critical thinking, analytical ability and creative skills;
- To supplement the curricula, team work, leadership, communication skills, project management, social concerns and ethics and
- To establish interaction with industries for Technology, Research & Development.

In line with above vision and mission statements, Lingaya's Vidyapeeth has the following special characteristics:

- Lingaya's Vidyapeeth is an Institution for providing a student with opportunity for all round development and education with the aim of effective living as a good citizen.
- It has special strength in the field of Engineering and Technology with emphasis on practice and problem solving skills.
- Its activities and course curriculum concentrate on design, self-COURSE and research, which are the unique features of the Vidyapeeth.
- The primarily value of knowledge and skill imparted by Lingaya's Vidyapeeth resides in its utility in creating an infrastructure for the physical welfare of the general public, in sustaining good health of individual and the community.
- Lingaya's Vidyapeeth facilitates and promotes creativity and critical thinking capabilities in its students.
- The education in Lingaya's Vidyapeeth enhances the inherent capacity of a student with honesty, courage and fairness.

SCHOOL OF BASIC AND APPLIED SCIENCES LINGAYAS VIDYAPEETH

VISION OF SCHOOL

To be a School committed to promote Science and research exploration and education for attracting young talented students to contribute effectively in augmenting the national pool for scientific development who are responsible citizens and sincere professionals with the deep knowledge.

MISSION OF SCHOOL

1. To strive to maximize human welfare through the understanding the different phenomena of science with advance scientific development.
2. To develop and maintain state –of –the –art infrastructure and research facilities to enable create, apply and disseminate knowledge.
3. To create inter-disciplinary research environment and
4. To prepare students who are capable to take up their future educational and career challenges.

Vision and Mission of Department of Physics

School of Basic and Applied Sciences , LV

VISION OF DEPARTMENT

To be a department dedicated to promoting multidisciplinary Physical science and research activities, as well as education for interesting young brilliant students, in order to efficiently contribute to augmenting the local and national pool of responsible people and genuine professionals with deep expertise.

MISSION OF DEPARTMENT

1. To encourage young minds and help them to explore their strengths in both theory and experimental work of physical sciences
2. To prepare our graduate to understand the Physical analysis to apply in other disciplinary approach.
3. To explore applications of Physical sciences in engineering, material sciences and engage in collaborative research in a multidisciplinary environment.
4. The Physics Department is dedicated to producing competitive and professional graduates in multi-Disciplinary areas.

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

PEO1: To produce graduates who excel in the competencies and values required for leadership to serve a rapidly evolving global community

PEO2: To motivate the students to pursue PG courses in reputed institutes

PEO3: To kindle the interest for research in students.

PEO4: To acquire placement in educational institutions, engineering and industrial firms.

Mapping of PEOs with Mission Statements

PEO Statements	Department Mission 1	Department Mission 2	Department Mission 3	Department Mission 4
PEO1	3	2	1	1
PEO2	1	2	3	2
PEO3	2	3	2	1
PEO4	2	1	2	3

LINGAYA'S VIDYAPEETH
SCHEME OF STUDIES
SESSION: 2024-2027

School: School of Basic and Applied Sciences	**Batch: 2024-2027**
Department: Physics	**Year: 1st**
Course: B.Sc. Hons. Physics	**Semester: 1st**

SN	**Category**	**Course Code**	**Course Name**	**Periods**			**Credits**	**Evaluation Scheme**					**Subject Total Marks**
								Theory			**Practical**		
				L	**T**	**P**		**ABQ**	**MSE**	**ESE**	**IP**	**EXP**	
1.1	PCC	**BPH-101**	Waves & Optics	4	0	0	4	15	25	60	-	-	100
2.	PCC	**BMA**	Algebra	4	0	0	4	15	25	60	-	-	100
3.	GE	**BCH**	Physical Chemistry	4	0	0	4	15	25	60	-	-	100
4.	PCC	**BPH-151**	Waves & Optics Lab	0	0	4	2				60	40	100
5.	GE	**BCH**	Physical Chemistry Lab	0	0	4	2				60	40	100
6.	AECC	**HSS-107**	Communication Skill-I	2	0	0	2	15	25	60	-	-	100

			Total---->	**14**	**0**	**8**	**18**	**60**	**100**	**240**	**120**	**80**	**600**

School: School of Basic and Applied Sciences									**Batch: 2024-2027**				
Department: Physics									**Year: 1st**				
Course: B.Sc. Hons. Physics									**Semester: 2nd**				
SN	**Cat e- gor y**	**Course Code**	**Course Name**	**Periods**			**Credit s**	**Evaluation Scheme**					**Subject Total Marks**
								Theory			**Practical**		
				L	**T**	**P**		**AB Q**	**MS E**	**ES E**	**IP**	**EX P**	
1	PC C	**BPH-102**	Electricity & Magnetism	4	2	0	6	15	25	60	-	-	100
2	PC C	**BPH-104**	Mechanics	4	0	0	4	15	25	60	-	-	100
3	GE	**BMA**	Calculus	4	2	0	6	15	25	60	-	-	100
5	PC C	**BPH-152**	Electricity & Magnetism Lab	0	0	4	2	-	-	-	60	40	100
6	PC C	**BPH-154**	Mechanics Lab	0	0	4	2	-	-	-	60	40	100
7	AE CC	**CE-108**	Environmental Science	2	0	0	2	15	25	60	-	-	100
			Total---->	**14**	**4**	**8**	**22**	**60**	**100**	**240**	**120**	**80**	**600**

School: School of Basic and Applied Sciences									**Batch: 2024-2027**				
Department: Physics									**Year: 2nd**				
Course: B.Sc. Hons. Physics									**Semester: 3rd**				
S N	**Cate - gory**	**Course Code**	**Course Name**	**Periods**			**Credit s**	**Evaluation Scheme**					**Subject Total Marks**
								Theory			**Practical**		
				L	**T**	**P**		**AB Q**	**MS E**	**ES E**	**IP**	**EX P**	
1	PCC	**BPH-201**	Thermal Physics	4	0	0	4	15	25	60	-	-	100
2	PCC	**BPH-203**	Digital Systems and Applications	4	0	0	4	15	25	60	-	-	100
4	GE	**BPH-207**	Applied Optics	4	0	0	4	15	25	60	-	-	100
5	SEC	**BPH-209**	Renewable Energy and Energy harvesting	2	0	0	2	15	25	60	-	-	100
6	PCC	**BPH-251**	Thermal Physics Lab	0	0	4	2				60	40	100
7	PCC	**BPH-253**	Digital Systems and Applications Lab	0	0	4	2				60	40	100
8	PCC	**BPH-255**	Applied optics Lab	0	0	4	2				60	40	100
			Total---->	**14**	**0**	**12**	**22**	**75**	**125**	**300**	**180**	**120**	**700**

