School of Basic Science & Humanities

SCHEME OF STUDIES AND SYLLABUS

CHOICE BASED CREDIT SYSTEM (CBCS)

BACHELOR OF SCIENCE (HONS.)-PHYSICS

(2018-19 Batch Onwards)

Lingaya's Vidyapeeth, Faridabad

Deemed to be university (u/s of UGC act 1956)

(Approved By UGS, MHRD, AICTE, BCI, PCI & ACI)

SYLLABUS SCHEME

BACHELOR OF SCIENCE (HONS.) PHYSICS

SCHEME B.SC.: FIRST YEAR

SEMESTER-I-				
SN	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
Core-I	**BPH-120**	**Mathematical Physics-I**	**3-1-0**	**4**
Core-II	**BPH-122**	**Electricity and Magnetism (Common for Phy/Chem)**	**3-1-0**	**4**
Core-III	**BPH-124**	**Mechanics**	**3-1-0**	**4**
GE-01	**BMA-115**	**Calculus**	**5-1-0**	**6**
AECC-01	**BEN-101**	**Communication Skill (English)**	**2-0-0**	**2**
Core-I Lab	**BPH-170**	**Mathematical Physics-I Lab**	**0-0-4**	**2**
Core-II Lab	**BPH-172**	**Electricity and Magnetism Lab**	**0-0-4**	**2**
Core-III Lab	**BPH-174**	**Mechanics Lab**	**0-0-4**	**2**
TOTAL			**17-4-12**	**26**

SEMESTER – II				
SN	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
Core-IV	**BPH-123**	**Waves and Optics**	**3-1-0**	**4**
Core-V	**BPH-125/220**	**Thermal Physics**	**3-1-0**	**4**
Core-VI	**BPH-126/222**	**Mathematical Physics- II**	**3-1-0**	**4**
GE-02	**BCH-115**	**Physical Chemistry-II**	**3-1-0**	**4**
AECC-02	**CEA-101A**	**Environmental Science/Ecology (Phy/Chem/Maths)**	**3-0-0**	**2**
Core-IV Lab	**BPH-173**	**Waves & Optics Lab**	**0-0-4**	**2**
Core-V Lab	**BPH-175/270**	**Thermal Physics Lab**	**0-0-4**	**2**
Core-VI Lab	**BPH-176/272**	**Mathematical Physics-II Lab**	**0-0-4**	**2**
GE-02 Lab	**BCH-165**	**Physical Chemistry Lab**	**0-0-4**	**2**
	HD-101	**Hobby Club**	**0-0-2**	**2**
TOTAL			**15-4-18**	**28**

SYLLABUS SCHEME

BACHELOR OF SCIENCE (HONS.) PHYSICS

SCHEME B.SC.: SECOND YEAR

SEMESTER – III				
SN	Course No.	Course Name	L-T-P	Cr.
Core-VII	BPH-221	Digital Systems and Applications	3-1-0	4
GE-03	BPH-223	Applied Optics	3-1-0	4
Core- VIII	BPH-224	Elements of Modern Physics	3-1-0	4
Core-IX	BPH-225	Analog Systems and Applications	3-1-0	4
Skill Based-01	BCS-201	Web Designing	3-0-0	3
Core-VII Lab	BPH-271	Digital Systems and Applications Lab	0-0-4	2
Core-VIII Lab	BPH-274	Elements of Modern Physics Lab	0-0-4	2
Core-IX Lab	BPH-275	Analog Systems and Applications Lab	0-0-4	2
Skill Based-02		Entrepreneurship	3-0-0	3
TOTAL			15-4-12	28

Semester- IV				
SN	Course No.	Course Name	L-T-P	Cr.
Core-X	BPH-226	Mathematical Physics- III	3-1-0	4
Core-XI	BPH-227/320	Quantum Mechanics & Applications	3-1-0	4
Core-XII	BPH-228/321	Solid State Physics	3-1-0	4
GE-04	BCH-220	Physical Chemistry	3-1-0	4
Skill Based-02	BA-264 A	Managerial Skill	3-0-0	3
Personality Enhancement	PD-293A	PDP/Inter Personal Skill	2-0-0	2
Core-XLab	BPH-276	Mathematical Physics- III Lab	0-0-4	2
Core-XI Lab	BPH-277/370	Quantum Mechanics & Applications Lab	0-0-4	2
Core-XII Lab	BPH-278/371	Solid State Physics Lab	0-0-4	2
GE-04 Lab	BPH-270	Physical Chemistry Lab	0-0-4	2
TOTAL			17-4-16	29

