Dept. of Physics, Proposed course structure for Four Years UG (Hons)

Sem	Major (DSC)	Minor (GE)	IDC/MDC	AEC	SEC	VAC	IA PC	DSR	Total Credit
I	1. Basic Physics-I (Math. Physics + Mechanics) (4)(3T+1L)	Minor-1 Mechanics(4) (3T+1L)	Frontiers in Physics (3) (2T+1Tu)	AEC-I(2)	SEC-I (3) computation on physics skills 3L	VAC-1(4)			20
II	2. Basic Physics-II (Mechanics +Electricity & magnetism) (4) (3T+1L)	Minor-2 Electricity &magnetism (4) (3T+1L)	Frontiers in Physics (3) (2T+1Tu)	AEC-II(2)	SEC-II (3) Electrical circuits and network skills (3L)	VAC-2(4)	(4)		24
Students may exit with certificate at the end of semester –II									
III	3. Mathematical Physics-I(4) 4. Wave &Optics(4)	Minor-3 Thermal Physics(4) (3T+1L)	Frontiers in Physics (3)	AEC-III(2)	SEC-III (3) Basic instrumentation skills				20
IV	5. Mathematical Physics-II 6. Analog System & Application 7. Quantum Mechanics 8. Electromagnetic theory	Minor-4 Wave &Optics(4)		AEC-IV(2)					22
Students may exit with Diploma at the end of semester –IV									

V	9. Digital Electronics 10. Atomic & Nuclear Physics 11. Classical Dynamics and Spl. Theory of Relativity 12. Advanced Math Physics-I	Minor-5 Modern Physics							20
VI	13. Solid State Physics 14. Thermal physics 15. Statistical Mechanics 16. Astronomy & Astrophysics	Minor-6 Analog Electronics							20
Students will be awarded 3 years graduate degree at the end of semester –VI after securing 126 marks									
VII	17. Adv. Cl Mechanics 18. Electronics 19. Adv. Quantum Mechanics-I 20. . Nano-materials and App. / Communication electronic/Numerical Analysis (Optional)	Minor-7 Instrumentation						Project of credit -4 Or, 1 Major Course (DSC-20)	
VIII	21. Electrodynamics 22. Adv. Statistical Mechanics 23. General	Minor-8 Digital Electronics						Project of credit -8 Or Two Major course (DSC-23	

	Relativity and cosmology/ Condensed Matter physics/ (Optional) 24. Nuclear & Particle Physics /Liquid crystal (Optional)							& DSC-24)	

- * Marks Distribution is as per the decision taken in the Meeting with HoD's and Task Force Committee

Major Subjects Syllabus

B.SC (Hons) with Research…….

Semester I

Course Title: Basic Physics-I Total marks: 60

Course Code: DSC- 1

Course type: Major~~/Minor/MDC/AEC/SEC/VAC/DSR/DSE/IAPC~~ Tutorial Test: 15

Total No of Lecture: 50 Th. 30 Pr. End semester test: 30 Th. 15 Pr.

Theory:50

Tutorial: nil

Laboratory work/Practical/Tutorial: 30 Duration of Examination: 1.5 hrs Th
2 hrs Pr

Total Credit: 04

Theory: 03

Tutorial: nil

Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To make the students to develop a concept of the fundamentals of mathematical tools needed in physics.
2. To make the students to understand the fundamentals of Newtonian mechanics, dynamics of a system of particles, collision problems in CM frame, elasticityand fluid motion.
3. To apply the methods developed above for understanding other areas of advanced Physics.

Course learning Outcomes:

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

1. Apply the knowledge acquired mainly in calculus, vector calculus, differential equation, different Curvilinear Coordinates system and probabilities necessary in different branches of Physics.
2. Apply the knowledge of vector calculus necessary in Electrostatics and Electrodynamics.
3. Apply the theory learned in this course to the experimental observations in different areas of Physics.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

A. Mathematical Physics (30 Periods)

Unit	Topic	No. Of Lectures
I	**Calculus: Recapitulation:** Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only). First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral. Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Constrained Maximization using Lagrange Multipliers.	9L
II	**Vector Calculus:** Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.	8L

	Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. ∇ and Laplacian operators. Vector identities. Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).	
III	**Orthogonal Curvilinear Coordinates**:Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems.	7L
IV	**Introduction to probability:**Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.	6L

B. **Mechanics-I (20** Periods)

Unit	Topic	No. Of Lectures
I	**Fundamentals of Dynamics**:Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.	4L
II	**Work and Energy:**Work and Kinetic Energy Theorem. Conservative and non- conservative forces. Potential Energy. Qualitative study of one dimensional motion from potential energy curves. 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.	3L
III	**Collisions:**Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.	3L
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.	6L

	Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation	
V	**Elasticity:**Relation between Elastic constants. Twisting torque on a Cylinder or Wire.	2L
VI	**Fluid Motion**: Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.	2L

Mechanics Laboratory (1 credit, 30 Periods)

List of Practical

1. To determine the Moment of Inertia of a rectangular Rod.
2. To determine the Moment of Inertia of a cylindrical disk.
3. To determine the Rigidity Modulus of a Wire by Dynamical method
4. To determine the Rigidity Modulus of a Wire by Statical Method.
5. To determine the Young's Modulus of a Wire by Searle's method.
6. To determine the Young's Modulus of a bar by flexure method.
7. To determine the value of g using Kater's pendulum.