School: School of Basic and Applied Sciences	Batch: 2024-2027
Department: Physics	Year: 2nd
Course: B.Sc. Hons. Physics	Semester: 4th

S N	Cate gory	Course Code	Course Name	Periods			Credit s	Evaluation Scheme					Subj Tot Mar
								Theory			Practical		
				L	T	P		AB Q	MS E	ES E	IP	EX P	
1	PCC	**BPH-202**	Elements of Modern Physics	4	2	0	6	15	25	60	-	-	10
2	PCC	**BPH-204**	Physics of Devices and Communications	4	0	0	4	15	25	60			10
3	PCC	**BPH-206**	Solid state Physics	4	0	0	4	15	25	60	-	-	10
4	SEC	**BPH-208**	Spectroscopy Physics	4	0	0	4	15	25	60	-		10
5	GE	**BPH-210**	Nuclear and Particle Physics	4	0	0	4				60	40	10
6	PCC	**BPH-254**	Physics of Devices and Communications Lab	0	0	4	2				60	40	10
7	PCC	**BPH-256**	Solid state Physics Lab	0	0	4	2				60	40	10
			Total---->	**20**	**2**	**8**	**26**	**60**	**100**	**240**	**180**	**120**	**700**

School: School of Basic and Applied Sciences	Batch: 2024-2027
Department: Physics	Year: 3rd
Course: B.Sc. Hons. Physics	Semester: 5th

SN	Cate-gory	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	**BPH-301**	Quantum Mechanics & Applications	4	0	0	4	15	25	60	-	-	100
2	PCC	**BPH-303**	Research Methodology	4	2	0	6	15	25	60	-	-	100
3	DSE	**BPH-305**	Solar energy & Energy Harvesting	4	2	0	6	15	25	60			100
4	DSE	**BPH-307**	Nano Materials and Applications	4	0	0	4	15	25	60			100
5	PCC	**BPH-351**	Quantum Mechanics & Applications lab	0	0	4	2				60	40	100
7	DSE	**BPH-357**	Nano Materials and Applications lab	0	0	4	2	-	-	-	60	40	100
			Total---->	**16**	**4**	**8**	**24**	**60**	**100**	**240**	**120**	**80**	**600**

School: School of Basic and Applied Sciences	**Batch: 2024-2027**
Department: Physics	**Year: 3rd**
Course: B.Sc. Hons. Physics	**Semester: 6th**

SN	Category	Course Code	Course Name	Periods			Credits	Evaluation Scheme					Subject Total Marks
								Theory			Practical		
				L	T	P		ABQ	MSE	ESE	IP	EXP	
1	PCC	**BPH-302**	Electro-Magnetic	4	0	0	4	15	25	60	-	-	100

			Theory										
2	PCC	**BPH-304**	Statistical Mechanics	4	2	0	6	15	25	60	-	-	100
3	DSE	**BPH-306**	Solar Photo voltaic energy conversion	4	0	0	4	15	25	60	-	-	100
4	DSE	**BPH-308**	Nano-Synthesis Techniques	4	0	0	4	15	25	60	-	-	100
5	PCC	**BPH-352**	Electro-Magnetic Theory lab	0	0	4	2	-	-	-	60	40	100
5	DSE	**BPH-360**	Project/ Dissertation	0	0	12	6	-	-	-	60	40	100
			Total---->	**16**	**2**	**16**	**26**	**60**	**100**	**240**	**120**	**80**	**600**

Total Credit: 138

Students should enroll in Three Compulsory MOOC courses mapped to any of course in the scheme in three year of degree.

Abbreviations:

PCC: Programme Core Course

AECC: Ability Enhancement Compulsory Course

AEC: Ability Enhancement Course

SEC: Skill Enhancement Course

GE: Generic Elective

DSE: Discipline Specific Elective

PROJ: Project

ABQ: Assignment Based Quiz

MSE: Mid Semester Examination

ESE: End Semester Examination

IP: Internal Practical

EXP: External Practical

L: Lecture

T: Tutorial

P: Practical

Mapping of Program Outcome with Program Educational Objectives

	PEO1	PEO2	PEO3	PEO4
PO1	1	2	1	2
PO2	2	1	3	2
PO3	2	1	3	1
PO4	2	1	3	1

SEMESTER –I

SUBJECT NAME: WAVE AND OPTICS

Unit-I Superposition of Collinear Harmonic oscillations:
Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.
Graphical and Analytical Methods. Lissajous Figures (1:1 and 1:2) and their uses.

Unit-II: Wave Motion & Velocity of Waves: **:** 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.
Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound waves and Laplace's Correction.

Unit-III:Superposition of Two Harmonic Waves:
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. Open and Closed Pipes. Superposition of N Harmonic Waves.

Unit-IV:Wave Optics:
Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.
Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes);

Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

Unit-V:Diffraction:

Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit.

Fraunhofer Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.

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

Reference Books

- 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, 7^{th} 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.

SUBJECT NAME: PHYSICSAL CHEMISTRY (ELECTIVE)

Unit-I Thermochemistry-I:

Intensive and extensive variables; state and path functions; isolated, closed and open systems; zeroth law of thermodynamics.

First law: Concept of heat, *q*, work, *w*, internal energy, *U*, and statement of first law; enthalpy, *H*, relation between heat capacities, calculations of *q*, *w*, *U* and *H* for reversible, irreversible and free expansion of gases (ideal and van der Waals) under isothermal and adiabatic conditions.

Unit-II Thermochemistry-II :

Heats of reactions: standard states; enthalpy of formation of molecules and ions and enthalpy of combustion and its applications; calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data, effect of temperature (Kirchhoff's equations) and pressure on enthalpy of reactions. Adiabatic flame temperature, explosion temperature.

Second Law: Concept of entropy; thermodynamic scale of temperature, statement of the second law of thermodynamics; molecular and statistical interpretation of entropy. Calculation of entropy change for reversible and irreversible processes.

Third Law: Statement of third law, concept of residual entropy, calculation of absolute entropy of molecules.

Free Energy Functions: Gibbs and Helmholtz energy; variation of S, G, A with T, V, P; Free energy change and spontaneity. Relation between Joule-Thomson coefficient and other thermodynamic parameters; inversion temperature; Gibbs-Helmholtz equation; Maxwell relations; thermodynamic equation of state.