SYLLABUS SCHEME

BACHELOR OF SCIENCE (HONS.) PHYSICS

SCHEME B.SC.: THIRD YEAR

Semester- V				
SN	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
DSE-01	BPH-322	Physics of Devices and Communication	3-1-0	4
DSE-02	BPH-323	Nuclear & Particle Physics	3-1-0	4
Core-XIII	BPH-324	Electro-Magnetic Theory	3-1-0	4
Core-XIV	BPH-325	Statistical Mechanics	3-1-0	4
DSE-01 Lab	BPH-372	Physics of Devices and Communication Lab	0-0-4	2
Core-XIII Lab	BPH-374	Electro-Magnetic Theory Lab	0-0-4	2
Core-XIV Lab	BPH-375	Statistical Mechanics Lab	0-0-4	2
	PD-392	PDP	2-0-0	2
			12-4-12	24

Semester- VI				
SN	**Course No.**	**Course Name**	**L-T-P**	**Cr.**
DSE-03	BPH-326	Nano-Materials and Applications	3-1-0	4
DSE-04	BPH-327	Biophysics	4-0-0	4
DSE-03 Lab	BPH-376	Nano-Materials and Applications Lab	0-0-4	2
DSE-04	BPH-377	Industrial Training/Dissertation & Seminar	0-2-8	10
TOTAL			4-2-8	14

Total Credits

Sem-I	Sem-II	Sem-III	Sem-IV	Sem-V	Sem-VI	Total
26	28	28	29	30	14	155

SEMESTER-I

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-120	MATHEMATICAL PHYSICS-I	3	1	0	4

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

UNIT-I: CALCULUS: (12 LECTURES)

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 Differential Equations and Integrating Factor.

Second Order Differential equations: 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. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers.

UNIT-II: VECTOR CALCULUS (10 LECTURES)

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

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

UNIT-III: VECTOR INTEGRATION: (10 LECTURES)

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

UNIT-IV: ORTHOGONAL CURVILINEAR COORDINATES: (08 LECTURES)

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

UNIT-V: PROBABILITY & DIRAC DELTA FUNCTION AND ITS PROPERTIES: (10 LECTURES)

Independent random variables: Probability distributions functions, binomial, Gaussian, and Possion, with examples, Mean and Variance

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

TEXT BOOKS/REFERENCE BOOKS:

- ***Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.***
- ***An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning***
- ***Differential Equations, George F. Simmons, 2007, McGraw Hill.***
- ***Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.***
- ***Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book***
- ***Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning***
- ***Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.***
- ***Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press***

Course outcomes:
In this course the students should learn to master the tools from vector and calculus analysis that are important prerequisites for other theoretical physics courses like electrodynamics or continuum mechanics. This module have initial- and boundary value problems for linear partial differential equations which are important in electrodynamics, quantum mechanics etc. The students should learn to formulate specific physics problems through mathematical models of this kind, to master various important analytical and numerical methods to solve such models, and to give physical interpretations of the solutions of such models.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-170	MATHEMATICAL PHYSICS-I LAB	0	0	4	2

Course Objectives:
The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.
a) ***Highlights the use of computational methods to solve physical problems***
b) ***The course will consist of lectures (both theory and practical) in the Lab***
c) ***Evaluation done not on the programming but on the basis of formulating the problem***
d) ***Aim at teaching students to construct the computational problem to be solved***
e) ***Students can use any one operating system Linux or Microsoft Windows and programming language MATLAB or Scilab.***

Topics	Description with Applications
Introduction and Overview	**Computer architecture and organization, memory and Input/output devices**
Basics of scientific computing	**Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single, and double precision arithmetic, underflow & overflow, emphasize the importance of making equations in terms, of dimensionless variables, Iterative methods**
Errors and error Analysis	**Truncation and round off errors, Absolute and relative, errors, Floating point computations**
EXP-1 Mat Lab 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**
EXP-2 Random number generation	**Area of circle, area of square, volume of sphere, value of Pi**
Exp-3 Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	**Solution of linear and quadratic equation, solving α □ tanα□ I □ I_o [(Sinα)/α]^2 in optics**
Exp-4 Interpolation Method	**Evaluation of trigonometric function e.g. $\sin\theta, \cos\theta, \tan\theta$.** **First order differential equation**
Exp-5 Solution of ordinary differential equation	**Radioactive decay** **Current in RC,LC Circuits and DC circuits**
Exp-6 First order differential equation	**Differntial equation describing the motion of a pendulum.** **Differntial equation describing the motion of a pendulum**
Exp-7 Programs:	**Sum and average of a list of numbers, largest of a given list of number, sorting of numbers in ascending and descending order.**
Exp-8 Ploting	**Basic curve and their fitting**
Exp-9 Roots	**Roots of a polynomial, Roots of a Quadratic equation** **Conversion of Temp**

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

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

- ***Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.***
- ***Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007 Cambridge University Press.***
- ***A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.***
- ***Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn. , 2007, Wiley India Edition.***
- ***Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub.***
- ***An Introduction to computational Physics, T.Pang, 2nd Edn. , 2006,Cambridge Univ. Press***

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-122	ELECTRICITY AND MAGNETISM (COMMON FOR PHY/CHEM)	3	1	0	4

Course Objectives:
This module discusses the basic phenomena of electricity and magnetism as they relate to effects animation.