Suggested Reading

Mathematical Physics

1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
3. Differential Equations, George F. Simmons, 2007, McGraw Hill.
4. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
5. Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
6. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
7. Mathematical Physics, Goswami, 1st edition, Cengage Learning
8. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
9. Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
10. Essential Mathematical Methods, K.F.Riley&M.P.Hobson, 2011, Cambridge Univ. Press
11. Mathematical methods in the Physical Sciences, M. L. Boas, 2005, Wiley.

Classical Mechanics

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.

3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wil**Mechanics Lab: (1 credits,**
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Laboratory

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, I.Prakash& Ramakrishna, 11th Edn, 2011, Kitab Mahal
4. Engineering Practical Physics, S.Panigrahi&B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	5
Internal Class Test	10
Course prerequisite	

SEC Course

Course Title: Computational Physics (3 Credits, 45 Laboratory Periods) Total marks: 45
Course Code: SEC-1
Course type: SEC Continuous Evaluation: 15
Total No of Lecture: End semester test:30
Theory: nil
Tutorial: nil
Laboratory work/Practical/Tutorial: 45 Duration of Examination: 4 hrs
Total Credit: 03
Theory: nil
Tutorial: nil
Laboratory work/Practical/Tutorial: 03

Course Objective:

1. To make the students understand the fundamentals of programming tools needed in physics.
2. To make the students to learn basic levelprogramming in Fortran, Gnuplot and Python

Course learning Outcomes:

After the end of the course the students will be able to

1. Understand the fundamentals of programming tools needed in physics.
2. Write and execute basic level programming in Fortran, Gnuplot and Python

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures
I	**Introduction :**Importance of computers in Physics, paradigm for solving physics problems,Linux, Algorithms and Flowcharts, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, Programing of sin(x) as a series, algorithm for plotting (1) Lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.	6L
II	**Scientific Programming:**Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. FORTRAN Statements: I/O Statements	12L

	(unformatted/formatted), Executable and Non-Executable Statements, Layout of FORTRAN Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.	
III	**Introduction to plot graphs with Gnuplot:** Basic 2D and 3D graph plotting - plotting functions and datafiles, fitting data using Gnuplot's fit function, polar and parametric plots, modifying the appearance of graphs, Surface and contour plots, exporting plots.	6L
IV	**Introduction to programming in python: P**rogram Lay out in Python, constants, variables and data types, dynamical typing, operators and expressions, modules, I/O statements, iterables, compound statements, indentation in python, the if-elif-else block, for and while loops, nested compound statements, lists, tuples, dictionaries and strings, basic ideas of object oriented programming.	10L
V	**Programs:** Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search	6L
VI	**Random number generation:** Area of circle, area of square, volume of sphere, value of pi (π)	5L

Hands on exercises

1. To find the product of two matrices
2. To find a set of prime numbers and Fibonacci series.
3. To evaluate sum of finite series and the area under a curve.
4. To find the roots of a quadratic equation.
5. Plotting trajectory of a projectile projected horizontally.
6. Motion of a projectile using simulation and plot the output for visualization.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.
8. To write program to open a file and generate data for plotting using Gnuplot.
9. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
10. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
11. Motion of particle in a central force field and plot the output for visualization.

12. To compile a frequency distribution and evaluate mean, standard deviation etc.

Suggested Reading

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.

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

3. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)

4. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.

5. Computational Physics: An Introduction, R.C. Verma, et al. New Age International Publishers, New Delhi(1999)

6. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning

7. Elementary Numerical Analysis, K.E. Atkinson, 3 rdEdn., 2007, Wiley India Edition.

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	15
Internal Class Test	
Course prerequisite	

Please sev page no 11-15 UGC for Curriculum and credit framewok

Physics Minor

B.SC (Hons) with Research…….

Semester I

Course Title:Physics Minor Total marks: 60

Course Code:GE- 1

Course type: Minor Tutorial Test: 15

Total No of Lecture: 45 End semester test: 30 Th. 15 Pr.

Theory:45
Tutorial: nil
Laboratory work/Practical/Tutorial: 30 Duration of Examination: 1.5 hrs Th.
: 2 hrs Pr.

Total Credit: 04
Theory: 03
Tutorial: nil
Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To prepare the students to understand the fundamentals of mathematical tools needed in physics.
2. To prepare the students to understand the fundamentals of Newtonian mechanics, dynamicsof a system of particles and elasticity.

Course learning Outcomes:

1. Apply the knowledge of the solution of differential equation and vector calculus to different branches of Physics.

2. Students will be able to perform the experiment of general properties of matter.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures
I	**Vectors:**Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter.	4L
II	**Ordinary Differential Equations:**1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients	4L
III	**Laws of Motion:**Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass.	6L

IV	**Momentum and Energy:**Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets.	4L
V	**Rotational Motion:**Angular velocity and angular momentum. Torque. Conservation of angular momentum.	3L
VI	**Gravitation:**Newton's Law of Gravitation. Motion of a particle in a central force field, Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits.	6L
VII	**Oscillations:**Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations	5L
VIII	**Elasticity:**Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion – Torsional pendulum-Determination of Rigidity modulus and moment of inertia by Searles method to determine rigidity modulus.	8L
IX	**Special Theory of Relativity:**Michelson-Morley Experiments**,** Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Addition of velocities of relativistic particles.	5L

Mechanics Lab (1 credit, 30 Laboratory periods)

List of Practical

1. To determine the Moment of Inertia of a rectangular Rod

2. To determine the Moment of Inertia of a cylindrical disk.

3. To determine the Rigidity Modulus of a Wire by Dynamical method

4. To determine the Rigidity Modulus of a Wire by Statical Method.

5. To determine the Young's Modulus of a Wire by Searle's method.

6. To determine the Young's Modulus of a bar by flexure method.

Suggested Reading:

Theory

1. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young, 13/e, 1986. Addison-Wesley

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

3. Physics – Resnick, Halliday &Walker 9/e, 2010, Wiley

4. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press

5. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Practical

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

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

3 Engineering Practical Physics, S.Panigrahi&B.Mallick, 2015, Cengage Learning India Pvt. Ltd.

4 A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	
Internal Class Test	15
Course prerequisite	

Please sev page no 11-15 UGC for Curriculum and credit framework

IDC/MDC course

Course Title:FRONTIERS IN PHYSICS (3 Credit) Total marks: 45
Course Code:IDC
Course type: MDC Tutorial Test: 15
Total No of Lecture: 45 End semester test: 30
Theory: 45

Tutorial: nil

Laboratory work/Practical/Tutorial: nil

Duration of Examination: 1.5 hrs

Total Credit: 03

Theory: 03

Tutorial: nil

Laboratory work/Practical/Tutorial: nil

Course Objective:

Course learning Outcomes:

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures
I	**Nature of Science:**Role of proper reasoning and experiments, with examples. Inductive and deductive logic. The character of physical laws, including universality. Difference between science and pseudoscience.	9L
II	**Universe:**The Copernican revolution, Kepler's laws and the Solar system, Galileo and birth of Telescopic Astronomy, Modern observations: Stars and galaxies, Life cycle of stars. Birth of the Universe, Big Bang and Hubble expansion, Dark matter and dark energy.	10L
III	**Matter:** Atoms and molecules: The physical basis of the Periodic table. Heat and Thermodynamics: Basic idea about the kinetic theory of gases; Distinction between ideal and real gases; The three laws of thermodynamics. Concept of Entropy. Radioactivity: Alpha, beta & gamma decay; X-Rays – Properties. Structure of the atom: Electron, Nucleus: proton and neutron. Mention of the Standard Model of particles & interactions	16L
IV	**Forces:**Laws of falling bodies, Inertia, Gravitation, Electricity and Magnetism, Light and its dual property. The microscopic world	10L

	of Quantum Mechanics. Special and General Theory of Relativity (brief and qualitative ideas only) [**No Mathematical derivation beyond simple algebra should be used**]	

Suggested Reading

1. Six Easy Pieces – Richard P. Feynman

2. The first three minutes – Steven Weinberg

3. The character of physical laws – Richard P. Feynman

4. Introduction to Astronomy: From Darkness to Blazing Glory – J. W Scott, JAS Educational Publications

5. আধুনিকবিজ্ঞানেরক্রমবিকাশ, সম্পাদনাসুশান্তমজুমদার, ভুপতিচক্রবর্তী, অনুস্তুপপ্রকাশনী।

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	
Internal Class Test	15
Course prerequisite	

Please sev page no 11-15 UGC for Curriculum and credit framework

2nd Semester

Major Subjects Syllabus

B.SC (Hons) with Research……..

Semester II

Course Title: Basic Physics-II Total marks: 60

Course Code:Physics Major- 2

Course type: Major~~/Minor/MDC/AEC/SEC/VAC/DSR/DSE/IAPC~~ Tutorial Test: 15

Total No of Lecture: 50 End semester test: 30 Th., 15 Pr.

Theory:50

Tutorial: nil

Laboratory work/Practical/Tutorial: 30 Duration of Examination: 1.5 hrs Th.
2 hrs Pr.

Total Credit: 04

Theory: 03

Tutorial:nil

Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To make the students understand the fundamentals of Central force, Oscillation special theory of relativity.
2. To make the students understand the fundamentals of Electric and magnetic fields and potentials
3. To make the students understand the fundamentals of ac and dc Electrical Circuits.

Course learning Outcomes:

1. Apply the knowledge of the solution of Central force to the launching of Polar, Geostationary and interplanetary satellites.
2. Students can apply the knowledge of Special theory of Relativity to calculate time dilation and length contraction.
3. Students will be able to perform the experiments of basic electrical circuits.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

A. Mechanics-II (20 Periods)

Unit	Topic	No. Of Lectures
I	**Gravitation and Central Force Motion:** 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	6L

	energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).	
II	**Oscillations:** Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.	4L
III	**Non-Inertial Systems:**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.	4L
IV	**Special Theory of Relativity:**Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.	6L

B. Electricity and Magnetism (30 Periods)

Unit	Topic	No. Of Lectures
I	**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. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor.Uniqueness theorem (statement). Method of	10L

	Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.	
II	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 $\vec{D}$. Relations between $\vec{E}$, P and D. Gauss' Law in a dielectric medium.	4L
III	**Magnetic Field**: Magnetic force between current elements and definition of Magnetic Field $\vec{B}$. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) infinite straight wire, (2) Infinite planar surface current, and (3) Solenoid. Properties of $\vec{B}$.: *curl* and *divergence*. Axial vector property of $\vec{B}$. and its properties. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.	6L
IV	**Magnetic Properties of Matter:** Magnetization vector ($\vec{M}$). Magnetic Intensity ($\vec{H}$.). Magnetic Susceptibility and permeability. Relation between $\vec{B}$, $\vec{H}$, $\vec{M}$. Ferromagnetism. B-H curve and hysteresis.	3L
V	**Electromagnetic Induction:** Faraday's Law. Lenz's Law. Self-Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current	3L
VI	**Electrical Circuits:**AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit	2L
VII	**Net worktheorems:**Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to DC circuits	2L
	Note: *For the sake of brevity, details of ballistic galvanometer may be omitted from the theory course. Some part of the theory may be needed for the experiments, but this can be covered as part of Practical.*	

Electricity and Magnetism Lab (1 credit, 30 Laboratory Periods)

Use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.