Unit-III Systems of Variable Composition:

Partial molar quantities, dependence of thermodynamic parameters on composition; Gibbs-Duhem equation, chemical potential of ideal mixtures, change in thermodynamic functions in mixing of ideal gases.

Unit-IV Chemical Equilibrium:

Criteria of thermodynamic equilibrium, degree of advancement of reaction, chemical equilibria in ideal gases, Thermodynamic derivation of relation between Gibbs free energy of reaction and reaction quotient. Equilibrium constants and their quantitative dependence on temperature, pressure and concentration. Free energy of mixing and spontaneity; thermodynamic derivation of relations between the various equilibrium constants K_p , K_c and K_x. Le Chatelier principle (quantitative treatment); equilibrium between ideal gases and a pure condensed phase.

Unit-V Solutions and Colligative Properties:

Dilute solutions; lowering of vapour pressure, Raoult's and Henry's Laws and their applications. Thermodynamic derivation using chemical potential to derive relations between the four colligative properties [(i) relative lowering of vapour pressure, (ii) elevation of boiling point, (iii) Depression of freezing point, (iv) osmotic pressure] and amount of solute. Applications in calculating molar masses of normal, dissociated and associated solutes in solution.

Reference Books:

- Peter, A. & Paula, J. de. *Physical Chemistry 9th Ed.,* Oxford University Press (2011).
- Castellan, G. W. *Physical Chemistry 4th Ed.,* Narosa (2004).
- Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.,* Prentice-Hall (2012).
- McQuarrie, D. A. & Simon, J. D. *Molecular Thermodynamics* Viva Books Pvt. Ltd.: New Delhi (2004).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. *Commonly Asked Questions in Thermodynamics.* CRC Press: NY (2011).
- Levine, I .N. *Physical Chemistry* 6th Ed., Tata Mc Graw Hill (2010).
- Metz, C.R. *2000 solved problems in chemistry,* Schaum Series (2006)

SUBJECT NAME: Wave and Optics Lab

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Note: Each student is required to perform at least seven experiments.

Reference Books:

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

SUBJECT NAME: Physical Chemistry Lab

(a) Determination of heat capacity of a calorimeter for different volumes using change of enthalpy data of a known system (method of back calculation of heat capacity of calorimeter from known enthalpy of solution or enthalpy of neutralization).

(b) Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

(c) Calculation of the enthalpy of ionization of ethanoic acid.

(d) Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.

(e) Determination of basicity/proticity of a polyprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

(f) Determination of enthalpy of hydration of copper sulphate.

(g) Study of the solubilityΔ of benzoic acid in water and determination of H.

Any other experiment carried out in the class.

SEMESTER-II

Course Code BPH-102	Subject Name ELECTRICITY AND MAGNETISM (Semester I)	L T P	Cr.
		4+0+0	4

OBJECTIVES: Learn the mathematical methods to solve the problems involving electric potential and fields.
Course OUTCOMES: CO1: Master the mathematical tools to find electric potential and fields.

CO2: Learning of important theorems as Gauss theorem. CO3: Calculating the electric fields around conductors. CO4: The use of Coulomb's law and Gauss' law for the electrostatic force.

Unit	Contents	Lectures
I	Vector Calculus : Differentiation of vectors, scalar and vector fields, conservative fields and potentials, line integrals, gradient of a scalar field, divergence of a vector field and divergence theorem, curl of a vector field and its physical significance, Stokes' theorem.	8
II	Electric field and electric potential: Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. 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.	14
III	Dielectric properties of matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics.	10
IV	Magnetic field: Definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Magnetic force between current elements Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Torque on a current loop in a uniform Magnetic Field. Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: Magnetic Force on (1) point charge (2) current carrying wire between current elements.	10
V	Electromagnetic induction & ballistic galvanometer: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Energy stored in a Magnetic Field. Behavior of various substances in magnetic fields. Magnetic permeability and susceptibility and their interrelation. Orbital motion of electrons and diamagnetism. Electron spin and paramagnetic. Ferromagnetism. Domain theory of ferromagnetism, magnetization curve, Losses in magnetic materials	10

REFERENCE BOOKS:

1. Mathematical Methods in the Physical Sciences: ML Boas, Wiley, 2002.
2. Introduction to Mathematical Physics: C Harper, Prentice Hall of India, 2004.
3. Electricity and Magnetism (Berkley, Phys. Course 2): EM Purcell, Tata McGraw Hill, 1981
4. Elements of Electromagnetics: MNO Sadiku, Oxford University Press, 2001.
5. Electricity and Magnetism: AS Mahajan, AA Rangwala, Tata McGraw Hill, 1988.

Course Code	Subject Name	L T P	Cr.
BPH-103	Mechanics	4-0-0	4

Objectives: To acquire skills allowing the student to identify and apply formulas of optics and wave physics using course literature.

Unit-I Fundamentals of Dynamics
(10 Lectures)
Reference frames. Inertial frames; Galilean transformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Unit-II Special Theory of Relativity
(10 Lectures)
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 Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector.

Unit-III Work Energy and Collisions
(10 Lectures)
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. Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

UNIT-IV Rotational dynamics:
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, cynlindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

(10 lectures)

Unit-V Gravitational, Central force motion and Oscillations:
Gravitation, Central force motion and oscillations: 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. Satellite in circular orbit and applications. **(10 lectures)**

Reference Books:

- An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
- Mechanics, Berkeley Physics, vol.1, C. Kittel, W. Knight, et.al. 2007, Tata McGraw-Hill.
- Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
- Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
- Feynman Lectures, Vol. I, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education
- Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

- **SUBJECT NAME: CALCULUS (WITH ELECTIVE)**
- **SUBJECT CODE: BMA-111**
- **Unit-1: Limit & Continuity :** The real line and its geometrical representation; *e*-*δ* treatment of limit and continuity; Properties of limit and classification of discontinuities; Properties of continuous functions.
- **Unit-2: Differentiability:** Successive differentiation; Leibnitz Theorem; Statement of Rolle's Theorem; Mean Value Theorem; Taylor and Maclaurin's Theorems; Indeterminate forms.
- **Unit 3: Applications of Differentiation :** Asymptotes; Concavity, convexity and points of inflection; Curvature; Extrema; elementry curves, tangent and normal in parametric form; Polar Coordinates.
- **Unit-4: Partial Differentiation:** Limits and continuity of functions of two variables; Partial derivatives; Taylor's theorem and Maclaurin's Theorem for function of two variable; Maxima and minima for function of two variable.
- **Unit-5: Double and triple integrals;** Change of order in double integrals. Application of Integration : length of a curve; Arc length as a parameter; Evoute & Envelope; Volumes and surface areas of solids of revolution.
- **Reference Books:**

- 1. Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
- 2. Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.
- 3. Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar Inc. New York 1975.
- 4. Shanti Narayan, Elements of Real Analysis, S. Chand & Company,

New Delhi.
- 5Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.
- 6. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
- 7. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) P.
- Ltd. (Pearson Education), Delhi, 2007.
- 8. H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd.,Singapore, 2002.