UNIT-I ELECTRIC FIELD AND ELECTRIC POTENTIAL (14 LECTURES)

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. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere.

UNIT-II DIELECTRIC PROPERTIES OF MATTER: (08 LECTURES)

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

UNIT-III MAGNETIC FIELD: (12 LECTURES)

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

UNIT-IV ELECTROMAGNETIC INDUCTION & BALLISTIC GALVANOMETER: (12 LECTURES)

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. Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping.

UNIT-V ELECTRICAL CIRCUITS & NETWORK THEOREMS: (12 LECTURES)

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.

Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem,, Maximum Power Transfer theorem.

TEXT BOOKS/REFERENCE BOOKS

- **Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw**
- **Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education**
- **Introduction to Electrodynamics, D.J. Griffiths, 3rd Edn., 1998, Benjamin Cummings.**
- **Feynman Lectures Vol.2, R.P.Feynman, R.B.Leighton, M. Sands, 2008, Pearson Education**
- **Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.**
- **Electricity and Magnetism, J.H.Fewkes & J.Yarwood. Vol. I, 1991, Oxford Univ. Press.**

Course outcomes:
Having successfully completed this module, you will be able to demonstrate knowledge and understand of • The use of Coulomb's law and Gauss' law for the electrostatic force • The relationship between electrostatic field and electrostatic potential • The use of the Lorentz force law for the magnetic force • The use of Ampere's law to calculate magnetic fields • The use of Faraday's law in induction problems • The basic laws that underlie the properties of electric circuit elements

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-172	ELECTRICITY AND MAGNETISM (COMMON FOR PHY/CHEM)	0	0	4	2

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) Anti-resonant 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.**

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

TEXT BOOKS/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.**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-124	MECHANICS	3	1	0	4

Course Objectives:

- **To acquire skills allowing the student to identify and apply formulas of optics and wave physics using course literature.**
- **To be able to identify and illustrate physical concepts and terminology used in optics and to be able to explain them in appropriate detail.**
- **To be able to make approximate judgments about optical and other wave phenomena when necessary.**
- **To acquire skills allowing the student to organize and plan simpler laboratory course experiments and to prepare an associated oral and written report**

UNIT-1: WAVE OPTICS-I : (10 LECTURES)

Interference: Interference of light and its necessary conditions, path & Phase difference for reflected & transmitted rays, Interference in thin films (parallel and wedge shaped film), Newton's rings.

Diffraction: Single, double and N- Slit Diffraction, Diffraction grating, Grating spectra, dispersive power, Rayleigh's criterion and resolving power of grating.

UNIT-II FUNDAMENTALS OF DYNAMICS: (10 LECTURES)

Reference frames. Inertial frames; Galileantransformations; Galilean invariance. Review of Newton's Laws of Motion. Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse. Momentum of variable-mass system: motion of rocket.

Non-inertial frames and fictitious forces. Uniformly rotatingframe. 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-III 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 Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. Energy-Momentum Four Vector. (10 Lectures)

UNIT-IV 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.

UNIT-V MAGNETIC & SUPERCONDUCTING PROPERTIES: (10 LECTURES)

Magnetization, Origin of magnetic moment, Dia, para and ferro magnetism, Langevin's theory for diamagnetic material, Applications of Magnetism.

Superconductors: Temperature dependence of resistivity in superconducting materials, Effect of magnetic field (Meissner effect), Temperature dependence of critical field, Type I and Type II superconductors. Applications of Superconductors.

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

- ***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.***

Additional Books for Reference

- ***Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000***
- ***University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley***
- ***Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning***
- ***Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.***

Course outcomes: Students will be able to articulate and describe:

- **Relative motion. Inertial and non inertial reference frames.**
- **Parameters defining the motion of mechanical systems and their degrees of freedom.**
- **Study of the interaction of forces between solids in mechanical systems.**
- **Centre of mass and inertia tensor of mechanical systems.**
- **Application of the vector theorems of mechanics and interpretation of their results.**

- **Newton's laws of motion and conservation principles.**
- **Introduction to analytical mechanics as a systematic tool for problem solving.**
- **Use of mechanical simulation software.**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-174	MECHANICS	0	0	4	2

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.