List of Practicals

1. To study the characteristics of a series RC Circuit.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To determine the Mutual Inductance of two coils.
5. To verify the Thevenin's and Norton's theorems.
6. To verify the Superposition, and Maximum power transfer theorems.
7. To determine self-inductance of a coil by Anderson's bridge.
8. 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.

Suggested Reading

Mechanics

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

Electricity and Magnetism

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

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

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

4. Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education

5. Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.

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

Practical

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

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

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

4. Engineering Practical Physics, S.Panigrahi&B.Mallick, 2015, Cengage Learning India Pvt. Ltd.

5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	5
Internal Class Test	10
Course prerequisite	

Course Title:Electrical Circuits and Network Skills (3 Credits, 45 Laboratory Periods)

Total marks: 45

Course Code: SEC- 2

Course type: SEC- Tutorial Test: 15

Total No of Lecture: End semester test: 30

Theory: nil

Tutorial:nil

Laboratory work/Practical/Tutorial: 45 Duration of Examination: 4 hrs

Total Credit: 03

Theory: nil

Tutorial:nil

Laboratory work/Practical/Tutorial: 03

Course Objective:

1. To make the students understand the fundamentals of Electric circuit symbols and circuit drawing.
2. To make the students understand the fundamentals of ac and dc Electrical Circuits with active and passive components.

Course learning Outcomes:

1. Students will be able to draw the basic electrical circuits using active and passive components.

2. Students will be able to perform the experiments of basic electrical circuits.

3. Students will be able tomake a diagram of the electrical wiring in their houses.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures/periods
I	**Basic Electricity Principles:** Basic idea of Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations of resistors. AC Electricity and DC Electricity. Electricity Measurement: Multimeter, voltmeter and ammeter.	4
II	**Understanding Electrical Circuits:**Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across	7

	the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.	
III	**Electrical Drawing and Symbols:**Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.	5
IV	**Generators and Transformers:**DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.	4
V	**Electric Motors:**Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor	6
VI	**Solid-State Devices:** Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources	6
VII	**Electrical Protection**: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)	5
VIII	**Electrical Wiring:**Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.	8

Suggested Reading

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

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	15
Internal Class Test	
Course prerequisite	

Minor Course

Course Title: Electricity & Magnetism Total marks: 60

Course Code:Minor Physics - 2

Course type: Minor Tutorial Test: 15

Total No of Lecture: 45 Th +30L End semester test: 30Th. , 15 Pr.

Theory:45

Tutorial: nil

Laboratory work/Practical/Tutorial: 30 Duration of Examination: 1.5 hrs Th.
: 2 hrs Pr.

Total Credit: 04

Theory: 3

Tutorial: 0

Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To make the students to understand the fundamentals of Electric and magnetic fields and their Potentials
2. To make the students understand the fundamentals of AC and DC Electrical Circuits.

Course learning Outcomes:

1. Students will be able to derive the field and potentials of both electric and magnetic fields
2. Students will be able to perform the experiments of basic electrical circuits.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures
I	**Vector Analysis:**Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem (statement only).	8L
II	**Electrostatics:**Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric.	15L
III	**Magnetism:**Magnetostatics: Biot-Savart's law and its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law. Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para-and ferro- magnetic materials.	10L
IV	**Electromagnetic Induction:**Faraday's laws of electromagnetic induction, Lenz's law, self inductance (L) and mutual inductance (M), L of single coil, M of two coils. Energy stored in magnetic field. Maxwell`s equations and Electromagnetic wave propagation Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, polarization.	12L

Electricity and Magnetism Lab (1 Credit, 30 Laboratory Periods)

List of Practical

1. To study the characteristics of a series RC Circuit.

2. To determine an unknown Low Resistance using Potentiometer.

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

4. To determine the MutaualInductance of two coils.

5. To verify the Thevenin's and Norton's theorems.

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

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

8. 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.

Suggested Reading:

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

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

3. Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.

4. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

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

Practical

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

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

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

4. Engineering Practical Physics, S.Panigrahi& B.Mallick,2015, Cengage Learning India Pvt. Ltd.

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	
Internal Class Test	15
Course prerequisite	

3rd Semester

Major Subjects Syllabus

B.SC (Hons) with Research…….

Semester III

Course Title: Mathematical Physics-I Total marks: 60

Course Code: Physics Major- 3

Course type: Major~~/Minor/MDC/AEC/SEC/VAC/DSR/DSE/IAPC~~ Tutorial Test: 15

Total No of Lecture: 45 Th +30 Pr End semester test: 30 Th., 15 Pr.

Theory: 45

Tutorial: nil

Laboratory work/Practical/Tutorial: 30 Duration of Examination: 1.5 hrs Th.

2 hrs Pr.

Total Credit: 04

Theory: 03

Tutorial:nil

Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To make the students understand the fundamentals of Mathematical Physics.
2. To make the students understand the fundamentals of Even and odd functions, Fourier series expansions.
3. To train them to apply special functions like Bessel function, Hermite function and Legendre Polynomials in widely used and important applications.