PHYSICS LAB-C III LAB
60 Lectures

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

Reference Books

- Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal

SUBJECT NAME: MECHANICS LAB

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.

4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

Note: Each student is required to perform at least seven experiments.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

SEMESTER-III

SUBJECT NAME: THERMAL PHYSICS

Unit I Introduction to Thermodynamics

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Unit II Second Law of Thermodynamics:

Reversible and Irreversible process with examples. Conversion of Work into Heat and

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

Unit III Entropy:

Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. 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.

Thermodynamic Potentials: 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 IV Maxwell's Thermodynamic Relations:

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

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

Unit V Molecular Collisions:

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

Real Gases**:** 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.

Reference Books:

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
Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.

Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

SUBJECT NAME: DIGITAL SYSTEM AND APPLICATION

Unit I Introduction to CRO:
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.
Integrated Circuits (Qualitative treatment only): 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 II **Digital Circuits:** Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.
Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Unit III Data processing circuits:
Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.
Sequential Circuits: SR, D, 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.
Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.

Unit IV Shift registers:
Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).
Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.
Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.

Unit V Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI.
Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions.

Reference Books:

- Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
- Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
- Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
- Digital Electronics G K Kharate ,2010, Oxford University Press
- Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning

APPLIED OPTICS

(Credits: 02)

Unit-I Wave Optics: Interference: Wavefront and Division of amplitude. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment, Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula and its application to rectangular slit. Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light.

Unit-II Fourier Optics (6 Periods)

Concept of Spatial frequency filtering, Fourier transforming property of a thin Lens

Unit-III Holography (6 Periods)

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

Unit-IV Photonics: Fibre Optics (9 Periods)

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

Reference Books:

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

LASERS: Fundamentals & applications, K.Thyagrajan & A.K.Ghatak, 2010, Tata McGraw Hill

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

RENEWABLE ENERGY AND ENERGY HARVESTING
(Credits: 02)
Theory: 30 Lectures

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

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

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

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

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

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

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

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

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity,

<u>SUBJECT NAME: Thermal Physic Lab</u>

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.

Note: Each students is required to perform at least seven experiments.

Reference Books

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

reprinted 1985, Heinemann Educational Publishers
🎬A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, Vani Pub

SUBJECT NAME: DIGITAL SYSTEM AND APPLICATION LAB

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. 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.).

Note: Each students is required to perform at least seven experiments

Reference Books:

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

SUBJECT NAME: APPLIED OPTICS LAB

Experiments on Fourier Optics:

a. Fourier optic and image processing

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

b. Fourier Transform Spectroscopy

Fourier Transform Spectroscopy (FTS) is a powerful method for measuring emission and absorption spectra, with wide application in atmospheric remote sensing, NMR spectrometry and forensic science.

Experiment:
To study the interference pattern from a Michelson interferometer as a function of mirror separation in the interferometer. The resulting interferogram is the Fourier transform of the power spectrum of the source. Analysis of experimental interferograms allows one to determine the transmission characteristics of several interference filters. Computer simulation can also be done

Experiments on Holography and interferometry:

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

Experiments on Photonics: Fibre Optics

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

SEMESTER-IV

SUBJECT NAME: ELEMENTS OF MODERN PHYSICS

Unit I

Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.

Unit II

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. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude.

Unit III

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 IV

(i) Sources and Detectors (9 Periods)

Lasers, Spontaneous and stimulated emissions, Theory of laser action, Einstein's coefficients, Light amplification, Characterization of laser beam, He-Ne laser, CO_2, Ruby Laser, Semiconductor lasers, Fiber Optics,

.

Unit V

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 - 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).

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
- Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
- Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.

SUBJECT NAME: PHYSICS OF DEVICE AND COMMUNICATION

Unit I: Measurement Science

Static characteristics of measuring instruments - accuracy, precision sensitivity, non-linerarity, hysteresis - dynamic characteristics - I order and II order instruments - Standards and calibration-
errors and error analysis.

Unit II: Transducers

Variable resistance transducers - potentiometer, strain gauge RTD, thermistor, hygrometer-Variable inductance transducers - LVDT - variable relectance accelerometer – variable capacitance tranaducers for differential pressure, sound and thickness measurement- piezoelectric transducer – smart transducors.

Unit III: Industrial Instruments

Temperature measurement - thermocouples, cold-junction compensation for thermocouple, radiation and optical pyrometers - pressure measurements - bourdon gauge, bellows, diaphragme, differential pressure transmitter, vacum gauges, melead gauge, pirani gauge-flow measurement-office meter, venturimeter, electro-magnetic flow meter, ultrasonic flow meter, rotameter positive displacement meters, mass flowmeters.

Unit IV: Fundamentals of Networks:

Dc And Ac Series And Parallel Circuits - Kirchhoffs Law - Network Graph – Matrix Representation- Solution Of Steady State, equations - transients in AC networks-frequency response of RL, RC, RLC series and parallel circuits.

Unit V: Fundamentals Electronics and Bio-Medical Measurements:

Electronics Instruments: BJT, FET and MOSFET voltmerters - solid state multimeter - DMM - audio and Radio frequency signal generators - AM signal generator
Bio-Medical Instruments: Measurement of biological signals - ECG,EEG, EMG - blood pressure and blood flow measurements-defibrillators-pace maker.

Reference Books:

1. Electrical Measurements and Measuring Instruments By S. Kamakshaiah, J. Amarnath, KrishnaMurthy, Published by I K International Publishing House Pvt. Ltd, 2011.
2. Helfrick and Cooper, “Modern Electronic Instrumentation and Measurement Techniques”, Prentice-Hall of India, Reprint 1988.
3. Jones, B.E., “Instrumentation Measurement and Feedback”, Tata McGraw-Hill, 1986.

4. Golding, E.W., “Electrical Measurement and Measuring Instruments”, 3rd Edition, Sir Issac Pitman and Sons, 1960.
5. Buckingham, H. and Price, E.N., “Principles of Electrical Measurements”, 1961.

- Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
- Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
- Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan

Additional Books for Reference

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

SUBJECT NAME: SOLID STATE PHYSICS

Unit-I Crystal Structure:

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

Unit-II Elementary Lattice Dynamics:

Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the 34 Phonon Spectrum in Solids. Dulong and Petit’s Law, Einstein and Debye theories of specific heat of solids. T3 law

Unit-III Properties of Matter:

Magnetic Properties: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains.Quantum Mechanical Treatment of Paramagnetism.Curie’s law, Weiss’s Theory of Ferromagnetism and Ferromagnetic Domains.Discussion of B-H Curve. Hysteresis and Energy Loss.; Dielectric Properties: Polarization. Local Electric Field at an Atom.Depolarization Field.Electric Susceptibility.Polarizability.ClausiusMosotti Equation.Classical Theory of Electric Polarizability.Normal and Anomalous Dispersion.Cauchy and Sellmeir relations.Langevin-Debye equation.Complex Dielectric Constant.Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes. Ferroelectric Properties: Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Unit-IV Elementary band theory:

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-V Superconductivity:

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

Reference Books:

- Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
- Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
- Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
- Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
- Solid-state Physics, H. Ibach and H. Luth, 2009, Springer • Solid State Physics, Rita John,

2014, McGraw Hill
- Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India
- Solid State Physics, M.A. Wahab, 2011, Narosa Publications

SPECTROSCOPY Physics

UNIT-I : Microwave spectroscopy Pure rotational spectra of diatomic molecules - Polyatomic molecules - Study of linear molecules and symmetric top molecules - Hyperfine structure and quadruple moment of linear molecules - Experimental techniques - Molecular structure determination - Stark effect - inversion spectrum of ammonia - Applications to chemical analysis.
UNIT-II : Infrared spectroscopy Vibrational spectroscopy of diatomic and simple ployatomic molecules - Harmonic Oscillator - Anharmonic Oscillator - Rotational vibrators - Normal modes of vibration of Polyatomic molecules - Experimental techniques - Applications of infrared spectroscopy - H2O and N2O molecules - Reflectance spectroscopy.
UNIT-III : Raman Spectroscopy Classical theory of Raman Scattering - Raman effect and molecular structure - Raman effect and crystal structure - Raman effect in relation to inorganic, organic and physical chemistry - Experimental techniques - Coherent anti-Stokes Raman Spectroscopy - Applications of infrared and Raman spectroscopy in molecular structural confirmation of water and CO2 molecules.
UNIT-IV : NMR and NQR Techniques Theory of NMR - Bloch equations - Steady state solution of Bloch equations - Theory of chemical shifts - Experimental methods - Single Coil and double coil methods - Pulse Method - High resolution method - Applications of NMR to quantitative measurements. Quadruple Hamiltonian of NQR - Nuclear quadruple energy levels for axial and nonaxial symmetry - Experimental techniques and applications.
UNIT-V : ESR and Mossbauer Spectroscopy Quantum mechanical treatment of ESR - Nuclear interaction and hyperfine structure - Relaxation effects - Basic principles of spectrographs - Applications of ESR method. 14 Mossbauer effect - Recoilless emission and absorption - Mossbauer spectrum - Experimental methods - Massbauer spectrometer - Hyperfine interactions - Chemical Isomer shift - Magnetic hyperfine interactions - Electric quadruple interactions - Simple biological applications.

Books for Study

1. C.N. Banwell and E.M. McCash, 1994, Fundamentals of Molecular Spectroscopy, 4 th Edition, Tata McGraw-Hill Publications, New Delhi. 2. G. Aruldas, 2001, Molecular Structure and Spectorscopy, Prentice - Hall of India Pvt.Ltd., New Delhi. 3. D.N. Satyanarayana, 2004, Vibrational Spectroscopy and Applications, New Age International Publications, New Delhi.

Books for Reference

1. Atta Ur Rahman, 1986, Nuclear Magnetic Resonance, Spinger Verlag, New York. 2. Towne and Schawlow, 1995, Micorwave Spectroscopy, McGraw-Hill, 3. Raymond Chang, 1980, Basic Principles of Spectroscopy, Mc Graw-Hill, Kogakusha, Tokyo. 4. D.A. Lang, Raman Spectroscopy, Mc Graw-Hill International, N.Y.

SUBJECT NAME: NUCLEAR AND PARTICLE PHYSICS

Unit I: Structure of Nuclei and Radioactivity

Basic Properties of Nuclei: (1) Mass, (2) Radii, (3) Charge, (4) Angular Momentum, (5) Spin, (5) Magnetic Moment (μ), (6) Stability and (7) Binding Energy.
Radioactivity: Law of Radioactive Decay. Half-life, Theory of Successive Radioactive

Transformations. Radioactive Series, Binding Energy, Mass Formula. α-decay :- Range of α-particles, Geiger-Nuttal law and α-particle Spectra. Gamow Theory of Alpha Decay, β-decay. Energy Spectra and Neutrino Hypothesis, γ-decay :- Origin of γ-rays, Nuclear Isomerism and Internal Conversion.

Unit II: Nuclear Reactions

Types of Reactions and Conservation Laws. Concept of Compound and Direct Reaction. Compound Nucleus. Scattering Problem in One Dimension : Reflection and Transmission by a Finite Potential Step. Stationary Solutions, Attractive and Repulsive Potential Barriers, Scattering Cross-section. Reaction Rate. Q-value of Reaction. Fission and Fusion.

Unit III: Nuclear Models and Accelerators

Liquid Drop Model. Mass formula. Shell Model. Meson Theory of Nuclear Forces and Discovery of Pion. Van de Graaff Generator, Linear Accelerator, Cyclotron, Betatron,

Unit IV: Detectors of Nuclear Radiations

Interaction of Energetic particles with matter. Ionization chamber. GM Counter. Cloud Chambers. Wilson Cloud Chamber. Bubble Chamber. Scintillation Detectors. Semiconductor Detectors (Qualitative Discussion Only).