TEXT BOOKS/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**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BMA-115	CALCULUS	5	1	0	6

Course Objectives:
• Understand the major problems of differential and integral calculus.
• Appreciate how calculus allows us to solve important practical problems in an optimal way.

UNIT-1: LIMIT & CONTINUITY LECTURE 12

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: LECTURE 15

Successive differentiation; Leibnitz Theorem; Statement of Rolle's Theorem; Mean Value Theorem; Taylor and Maclaurin's Theorems; Indeterminate forms.

UNIT-3: APPLICATIONS OF DIFFERENTIATION LECTURE 15

Asymptotes; Concavity, convexity and points of inflection; Curvature; Extrema; elementry curves, tangent and normal in parametric form; Polar Coordinates.

UNIT-4: PARTIAL DIFFERENTIATION: LECTURE 17

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; LECTURE 15

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.

TEXT BOOKS/REFERENCE BOOKS:

- **Gorakh Prasad, Differential Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.**
- **Gorakh Prasad, Integral Calculus, Pothishala Pvt. Ltd. Allahabad, 2000.**
- **Gabriel Klambauer, Mathematical Analysis, Marcel Dekkar Inc. New York 1975.**
- **Shanti Narayan, Elements of Real Analysis, S. Chand & Company, New Delhi.**
- **Shanti Narayan, A Text Book of Vector Calculus, S. Chand & Company, New Delhi.**
- **G.B. Thomas and R.L. Finney, *Calculus,* 9th Ed., Pearson Education, Delhi, 2005.**
- **M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus,* 3rd Ed., Dorling Kindersley (India) Ltd. (Pearson Education), Delhi, 2007.**
- **H. Anton, I. Bivens and S. Davis, *Calculus,* 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.**

Course outcomes:	
1	Interpret a function from an algebraic, numerical, graphical and verbal perspective and extract information relevant to the phenomenon modeled by the function
2	Calculate the limit of a function at a point numerically and algebraically using appropriate techniques including L'Hospital's rule

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BEN-101	COMMUNICATION SKILL-I	2	0	0	2

Course Objectives:
1: Students should be able to communicate ethically, responsibly, and effectively as local, national, international, and global citizens and leaders.
2: Students should be able to communicate competently in groups and organizations.
3: Students will monitor and model interpersonal communication competence.

UNIT 1: COMMUNICATION AND ITS ELEMENTS: **10 LECTURES**

An introduction to the need of communication competency; Role of vocabulary in effective communication; Word formation; A set of selected 50 synonyms, antonyms, homonyms & homophones; suffixes & prefixes

UNIT 2: LISTENING AND READING SKILLS: **10 LECTURES**

Listening comprehension & reading comprehension; Listening to recorded speeches, TV News and other audio materials to test listening comprehension with given exercises

UNIT 3: WRITING SKILLS: **10 LECTURES**

Ad Creation; Slogan making; Picture composition; Expanding hints, proverbs; Movie review.

UNIT 4: LETTER WRITING: **10 LECTURES**

Types of letter writing; Structure & Lay out; Leave application; Letter of enquiry & response with respect to educational & official matters; Informal letter expressing or discussing social or educational issues.

UNIT5: SPOKEN SKILLS: **10 LECTURES**

Introduction to oral communication; Importance of Pronunciation; Importance of phonetics; Usage of Phonetics; Types of Conversation; Strategies for effective conversation for social and official interaction; Developing conversation on topics of current importance. Soft Skills Non-verbal Importance of Body Language and its usage to communicate better.

TEXT BOOKS/REFERENCE BOOKS:

- **Crucial Conversations: Tools for Talking When Stakes Are High (Paperback) by Kerry Patterson**
- **How to Win Friends and Influence People (Paperback) by Dale Carnegie**
- **The Definitive Book of Body Language by Allan Pease**
- **How to Talk to Anyone: 92 Little Tricks for Big Success in Relationships (ebook) by Leil Lowndes.**

Course outcomes:	
1	Students will recognize the ethical responsibilities to their community, society, discipline, and profession based on various perspectives and associated standards of ethical communication
2	Students will demonstrate ability to consume communication critically
3	Students will demonstrate intercultural sensitivity
4	Students will communicate appropriately and effectively within various organizational contexts
5	Students will communicate appropriately and effectively within groups
6	Students will demonstrate the ability to analyze a problem and devise a solution in a group

SEMESTER-II

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-123	WAVE AND OPTICS	3	1	0	4

Course Objectives:
The course aims to introduce the basic concepts required for a mathematical description of oscillations and waves, and to provide expertise for solving the differential equations which arise in simple mathematical models for oscillations and waves.