Course learning Outcomes:

1. Apply the knowledge of the solution of Fourier series.

2. Students can apply the knowledge of Special theory of Bessel function, Hermite function and Legendre Polynomials
3. Students will be able to perform the solutions to partial differential equations.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples and applications.
2. Students are encouraged to ask questions, and develop teacher - student and student – student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

B. Mathematical Physics-I (45 Periods)

Unit	Topic	No. Of Lectures/Periods
I	**Fourier Series:** Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.	15
II	**Frobenius Method and Special Functions** Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_o(x)$ and $J_1(x)$) and their orthogonality.	15
III	**Some Special Integrals** Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).	5
IV	**Partial differential equations** Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.	10

Mathematical Physics-I Lab

Sl No.	Topic	No. Of Lectures/Periods
I	**Introduction to Numerical computation using numpy and scipy:** Introduction to the python numpy module. Arrays in numpy, array operations, array item selection, slicing, shaping arrays. Basic linear algebra using the linalg submodule. Introduction to online graph plotting using matplotlib. Introduction to the scipy module. Uses in optimization and solution of differential equations. Introduction to OCTAVE(if time permits)	8
II	**Curve fitting, Least square fit, Goodness of fit, standard deviation:** Ohms law to calculate R, Hooke's law to calculate spring constant	2
	Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems: Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)	2
	Generation of Special functions using User defined functions: Generating and plotting Legendre Polynomials Generating and plotting Bessel function	2
	Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation Fixed difference method: First order differential equation **1.** Radioactive decay **2.** Current in RC, LC circuits with DC source **3.** Newton's law of cooling **4.** Classical equations of motion Second order Differential Equation **5.** Harmonic oscillator (without friction) **6.** Damped Harmonic oscillator **7.** Solve $x^2\frac{d^2y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^3$ with the boundary condition at x=1, y=$\frac{1}{2}e^2$, $\frac{dy}{dx} = -\frac{3}{2}e^2 - 0.5$, in the range 1≤x≤3. Plot y and $\frac{dy}{dx}$ against x in the given range in the same graph. Partial differential equations 1. Wave equation 2. Poisson equation	16

Suggested Reading

1. Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
4. Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
5. Partial Differential Equations for Scientists & Engineers, S.J. Farlow, 1993, Dover Pub.
6. Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
7. Mathematical methods for Scientists & Engineers, D.A. McQuarrie, 2003, Viva Books
8. Mathematical Physics, P. K. Chattopadhyay, 2014, New Academic Science.

Practical Books

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
3. Numpy beginners guide, Idris Alba, 2015, Packt Publishing
4. Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
5. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer

B.SC (Hons) with Research…….

Semester III

Course Title: Waves & Optics Total marks: 60
Course Code: Physics Major- 4
Course type: Major~~/Minor/MDC/AEC/SEC/VAC/DSR/DSE/IAPC~~ Tutorial Test: 15
Total No of Lecture: 45Th+30L End semester test: 30 Th., 15 Pr.
Theory: 45
Tutorial: nil
Laboratory work/Practical/Tutorial: 30 Duration of Examination: 1.5 hrs Th.
2 hrs Pr.

Total Credit: 04
Theory: 03
Tutorial:nil
Laboratory work/Practical/Tutorial: 01

Course Objective:

1. The detailed discussion of Hygiene's Principle is very important to learn about wave nature of light. Students can understand the basic wave nature of light.

2. Students can get an idea about interference and diffraction with respect to wave nature of light as explained by Hygiene.

Course learning Outcomes:

1. Hygiene's Principle is discussed at the beginning of wave optics.
2. Optical phenomenon like interferences and diffraction are explained in detailed.
3. Holography is another important phenomenon in optics which is discussed briefly.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Waves & Optics (45Th+30L Periods)

Unit	Topic	No. Of Lectures/Periods
I	**Superposition of 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 with equal and unequal frequency and their applications .	15
II	**Wave Motion** Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves **Velocity of Waves** Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction	15

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.	15

Wave & Optics Lab(1 credit, 30 Laboratory Periods)

List of Practicals

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

Suggested Reading

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.

2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill

3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.

4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill

5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.

6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.

7. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

Practical

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

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

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

4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Course Title: Basic Instrumentation Skills (3 Credits, 45 Laboratory Periods)
Total marks: 45

Course Code: SEC- 3

Course type: SEC- Tutorial Test: 15

Total No of Lecture: 45 End semester test: 30

Theory: nil

Tutorial:nil

Laboratory work/Practical/Tutorial: 45 Duration of Examination: 4 hrs

Total Credit: 03

Theory: nil

Tutorial:nil

Laboratory work/Practical/Tutorial: 03

Course Objective:

1. To make the students understand the fundamentals of basic Electrical and Electronics Instruments to measure the basic Electrical and Electronics parameter.
2. To make the students understand the fundamentals of Cathode Ray Oscilloscope (CRO)

Course learning Outcomes:

1. Students will be able to measure the basic Electrical and Electronics parameter
2. Students will be able to perform the experiments of CRO.
3. Students will be able to use the digital multimetre.

Teaching learning approach:

5. Class room lecture on the topic is delivered elaborately with examples.
6. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
7. Regular home assignments and monitoring the progress of students.
8. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures/ Periods
I	**Basic of Measurement:** Instruments, accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and current, ac voltage, current and resistance. Specifications of a multimeter and their significance.	6

II	**Electronic Voltmeter:**Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. AC millivoltmeter: Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter, specifications and their significance	12
III	**Cathode Ray Oscilloscope:**Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence & chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.	8
IV	**Signal Generators and Analysis Instruments:**Block diagram, explanation and specifications of low frequency signal generators. Pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.	5
V	**Digital Instruments** Principle and working of digital meters. Comparison of analog & digital instruments. Characteristics of a digital meter. Working principles of digital voltmeter.	6
VIII	**Digital Multimeters:** Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time-base stability, accuracy and resolution.	8

Laboratory Exercises

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

Suggested Reading

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.