Unit V: Elementary Particles

Cosmic Rays :- Nature and Properties, Fundamental Interactions, Classification of Elementary Particles. Particles and Antiparticles. Baryons, Hyperons, Leptons, and Mesons. Elementary Particle Quantum Numbers : Baryon Number,

Lepton Number, Strangeness, Electric Charge, Hypercharge and Isospin0. Conservation Laws and Symmetry. Different Types of Quarks and Quark Contents of Spin ½ Baryons. Photons,

Reference Books:

1. Concepts of Modern Physics by Arthur Beiser (McGraw-Hill Book Company, 1987)
2. Concepts of nuclear physics by Bernard L.Cohen.(New Delhi: Tata Mcgraw Hill, 1998).
3. Introduction to the physics of nuclei and particles by R.A. Dunlap.(Singapore: Thomson Asia, 2004).
4. Nuclear physics by Irving Kaplan. (Oxford & IBH, 1962).
5. Introductory nuclear physics by Kenneth S. Krane.(John Wiley & Sons, 1988)

PRACTICAL- DSE LAB: PHYSICS OF DEVICES AND INSTRUMENTS
60 Lectures

Experiments from both Section A and Section B:

Section-A

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.

Section-B:

SPICE/MULTISIM simulations for electrical networks and electronic circuits

1. To verify the Thevenin and Norton Theorems.
2. Design and analyze the series and parallel LCR circuits
3. Design the inverting and non-inverting amplifier using an Op-Amp of given gain
4. Design and Verification of op-amp as integrator and differentiator
5. Design the 1st order active low pass and high pass filters of given cutoff frequency
6. Design a Wein`s Bridge oscillator of given frequency.
7. Design clocked SR and JK Flip-Flop`s using NAND Gates
8. Design 4-bit asynchronous counter using Flip-Flop ICs
9. Design the CE amplifier of a given gain and its frequency response.
10. Design an Astable multivibrator using IC555 of given duty cycle.

Reference Books:

- Basic Electronics:A text lab manual, P.B. Zbar, A.P. Malvino, M.A.Miller,1994, Mc-Graw Hill
- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics : Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edn., 2000, Prentice Hall.
- Introduction to PSPICE using ORCAD for circuits & Electronics, M.H. Rashid, 2003, PHI Learning.
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India.

SUBJECT NAME: SOLID STATE PHYSICS LAB

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.

Note: Each student is required to perform at least seven experiments.

Reference Books :

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

• Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India

Experiments for Lasers : Experiments on Lasers:

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

Experiments on Semiconductor Sources and Detectors:

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

SEMESTER-V

SUBJECT NAME: QUANTUM MECHANICS AND APPLICATIONS

Unit-I Time dependent Schrodinger equation:

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

Unit-II Time independent Schrodinger equation:

Hamiltonian, stationary states and energy eigenvalues; expansion of an arbitrary wavefunction as a linear combination of energy eigenfunctions; General solution of the time dependent Schrodinger equation in terms of linear combinations of stationary states; Application to spread of Gaussian wave-packet for a free particle in one dimension; wave packets, Fourier transforms and momentum space wavefunction; Position-momentum uncertainty principle.

Unit-III General discussion of bound states in an arbitrary potential:

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

Unit-IV Quantum theory of Hydrogen-like atoms:

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

Many electron atoms: 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 atomsL-S and J-J couplings.Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

Unit-V Atoms in Electric & Magnetic Fields:

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;

Atoms in External Magnetic Fields: Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Reference Books:

• A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
• Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
• Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
• Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
•Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
• Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
• Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference:

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

Research Methodology

OBJECTIVES:

This course would focus on research methodology and making a good interpretation of research. It would also provide brief information about various instruments used for characterization purpose.

CO1: Understand the basic ideas about research methodology.
CO2: Able to understand research design.
CO3: Be able to learn about research techniques.
CO4: Understand the concept of research.

Unit	Contents	Lectures
I	**Research: a way of thinking:** Introduction to research, Research Process, defining research problem, Identification of a good research problem, , Significance of research, how to prepare yourself for research, Introduction to Research Methodology, Research design, Problems encountered by the researchers	**10**
II	**Data collection, interpretation, and research report:** Data collection, Interpretation of data, Field Research, Data analysis, Various Methods of Observation, Interpretation is the climax of research process, Research paper Writing, Research work Presentations	**12**
III	**Instruments:** FTIR: Introduction, working principle, construction, merits, demerits, and applications. UV Spectrophotometer: Introduction, working principle, construction, merits, demerits, and applications. Centrifuge: Introduction, working principle, construction, merits, demerits, and applications. pH-meter: Introduction, working principle, construction, merits, demerits, and applications.	**10**
IV	**Characterization Techniques-I:** XRD: Introduction, working principle, merits, demerits, and applications. Spectroscopy: Introduction, working principle, merits, demerits, and applications. Raman: Introduction, working principle, merits, demerits, and applications.	**10**
V	**Characterization Techniques-I:** DLS: Introduction, working principle, merits, demerits, and applications. SEM: Introduction, working principle, merits, demerits, and applications.	**10**

Course Code	**Subject Name**	**L T P**	**Cr.**
	Analog Systems and Applications	**4-0-0**	**4**

Objectives: Ability to apply knowledge of mathematics, science and engineering to the solution of complex engineering problems Strong b Ability to design and conduct experiments, analyze, interpret data and synthesize valid conclusions.

Unit I: Semiconductor Diodes

(10lectures) P and N type semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. Derivation for Barrier Potential, Barrier Width and Current for Step Junction. Current Flow Mechanism in Forward and

Reverse Biased Diode.

Unit II: Two-terminal Devices and their Applications

(12lectures) (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. Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions.

Unit III: Amplifiers-I

(10 lecturers) 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.

Unit IV: Amplifiers-II

(10 Lectures) Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

Unit V: Applications of Op-Amps **(12 Lectures)** (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation).

Reference Books:

- Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
- Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
- Solid State Electronic Devices, B.G. Streetman & S.K. Banerjee, 6th Edn.,2009, PHI Learning
- Electronic Devices & circuits, S. Salivahanan & N.S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall 2 9
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6thEdn., Oxford University Press.
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India

Course Code	Subject Name	L T P	Cr.
BPH-208	**Solar energy & Energy Harvesting**	**4-0-0**	**4**

Objectives: The objective of this course is to develop a working knowledge of the renewable energies need resources and methods to use them for energy harvesting laws and to use this knowledge to explore various applications of various ways of energy harvesting.