UNIT-I: MOTION AND OSCILLATIONS: 10 LECTURES

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

UNIT-II SUPERPOSITION OF COLLINEAR HARMONIC OSCILLATIONS: 12 LECTURES

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-III: WAVE MOTION & VELOCITY OF WAVES: 13 LECTURES

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-IV:SUPERPOSITION OF TWO HARMONIC WAVES: 12 LECTURES

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-V: WAVE OPTICS: 12 LECTURES

Interference: Division of amplitude and wavefront. 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.

TEXT BOOKS/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, 7th Edn., 1999, Pergamon Press.**
- **Optics, Ajoy Ghatak, 2008, Tata McGraw Hill**
- **The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.**
- **The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.**

Course outcomes: Students shall be able to:

1. **Solve for the solutions and describe the behavior of a damped and driven harmonic oscillator in both time and frequency domains**
2. **Understand and implement Fourier series**
3. **Construct travelling and standing solutions to the wave equation**
4. **Describe the behavior of waves at interfaces (reflection, transmission, impedance) and their behavior in dissipative media (damping)**
5. **Collect and analyze experimental data**
6. **Write clear lab reports containing all necessary detail**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-173	WAVE AND OPTICS LAB	0	0	4	2

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.**
13. **To determine the time period of bar endulum.**
14. **To determine the time period of Keters pendulum.**

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

TEXT BOOKS/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.**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-125/220	THERMAL PHYSICS	3	1	0	4

Course Objectives:
The objective of this course is to develop a working knowledge of the laws and methods of thermodynamics and elementary statistical mechanics and to use this knowledge to explore various applications. Many of these applications will relate to topics in materials science and the physics of condensed matter. The three laws of classical thermodynamics, which deal with the existence of state functions for energy and entropy, and the value of entropy at the absolute zero of temperature, are developed along phenomenological lines; the existence and properties of the entropy; different thermodynamic potentials and their uses; phase diagrams; introduction to statistical mechanics and its relation to thermodynamics; treatment of ideal gases.

UNIT I INTRODUCTION TO THERMODYNAMICS — 14 LECTURES

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: — 08 LECTURES

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: — 10 LECTURES

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: — 10 LECTURES

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: — 11 LECTURES

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

TEXT BOOKS/REFERENCE BOOKS:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Course outcomes: On satisfying the requirements of this course, students will have the knowledge and skills to:	
1	Identify and describe the statistical nature of concepts and laws in thermodynamics, in particular: entropy, temperature, chemical potential, Free energies, partition functions.
2	Use the statistical physics methods, such as Boltzmann distribution, Gibbs distribution, Fermi-Dirac and Bose-Einstein distributions to solve problems in some physical systems.
3	Apply the concepts and principles of black-body radiation to analyze radiation phenomena in thermodynamic systems
4	Apply the concepts and laws of thermodynamics to solve problems in thermodynamic systems such as gases, heat engines and refrigerators etc.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-175/270	THERMAL PHYSICS LAB	0	0	4	2

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.

TEXT BOOKS/REFERENCE BOOKS:

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 CODE	COURSE TITLE	L	T	P	CREDITS
BPH-126/222	MATHEMATICAL PHYSICS-II	3	1	0	4

Course Objectives:
The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen. The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in theoretical physics.

UNIT I FOURIER SERIES: 11 LECTURES

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.

UNIT II SPECIAL FUNCTIONS: 10 LECTURES

Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions (Jo(x) and J1(x))and Orthogonality.

UNIT III SOME SPECIAL INTEGRALS: 09 LECTURES

Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).

UNIT IV THEORY OF ERRORS: 09 LECTURES

Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line.

UNIT V PARTIAL DIFFERENTIAL EQUATIONS: 10 LECTURES

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.

TEXT BOOKS/REFERENCE BOOKS

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.**

Course outcomes: : After successfully completed course, student will be able to

1. **Use complex analysis in solving physical problems.**
2. **Solve ordinary and partial differential equations of second order that are common in the physical sciences.**
3. **Use Green functions.**
4. **Use the orthogonal polynomials and other special functions.**
5. **Use Fourier series and integral transformation.**
6. **Use the calculus of variations.**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-176/272	MATHEMATICAL PHYSICS-II- LAB	0	0	4	2

Course Objectives:
The aim of this Lab is to use the computational methods to solve physical problems. Course will consist of lectures (both theory and practical) in the Lab. Evaluation done not on the programming but on the basis of formulating the problem.