2. Performance and design of AC machines - M G Say ELBS Edn.

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

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

5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.

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

7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008, Springer

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

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	15
Internal Class Test	
Course prerequisite	

Minor Course

Semester-III

Course Title:Thermal Physics Total marks: 60

Course Code:Minor Physics - 3

Course type: Minor Tutorial Test: 15

Total No of Lecture: 45^{Th}+30L End semester test: 30th. , 15 Pr.

Theory:45

Tutorial: nil

Laboratory work/Practical/Tutorial: 30 Duration of Examination: 1.5 hrs Th.
: 2 hrs Pr.

Total Credit: 04

Theory: 3

Tutorial: 0

Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To make the students to understand the fundamentals of ideal and real gas.
2. To make the students understand the fundamentals of isothermal and adiabatic process.
3. To improve the efficiency of a process for the transformation between energy and work.

Course learning Outcomes:

1. The fundamental principles of thermodynamics and kinetic theory of gas explained and analyzed clearly.
2. Students will be able to derive the equation and relation between of various gases.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures/Periods
I	**Laws of Thermodynamics:** Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law of thermodynamics and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Coefficient, Reversible and irreversible processes, Second law of thermodynamics and Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero temperature. **Thermodynamical Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications - Joule-Thompson Effect, Clausius- Clapeyron Equation, Expression for C_P and C_V , $\frac{C_P}{C_V}$. T dS equations.**	25
II	**Kinetic Theory of Gases** : Derivation of Maxwell's law of distribution of velocities- Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; monoatomic and diatomic gases.	10
III	**Theory of Radiation:** Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh- Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law.	10

Heat & Thermodynamics Lab (1 Credit, 30 Laboratory Periods)

List of Practical

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. Measurement of Planck's constant using black body radiation.
3. To determine the coefficient of thermal conductivity of Cu by Searle's Apparatus.
4. To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.
5. To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
6. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.

Suggested Reading:

1. Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
3. Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
4. Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
5. Thermodynamics, Kinetic theory& Statistical thermodynamics, F.W.Sears and
6. G.L. Salinger. 1988, Narosa
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

Practical

1. Advanced Practical Physics for students, B.L.Flint&H.T.Worsnop, 1971, Asia Publishing House.
2. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
3. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
4. A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	
Internal Class Test	15
Course prerequisite	

4th Semester

Major Subjects Syllabus

B.SC (Hons) with Research…….

Semester IV

Course Title: Mathematical Physics-II Total marks: 60

Course Code: DSC- 2

Course type: Major~~/Minor/MDC/AEC/SEC/VAC/DSR/DSE/IAPC~~ Tutorial Test: 15

Total No of Lecture: 45 Th+30L End semester test: 30 Th., 15 Pr.

Theory: 45

Tutorial: nil

Laboratory work/Practical/Tutorial: 15 Duration of Examination: 1.5 hrs Th.

2 hrs Pr.

Total Credit: 04
Theory: 03
Tutorial:nil
Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To make the students understand the methods of solving some definite integrals using contours in complex plane.
2. To make the students understand the application of Fourier Transform to solve differential equations appearing in physics.
3. To make the students understand the use of matrices to solve Eigen value problems

Course learning Outcomes:

1. Apply the knowledge of the complex functions, residue theorems to evaluate some definite integrals appearing in advanced courses of physics.
2. Students can apply the knowledge of Fourier Transform to solve differential equations appearing in physics.
3. Students will be able to perform the matrix algebra to solve various Eigen value problems used in different branches of physics specially in Quantum Mechanics

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

A. Mathematical Physics-II (45 Periods)

Unit	Topic	No. Of Lectures/Periods
I	**Complex Analysis** Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.	15

II	**Integrals Transforms** Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.	10
III	**Matrices** Addition and Multiplication of Matrices. Null Matrices. Diagonal, Scalar and Unit Matrices. Upper-Triangular and Lower-Triangular Matrices. Transpose of a Matrix. Symmetric and Skew-Symmetric Matrices. Conjugate of a Matrix. Hermitian and Skew-Hermitian Matrices. Singular and Non-Singular matrices. Orthogonal and Unitary Matrices. Trace of a Matrix and Inner Product, Inverse of a Matrix.	10
IV	**Eigen-values and Eigenvectors** Diagonalization of Matrices. Eigen-values and Eigenvectors Solutions of Coupled Linear Ordinary Differential Equations.	10

Mathematical Physics-II Lab (30 Lab Periods)

1. Dirac Delta Function:

   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}}\int e^{\frac{-(x-2)^2}{2\sigma^2}}(x+3)dx$, for σ=1, .1, .01 and show it tends to 5
2. Fourier Series

   Program to sum $\sum_{n=1}^{\infty}(.2)^n$Evaluate the Fourier coefficients of a given periodic function (square wave)
3. Evaluation of trigonometric functions e.g. sin θ, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate 1/(x2+2) numerically and check with computer integration
4. Compute the nth roots of unity for n = 2, 3, and 4.
5. Find the two square roots of −5+12j.

Suggested Reading

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

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

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

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

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

6. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

Practical Books

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
4. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
5. https://web.stanford.edu/~boyd/ee102/laplace_ckts.pdf
6. https://ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf

B.SC (Hons) with Research…….

Semester IV

Course Title: Analog System and Applications Total marks: 60

Course Code: Physics Major- 6

Course type: Major~~/Minor/MDC/AEC/SEC/VAC/DSR/DSE/IAPC~~ Tutorial Test: 15

Total No of Lecture: 45 Th+30L End semester test: 30 Th., 15 Pr.