UNIT-1 Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell,

absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.
(10 Lectures)

Unit-II : BASICS IN SOLAR ENERGY SYSTEMS Different types of Renewable Energy Sources 1.2 Sun as a Source of Energy 1.3 Solar Radiation 1.4 Extra Terrestrial at Earth's Surface – Horizontal, Tilted Surface 1.5 Estimation of Radiation 1.6 Alternation of Solar Radiation by Atmosphere 1.7 Effect of Orientation of Receiving Surface
(8 lectures)

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

UNIT-IV Electromagnetic Energy Harvesting: Linear generators, physics mathematical models,
recent applications ,Carbon captured technologies, cell, batteries, power consumption Environmental issues and Renewable sources of energy, sustainability.
(10 Lecture)

UNIT-V BASIC SUNS-EARTH ANGLES : Angle of Latitude ,Declination Angle ,Hour Angle, Inclination Angle (Altitude) , Zenith Angle, Solar Azimuth Angle , Tilt Angle (Slope) , Surface Azimuth Angle , Angle of Incidence , Local Solar Time , SOLAR RADIATION , Solar Radiation Data , Estimation of Monthly Average, Daily Total Radiation on Horizontal Surface , Estimation of Monthly Average, Daily Diffuse Radiation on Horizontal Surface , Monthly Average, Daily Global Radiation on Tilted Surface, MEASUREMENT OF SOLAR RADIATION , Measurement of Solar Radiation , Pyranometer , Pyrheliometer , Sunshine Recorder , Radiation Characteristics of Opaque Materials , Radiation Transmission through covers and Absorption of Collectors
(12 lecture)

Reference Books:

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

Course Code	Subject Name	L T P	Cr.
BPH-108	**Nano-Materials and Applications**	**4-0-0**	**4**

OBJECTIVE: Main objective to study this course is to have a clean understanding of nano-materials and technology.

Unit I: Nanomaterials and Nanotechnology
(10 lectures)

Basic concepts of Nano science and technology – Quantum wire – Quantum well – Quantum dot – Properties and technological advantages of Nanomaterials– Carbon

Nanotubes and applications – Material processing by Sol – Gel method, Chemical Vapour deposition and Physical Vapour deposition – Microwave Synthesis of materials – Principles of SEM, TEM and AFM.

Unit II: Nanostructures

(10 lectures)

Electronic Structure of Nanoparticles- Kinetics in Nanostructured Materials and advance nana materials- Zero dimensional, one-dimensional and two-dimensional nanostructures-clusters of metals and semiconductors, nanowires, Buckywalls, CNTs, nanostructured beams, and nanocomposites-artificial atomic clusters-Size dependent properties-size dependent absorption spectra-phonons in nanostructures.

Unit III: Physical Properties of Nanomaterials

(10 lectures)

Melting point and phase transition processes- quantum-size-effect (QSE). Size-induced metal-insulator-transition (SIMIT)- nano-scale magnets, transparent magnetic materials, and ultrahigh-density magnetic recording materials chemical physics of atomic and molecular clusters.

Unit IV: Surface and Micro-structural Properties of Nanomaterials

(10 lectures)

Surface energy – chemical potential as a function of surface curvature-Electrostatic stabilization-surface charge density-electric potential at the proximity of solid surface-Van der Waals attraction potential. Micro-structural Properties: Properties slightly dependent on temperature and grain size; properties strongly dependent on temperature and grain size; strengthening mechanisms; enhancement of available plasticity; grain size evolution and grain size control; Hall Petch relation, microstructure – dislocation interactions at low and high temperatures; effects of diffusion on strength and flow of materials.

Unit V: Applications of Nanomaterials

(10 lectures)

Solar energy conversion and catalysis, Molecular electronics and printed electronics Nanoelectronics, Polymers with a special architecture, Liquid crystalline systems, Linear and nonlinear optical and electrooptical properties, Applications in displays and other devices, Advanced organic materials for data storage, Photonics, Plasmonics ,Chemical and biosensors, Nanomedicine and Nanobiotechnology.

Reference Books:

- Joel I. Gersten, "The Physics and Chemistry of Materials", Wiley, 2001.
- A. S. Edelstein and R. C. Cammarata, "Nanomaterials: Synthesis, Properties and Applications", Institute of Physics Pub., 1998.
- Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002
- S.Yang and P.Shen: "Physics and Chemistry of Nanostructured Materials", Taylor & Francis, 2000.

<u>SUBJECT NAME: QUANTUM MECHANICS AND APPLICATION LAB</u>

<u>SUBJECT CODE</u>

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

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

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

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is ≈ -13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511x106 eV/c^2 .

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

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

where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential

$$V(r)=-\frac{e^2}{r}e^{-r/a}$$

a

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

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

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

For the anharmonic oscillator potential

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

for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^2 , k = 100 33 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3} .In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

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

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

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

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

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function. Take: m = 940x106 eV/C^2 , D = 0.755501 eV, α = 1.44, r_o = 0.131349

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

NOTE: Each student is required to perform at least seven experiments.

Reference Books:

- Schaum's outline of Programming with C++.J.Hubbard, 2000,McGraw-Hill Publication
- Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.

- An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering Applications: A. VandeWouwer, P. Saucez, C. V. 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., Cambridge University Press

SUBJECT NAME: ANALOG SYSTEM AND APPLICATION LAB

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 $1^{st}/2^{nd}$ order differential equation.

Note: Each students is required to perform at least seven experiments

Reference Books:

- Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
- OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4^{th} edition, 2000, Prentice Hall.
- Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.

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

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PRACTICALS-DSE LAB: Nano Materials and Applications
60 Lectures

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.

Reference Books:

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
- K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

SEMESTER-VI

<u>SUBJECT NAME: ELECTROMAGNETIC THEORY</u>
<u>SUBJECT CODE: BPH-324</u>

<u>Unit-I: Maxwell Equations</u>

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

Density and Angular Momentum Density.

<u>Unit-II: EM Wave Propagation in Unbounded Media</u>

Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.

<u>Unit-III: EM Wave in Bounded Media</u>

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-IV: Polarization of Electromagnetic Waves

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. Analysis of Polarized Light.

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

Unit-V: Wave Guides & Optical Fibres

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.

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

Reference Books:

- Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
- Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
- Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning.
- Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill.
- Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning.
- Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
- Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer.

Additional Books for Reference:

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

Course Code	Subject Name STATISTICAL PHYSICS (Semester II)	L T P	Cr.
		3+1+0	4

OBJECTIVES:
The main objective of this course is to familiarize students with Statistical Physics that are essential for solving advanced problems in Statistical thermodynamics.

COURSE OUTCOMES:

CO1: Understanding of basics of Statistical Physics.
CO2: Use of the Maxwell- Boltzmann statistics.
CO3: Use of the Bose-Einstein and Fermi-Dirac Statistics.
CO4: Understanding the ensembles.