Topics	**Description with Applications**
Introduction to Numerical computation software Scilab, Matlab	**Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure, window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2)**
Curve fitting, Least square fit, Goodness of fit, standard deviation	**Ohms law to calculate R, Hooke's law to calculate spring constant**
Solution of Linear system of 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)**
Generation of Special functions using User defined functions in Scilab	**Generating and plotting Legendre Polynomials Generating and plotting Bessel function**
Solution of ODE **First order Differential equation Euler, modified Euler and Runge-Kutta second order methods** **Second order differential equation Fixed difference method**	**First order differential equation** • **Radioactive decay** • **Current in RC, LC circuits with DC source** • **Newton's law of cooling** • **Classical equations of motion** **Second order Differential Equation** • **Harmonic oscillator (no friction)** • **Damped Harmonic oscillator** • **Over damped** • **Critical damped** • **Oscillatory** • **Forced Harmonic oscillator** • **Transient and** • **Steady state solution** • **Solve** **With the boundary condition at** $x^2 \frac{d^2y}{dx^2} - 4x(1-x)\frac{dy}{dx} + 2(1+x)y = x^3$ $x^2 \frac{dy}{dx} - y\frac{1}{2}e^2, \frac{dy}{dx} = -\frac{3}{2}e^2 - 0.5$

Partial differential equations	**In the range $1 \leq x \leq 3$. Plot y and $\frac{dy}{dx}$ against x in the given range on the same graph.** **Partial Differential Equation** • **Wave equation** • **Heat equation** • **Poisson equation** • **Laplace equation**
Using Scicos / xcos	• **Generating square wave, sine wave, saw tooth wave** • **Solution to harmonic oscillator** • **Study of beat phenomenon** • **Phase space plots**

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

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

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. **First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett**
4. **Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.**
5. **A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press**
6. **Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer**
7. **Scilab by example: M. Affouf 2012, ISBN: 978-1479203444**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BCH-115	PHYSICSAL CHEMISTRY (ELECTIVE)	3	1	0	2

Course Objectives:
Here in this syllabus we start learning with aspects of thermochemistry and thermodynamics, it become easy to understand the aspect of thermodynamic behavior of chemical reaction and their direct indirect influence on chemical activity after the study. We also learn the theory of Chemical equilibrium and their different aspect of forward and backward reactions. Student may also able to understand the colligative properties of any chemical systems

UNIT-I THERMOCHEMISTRY-I: 08 LECTURES

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 vander Waals) under isothermal and adiabatic conditions.**

UNIT-II THERMOCHEMISTRY-II*:* 14 LECTURES

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: 09 LECTURES

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: 11 LECTURES

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: 10 LECTURES

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.

TEXT BOOKS/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)**

Course outcomes:
On finishing these modules of chemistry we are able to differentiate colligative properties of solution like elevation of boiling point, depression of freezing point with relatively lowering the vapor pressure. Its also easy to understand 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.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-165	PHYSICSAL CHEMISTRY LAB	0	0	4	2

1. **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).**
2. **Determination of heat capacity of the calorimeter and enthalpy of neutralization of hydrochloric acid with sodium hydroxide.**
3. **Calculation of the enthalpy of ionization of ethanoic acid.**
4. **Determination of heat capacity of the calorimeter and integral enthalpy (endothermic and exothermic) solution of salts.**
5. **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.**
6. **Determination of enthalpy of hydration of copper sulphate.**
7. **Study of the solubility∆ of benzoic acid in water and determination of H.**

TEXT BOOKS/REFERENCE BOOKS

- ***Experimental Physical Chemistry: A Laboratory Textbook, 2nd Edition (Halpern, Arthur M.) John H. Shibata University of the South, Department of Chemistry, Sewanee, TN 37375***
- **Experiments in Physical Chemistry (Second Edition) ; J. M. Wilson, R. J. Newcombe and A. R. Denaro**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
CEA-101-A	ENVIRONMETAL SCIENCE AND ECOLOGY	0	0	4	2

Course Objectives:
Environmental Studies is a multidisciplinary area, the issues of which everyone should know. The aim of the course is to make everyone aware of environmental issues like continuing problems of pollution, loss of forest, solid waste disposal, and degradation of environment. Issues like economic productivity and national security, global warming, the depletion of ozone layer and loss of biodiversity are other serious concerns before the mankind

UNIT 1: THE MULTIDISCIPLINARY NATURE OF ENVIRONMENTAL STUDIES: 08 LECTURES

Basic definitions related to environment; Scope, vis-à-vis environmental science and environmental engineering; a uses of environmental degradation, atmospheric composition and associated spheres, habitat and climate; objective, goals and principals involved in environmental education, environmental awareness, Environmental ethics, environmental organization and their involvement.