Theory: 45

Tutorial: nil

Laboratory work/Practical/Tutorial: 15 Duration of Examination: 1.5 hrs Th.

2 hrs Pr.

Total Credit: 04

Theory: 03

Tutorial:nil

Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To make the students understand the working mechanism of solid state P-N junction diode and Transistor.
2. To make the students understand the fundamentals principles of various types of amplifiers.
3. To make the students understand the fundamentals of Operational Amplifiers (OPAMP) and its application in electronics.

Course learning Outcomes:

1. Apply the knowledge of the working mechanism of solid state P-N junction diode and Transistor to characterize them and designing of electronic circuits.
2. Students can apply the knowledge of amplifiers to construct various Amplifier and oscillator circuits.

3. Students will be able to use OPAMP in designing various circuits to perform various operations like addition subtraction integration differentiation etc.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Analog Systems and Applications (45Th+30L Periods)

Unit	Topic	No. Of Lectures/Periods
I	**Semiconductor Diodes** 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.	10
II	**Two-terminal Devices and their Applications** Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell.	7
III	**Bipolar Junction transistors** n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β. Relation between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow in BJT. Active, Cutoff and Saturation Regions. **Field Effect transistors:** Basic principle of operation and characteristics of FET	10

IV	**Amplifiers** Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. Frequency response of a CE amplifier. Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **Coupled Amplifier** (Qualitative only) Two stage RC-coupled amplifier . 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 OPAMP. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. Applications of OPAMP: Linear - (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Logarithmic amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. Non-linear – (1) inverting and non-inverting comparators, (2) Schmidt triggers.	18

Analog Systems and Applications (1 credit, 30 Laboratory Periods)

List of Practicals

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.
4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.
5. To design an inverting amplifier using Op-amp (741,351) for dc voltage of given gain
6. To design amplifier using Op-amp (741,351) and study its frequency response
7. To investigate the use of an op-amp as an Integrator.
8. To investigate the use of an op-amp as a Differentiator.

Suggested Reading

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

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

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

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

Practical

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

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

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

4. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

B.SC (Hons) with Research……..

Semester IV

Course Title: Quantum Mechanics (4 Credits)

Total marks: 60

Course Code:Physics Major- 7

Course type: Major — Tutorial Test: 15

Total No of Lecture: 45 Th 30 Pr — End semester test: 30th. 15 Pr

Theory: 45

Tutorial:nil

Laboratory work/Practical/Tutorial: 30 — Duration of Examination: Th 1.5hrs, Pr. 2 hrs

Total Credit: 04

Theory: 03

Tutorial:nil

Laboratory work/Practical/Tutorial: 01

Course Objective:

1. To make the students understand the fundamentals properties and mathematical formulation of Quantum Mechanics
2. To make them explore the fundamental concept like wave-particle duality, the Schrodinger equation, quantum operators, principles of quantum measurements.
3. To introduce the students about the applications of quantum mechanics in various fields of physics.

Course learning Outcomes:

1. Students will understand the development of quantum mechanics its relationship to classical mechanics and its impact on physics and other scientific disciplines.
2. Will have the proficiency in using mathematical functions such as operators, wave functions and the Schrodinger equation to describe different quantum systems under different potentials.
3. Students will be able to analyse and understand different one-dimensional and three-dimensional quantum systems like: particle in a box, harmonic oscillator, H – atom etc.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures/Periods
I	Basics of Quantum Mechanics: 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 their relation. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. Heisenberg uncertainty principle position-momentum, energy-time.	5
II	**Schrodinger Equation:** Schrodinger equation of a non-relativistic particle. Time dependent Schrodinger equation; Properties of Wave Function. Time independent Schrodinger equation. Interpretation of Wave Function Probability and probability current densities; 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. 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, Energy time uncertainty principle.	20

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; Box potential and Tunnelling. Quantum mechanics of simple harmonic oscillator-energy levels and energy eigenfunctions using Frobenius method; Hermite polynomials; ground state, zero point energy & its relation with uncertainty principle.	10
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.	10

Quantum Mechanics and Application Lab: (1 credit, 30 Lab Periods)

List of Practical

1. Solution of time -independent Schrodinger equation for a particle in infinite 1D potential well.
2. Solution of time -independent Schrodinger equation for a particle in finite 1D potential well.
3. Solve the s-wave Schrodinger equation for the ground state and the first excited state of the hydrogen atom:

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

4. Solve the s-wave radial Schrodinger equation for a particle of mass m for the harmonic oscillator potential

Laboratory Based Equipments:

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

Suggested Reading

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

2. Quantum $\frac{d^2y}{dr^2} = A(r)u(r), A(r) = \frac{2m}{\hbar^2}[V(r) - E]$ Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.

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

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

5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.

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

7. Quantum Mechanics for Scientists & Engineers, D.A.B. Miller, 2008, Cambridge University Press

Additional Books for Reference

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

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

10. Quantum Mechanics, Walter Greiner, 4th Edn., 2001, Springer

Lab

1. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ.Press

2. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific &

3. Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández.2014 Springer.

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	5
Internal Class Test	10
Course prerequisite	

B.SC (Hons) with Research…….

Semester IV

Course Title: Electromagnetic Theory Total marks: 60

Course Code: Physics Major- 8

Course type: Major~~/Minor/MDC/AEC/SEC/VAC/DSR/DSE/IAPC~~ Tutorial Test: 15

Total No of Lecture: 45 Th & 30 Lab End semester test: 30 Th., 15 Pr.