Unit	Contents	Lectures
I	Basic Ideas of Statistical Physics: Introduction, Basic ideas of probability and their applications, Macrostates and microstates, Effect of constraints on the system.	11
II	Distribution of n particles in two compartments, deviation from the state of maximum probability, Equilibrium state of a dynamic system, distribution of N distinguishable particles in unequal compartments, Division into cells, Phase space and its division into cells.	10
III	Maxwell-Boltzmann Statistics: Phase space and its division into cells. Three kinds of statistics and their basic approach. Maxwell-Boltzmann Statistics for an ideal gas: Volume in phase space, values of α and β. Experimental verification and graphical depiction of Maxwell-Boltzmann distribution of molecular speeds	11
IV	Isolated System: Micro canonical Ensemble, Closed System : Canonical Ensemble, Open System : Grand Canonical Ensemble Bose-Einstein Statistics : Need for quantum statistics, Bose-Einstein statistics and its application to Black body radiation, photon gas, deductions from Planck's law.	11
V	Fermi-Dirac Statistics: Fermi-Dirac statistics and its application to electron gas, Fermi energy, comparison of M.B., B.E. and F.D. statistics	9

REFERENCE BOOKS:

1. Statistical Physics, Thermodynamics and Kinetic Theory: VS Bhatia, Vishal Pub. Co. Jalandhar, 2003
2. Introduction to Statistical Physics: Kerson Huang Taylor & Francis Inc. 2002

3. An Introduction to Statistical Mechanics and Thermodynamics: Robert H. Swendsen. Oxford University Press Inc. 2012.
4. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
5. Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.
6. Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.

Course Code	Subject Name	L T P	Cr.
	Solar Photo voltaic energy conversion	**4-0-0**	**4**

No. of Hours per week: 04 Total lectures: 50

Unit-I (10Hrs)

1. Fundamentals on Junctions: p-n junction, Type of junctions, homo, hetero and schottky junctions, depletion layer, junction in equilibrium, application of bias, energy band diagram, abrupt and graded junctions, electric field and potential distribution at the interface, calculation of built-in voltage, Expression depletion layer capacitance.

UNIT II : SOLAR ENERGY **8 hours**

Solar Radiation, Measurements Of Solar Radiation, Flat Plate And Concentrating Collectors, Solar Direct Thermal Applications, Solar Thermal Power Generation, Fundamentals Of Solar Photo Voltaic Conversion, Solar Cells, Solar PV Power Generation, Solar PV Applications.

UNIT-III (10Hrs)

2. Sun ñ Earth geometric relationship, Layers of the sun, Earth-Sun angles and their relationships, Solar energy reaching the earth surface, Solar cell, Module, Panel and array construction, Theory of solar cell ñ Energy band diagrams, Junction current, Solar cell equivalent circuit, IV Characteristics, Efficiency of Solar cell, Maximizing the solar PV output and load matching, Maximum power point tracker.

UNIT-IV (12Hrs)

3. Batteries, Rated storage capacity, Charging-discharging cycles, Choosing the best battery, Charge controllers and inverters ñ Why use charge controllers?, Low voltage disconnect, Over

charge protection, Charge controllers and system connections, Charge controller system connections, choosing charge controllers, Inverters, Choosing inverters, Voltage converters, Wiring cables, Switches, sockets and fuses, Wire size and voltage drop calculations, Earthing and lightning protection.

UNIT-V (10Hrs)

PV array combiner/junction boxes, string diodes and fuses, Grid connected inverters, Cabling, wiring and connection system, DC Main switch, AC switch disconnector, Inverter and PV array configurations, Inverter installation site, Sizing the inverter, Selecting and Sizing cables, Monitoring operating data and presentation.

Reference Books:

1. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009. (Ch:6)
2. Non-Conventional Energy Resources by Shobh Nath Singh, Pearson India., 2016. (Ch:2, 4)
3. Stand-Alone Solar Electric Systems by Frank Jackson, Mark hankins, Earthscan Publishing (2010)
4. Grid-connected Solar Electric Systems, Geoff Stapleton and Susan Neill, Mark hankins, Earthscan Publishing (2010)
5. Planning and Installing Photovoltaic Systems - A guide for installers, architects and engineers Second Edition, Earthscan publishing (2008)

Title of Paper: Nano Synthesis Techniques

Unit I: Basics of Fabrication Methods 10L

Top-Down fabrication methods –Types of Top-Down fabrication methods (mechanosynthesis, thermal, high energy, chemical fabrication and lithography-concepts with examples only).
Bottom-Up fabrication methods-Types of Bottom-Up fabrication methods (gaseous-phae, liquidphase,
solid-phase, template synthesis-concepts with examples only).
Nano perspective of the fabrication methods.

Unit II:Chemical Synthesis-I 8 L

i) Combustion: Chemical etching of silicon ii) Basic concepts of Chemical-Mechanical polishing.
iii) Anodization and Electropolishing: Chemical reactions of electrodeposition of aluminum.

Unit III: Chemical Synthesis-II 11 L

Introduction to molecular self-assembly (MSA), Template synthesis, Sol-gel methods, metal reduction, emulsion polymerization, block copolymerization, electrodeposition with examples and reactions involved.

Unit IV: Biological Synthesis 8 L

Biological synthesis of Nanoparticles, Concept of reducing and capping agents, introduction to biomolecules as reducing and capping agents, Bacteria, fungi and plants as sources of reducing and capping agents and for biogenic synthesis of nanomaterials. Advantages and applications of biologically synthesized nanomaterials. Introduction to biological nanomaterials.
Biomineralization, Magnetosomes, DNA based Nano structures, Protein based Nano structures

References:

1. Introduction to nanoscience and nanotechnology, CRC Press, Tylor and Francis Group, Boca Raton, G. L. Hornyak, H. F. Tibbals, J. Dutta and J J. Moore.
2. Introductory Nanoscience: Physical and Chemical Concepts, CRC Press, Tylor and Francis Group, Boca Raton, M. Kuno.
3. Nanotechnology-S. K. Kulkarni (3rd Edition

SUBJECT NAME: ELECTROMAGNETIC THEORY LAB

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.

Dissertation/Project

SUBJECT NAME: DISSERTATION

1. Identification of a research Topic, reading of relevant literature, Summary of National and International Scenario of course taught.
2. Understanding of the unsolved and unresolved problems in the literature, framing of objectives for dissertation.
3. Assessment about the feasibility of identified objectives within available resources, and fine tuning of objectives for future work.
4. Experimental / computational analysis, data analysis and writing of report.
5. Writing of manuscript and Poster making for presentation in scientific conferences or publication in Journal based on above work.