UNIT 2. NATURAL RESOURCES: 14 LECTURES

Renewable and non-renewable resources; forest resources, over-exploitation, and deforestation / afforestation; water resources, impact of over-utilization of surface and ground water, floods, drought, conflicts over water, dams; mineral resources: dereliction of mines, environmental effects of extracting and using mineral resources; Food resources, modern agriculture and its impact, problem associated with fertilizer and pesticide, water logging, salinity ; energy resources, renewable, non-renewable energy sources, solar energy, wind energy, hydro energy, biomass energy, geothermal energy, nuclear energy and its associated hazards; land as a resource, land degradation, man induced landslides, soil erosion and desertification.

UNIT 3. ECOSYSTEMS: 09 LECTURES

Concept of an ecosystem, structure and function of an ecosystem, producers, consumers and decomposers, energy flow in the ecosystem, ecological succession, food chains, food webs and ecological pyramids; characteristic features, structure and function of the following ecosystem -forest ecosystem, grassland ecosystem desert ecosystem and aquatic ecosystems.

UNIT 4. BIODIVERSITY AND ITS CONSERVATION: 08 LECTURES

Bio-geographical classification of India; biodiversity at global, national and local levels, India as a mega-diversity nation, hot-spots of biodiversity; value of biodiversity-consumptive use, productive use, social, ethical aesthetic and option values; threats to biodiversity; conservation of biodiversity: in-situ and ex-situ conservation of biodiversity.

UNIT 5. ENVIRONMENTAL POLLUTION AND SOCIAL ISSUES: 12 LECTURES

Causes, effects and control measures of air pollution, water pollution, soil pollution, marine pollution, noise pollution, thermal pollution; solid waste management, e-waste management; disaster management –floods, earthquake, cyclone and landslides. Water conservation, rain water harvesting, watershed management; climate change, global warming, acid rain, ozone layer depletion; Environmental Protection Act, Air (Prevention and Control of Pollution) Act, Water (Prevention and Control of Pollution) Act, Wildlife Protection Act, Forest Conservation Act.

TEXT BOOK

Kaushik, Anubha, and Kaushik, C.P., "Perspectives in Environmental Studies", 4th Edition, New Age International Publishers, 2004

REFERENCE BOOKS

1. Agarwal, K.C., "Environmental Biology", 2nd Edition, Nidhi Publ. Ltd., Bikaner, 2001.
2. Bharucha Erach, "The Biodiversity of India", 2nd Edition, Mapin Publishing Pvt. Ltd., 2006.
3. Brunner R. C., "Hazardous Waste Incineration", 1st Edition McGraw Hill Inc., 1989.
4. Clark R.S., "Marine Pollution", 1st Edition Clanderson Press Oxford,1989
5. .Cunningham, W.P., Cooper, T.H. Gorhani, E. & Hepworth, M.T., Environmental Encyclopedia", 2nd Edition, Jaico Publ. House, 2001.
6. De, A. K., "Environmental Chemistry", 2nd Edition, Wiley Eastern, 1989
7. Jadhav, H. and Bhosale, V.M ., "Environmental Protection and Laws", 1st Edition, Himalaya Pub. House, Delhi, 1995.
8. Mckinney, M.L. and Schocl. R.M., "Environmental Science Systems & Solutions", 2nd Edition, Web enhanced edition, 1996.

Course outcomes: On the completion of the course, students should be able to	
1	understand fundamental terms related to environment and aware of environmental problems.
2	analyze the complexities of environmental problems and should know remedies available to them and implement them at their own level
3	Move forward in their professional life with a environment conscious mind and preserve our environment as much as they can

SEMESTER-III

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-221	DIGITAL SYSTEM AND APPLICATION	3	1	0	4

Course Objectives:

More broadly, they will be ready to handle substantial and challenging design problems. In particular, students will be able to

- **Explain the elements of digital system abstractions such as digital representations of information, digital logic, Boolan algebra, state elements and finite state machine (FSMs).**
- **Design simple digital systems based on these digital abstractions, using the "digital paradigm" including discrete sampled information.**
- **Use the "tools of the trade": basic instruments, devices and design tools.**
- **Work in a design team that can propose, design, successfully implement and report on a digital systems project.**
- **Communicate the purpose and results of a design project in written and oral presentations.**

UNIT I INTRODUCTION TO CRO: 11 LECTURES

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: 10 LECTURES

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: 12 LECTURES

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: 10 LECTURES

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: 10 LECTURES

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.