Theory: 45

Tutorial: nil

Laboratory work/Practical/Tutorial: 30 Duration of Examination: 1.5 hrs Th.

2 hrs Pr.

Total Credit: 04

Theory: 03

Tutorial:nil

Laboratory work/Practical/Tutorial: 01

Course Objective:

1. Start the course with Maxwell's equations. Establish the theory for wave equations.
2. Electromagnetic waves through vacuum and isotropic medium. All the properties of EM waves; i.e. light waves established.

3. Introduce Polarization of light. The Polarization of light, double refraction and optically active substances are discussed and analysed in details.
4. To introduce Optical Fiber, concept of the indices, single and multi mode fibers are discussed.

Course learning Outcomes:

1. Maxwell's equations are very important in electromagnetic wave nature in optics. To learn about polarization of light EM theory is very important to learn in details.
2. In this course, applications of Maxwell's equations in electromagnetic wave nature of light are discussed.
3. Polarization of light is very important in optics. To learn about polarization of light THEORIES LIKE Fresnel's etc. are to be explained in details. Different optical phenomena like birefringence etc. are to be explained with the help of Polarisation of light.
4. A brief lesson about optical fibers is necessary to learn.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Electromagnetic Theory (45Th+30L Periods)

Unit	Topic	No. Of Lectures/Periods
I	**Maxwell's equations:** 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.	10

II	**EM Wave Propagation in Unbounded and Bounded Media:** Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.. 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)	15
III	**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.	14
IV	**Optical Fibres** Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).	6

Elctromagnetic Theory Lab(1 credit, 30 Laboratory Periods)

List of Practical

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

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

Suggested Reading

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Optics, E. Hecht, 2016, Pearson.
3. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
4. Introduction to Electromagnetic Theory, T.L. Chow, 2006, Jones & Bartlett Learning
5. Fundamentals of Electromagnetics, M.A.W. Miah, 1982, Tata McGraw Hill
6. Electromagnetic field Theory, R.S. Kshetrimayun, 2012, Cengage Learning
7. Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
8. Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer

Additional Books for Reference

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

Practical

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

B.SC (Hons) with Research……

Semester IV

Minor Course

Course Title: Waves & Optics — Total marks: 60
Course Code: Minor- 3
Course type: Minor — Tutorial Test: 15
Total No of Lecture: 45Th , 30 Pr — End semester test: 30th. , 15 Pr.
Theory:45
Tutorial: nil
Laboratory work/Practical/Tutorial: 30 — Duration of Examination: 1.5 hrs Th. : 2 hrs Pr.

Total Credit: 04
Theory: 3

Tutorial: 0
Laboratory work/Practical/Tutorial: 01

Course Objective:

1. The detailed discussion of Hygiene's Principle is very important to learn about wave nature of light. Students can understand the basic wave nature of light.
2. Students can get an idea about interference and diffraction with respect to wave nature of light as explained by Hygiene.

Course learning Outcomes:

1. Hygiene's Principle is discussed at the beginning of wave optics.
2. Optical phenomenon like interferences and diffraction are explained in detailed.
3. Holography is another important phenomenon in optics which is discussed briefly.

Teaching learning approach:

1. Class room lecture on the topic is delivered elaborately with examples.
2. Students are encouraged to ask questions, and develop teacher - student and student –student interactions to learn the topic effectively.
3. Regular home assignments and monitoring the progress of students.
4. Students are encouraged to acquire advanced information beyond the syllabus in the course.

Unit	Topic	No. Of Lectures/Periods
I	**Superposition of Two Collinear Harmonic oscillations** Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).	6
II	**Superposition of Two Perpendicular Harmonic Oscillations** Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.	4
III	**Waves Motion- General** Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves. Spherical waves, Wave intensity.	6
IV	**Sound** Simple harmonic motion - forced vibrations and resonance - Fourier's Theorem - Application to saw tooth wave and square wave - Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings:	6

	Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria.	
	Wave Optics Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.	4
	Interference Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index.	8
	Diffraction Fraunhofer diffraction- Single slit; Double Slit. Multiple slits and Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.	6
	Polarization Transverse nature of light waves. Plane polarized light – production and analysis. Circular and elliptical polarization.	4

Wave and Optics Lab (1 Credit, 30 Laboratory Periods)

List of Practical

1. To investigate the motion of coupled oscillators
2. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify $\lambda 2$ – T Law.
3. To study Lissajous Figures
4. Familiarization with Schuster`s focussing; determination of angle of prism.
5. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
6. To determine the Refractive Index of the Material of a Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a Prism using Mercury Light
8. To determine the value of Cauchy Constants.
9. To determine the Resolving Power of a Prism.
10. To determine wavelength of sodium light using Fresnel Biprism.
11. To determine wavelength of sodium light using Newton's Rings.
12. To determine the wavelength of Laser light using Diffraction of Single Slit.
13. To determine wavelength of (1) Sodium and (2) Spectral lines of the Mercury light using plane diffraction Grating
14. To determine the Resolving Power of a Plane Diffraction Grating.

15. To measure the intensity using photosensor and laser in diffraction patterns of single and double slits.

Suggested Reading:

1. Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill
2. Principles of Optics, B.K. Mathur, 1995, Gopal Printing
3. Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications
4. University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley

For Practical

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

Suggested continuous Evaluation Methods: continuous internal Evaluation shall be on Project/Assignment and Internal Class Test. The mark shall be as follows	
Project/Assignment	5
Internal Class Test	10
Course prerequisite	