TEXT BOOKS/REFERENCE BOOKS

1. **Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw**
2. **Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.**
3. **Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.**
4. **Digital Electronics G K Kharate ,2010, Oxford University Press**
5. **Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning**
6. **Logic circuit design, Shimon P. Vingron, 2012, Springer.**
7. **Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.**
8. **Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill**
9. **Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.**

Course outcomes: After reading this course, a student will be able to	
1	Create the appropriate truth table from a description of a combinational logic function
2	Create a gate-level implementation of a combinational logic function described by a truth table using and/or/inv gates, muxes or ROMs, and analyze its timing behavior
3	Create a state transition diagram from a description of a sequential logic function and then convert the diagram into an implementation of a finite-state machine with the appropriate combinational and sequential components
4	Describe the operation and timing constraints for latches and registers

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-271	DIGITAL SYSTEM AND APPLICATION LAB	0	0	2	2

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

TEXT BOOKS/REFERENCE BOOKS

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

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-223	APPLIED OPTICS	3	1	-	4

Course Objectives:
1. To make the student understand the principles of Lasers. 2. To enable the student to explore the field of Holography and Nonlinear optics.

UNIT-I FIBER OPTICS: 11 LECTURES

Optica1 fiber modes and configuration, fiber types, Ray optics, representation, Wave equation for Step index fiber, Model equation, modes in step index fiber, Fiber Material fabrication attenuation, Absorption, Scattering losses. Radiative losses, Core & Cladding Losses, Material Dispersion, Wave Guide Dispersion.

UNIT II: BASIC LASER THEORY & LASER SYSTEMS 10 LECTURES

Historical background of laser, Einstein coefficients and stimulated light amplification: population inversion, creation of population inversion in three level & four level lasers.

Gas Laser: CO2 laser, Solid State Laser: Host material and its characteristics, doped ions, Nd:YAG laser, Liquid laser: Dye laser, Semiconductor laser.

UNIT III: LASER BEAM PROPAGATION 10 LECTURES

Laser beam propagation, properties of Gaussian beam, resonator, stability, various types of resonators, resonator for high gain and high energy lasers, Gaussian beam focusing.

Concept of spatial frequency filtering, Fourier transforming property of a thinlens.

UNIT IV: NONLINEAR OPTICS & FOURIER OPTICS 09 LECTURES

Origin of nonlinearity, susceptibility tensor, phase matching, second harmonic generation, methods of enhancement, frequency mixing processes, nonlinear optical materials.

UNIT V: HOLOGRAPHY 09 LECTURES

Importance of coherence, resolution, types of hologram, white light reflection, hologram, Principle of holography and characteristics, Recording and reconstruction, classification of hologram and application, non-destructive testing.

TEXT BOOKS/REFERENCE BOOKS:

1. Principles of lasers- O Svelto
2. Solid State Laser Engineering- W Koechner
3. Laser- B A Labgyel
4. Gas laser- A J Boom
5. Methods of Experimental Physics Vol. 15B ed. By C L Tang
6. Industrial Application of Lasers – J F Ready
7. Handbook of Nonlinear Optics- R L Sautherland

Course outcomes:	
1.	The student should have had knowledge on the different types of lasers.
2.	The student should have understood the basics of nonlinear optics

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-224	ELEMENTS OF MODERN PHYSICS	3	1	0	4

Course Objectives:
Students will apply understanding and skill related to the principles and concepts of modern physics essential for graduate school and/or professional employment in the field.

UNIT I: BASICS OF QUANTUM PHYSICS 09 LECTURES

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 : QUANTUM PHYSICS 10 LECTURES

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: QUANTUM PHYSICS 10 LECTURES

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 12 LECTURES

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers
Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

UNIT V 09 LECTURES

Mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).
Lasers: Einstein's A and B coefficients. Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion. Three-Level and Four-Level Lasers. Ruby Laser and He-Ne Laser. Basic lasing.

TEXT BOOKS/REFERENCE BOOKS:

- **Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.**
- **Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill**
- **Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.**
- **Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.**
- **Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill**
- **Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmillan**

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.**

Course outcomes:	
1	Demonstrated ability to solve relativity of space and time problems
2	Demonstrated ability to solve relativistic mass, energy, and momentum problems
3	Demonstrated ability to solve problems involving the quantization of mass, charge, light, and energy including Avogadro's number, black-body radiation, photoelectric effect, and Compton scattering
4	Described various models of the atom and explained why each was proposed and rejected except for the

	quantum model
5	**Demonstrated ability to apply wave-particle duality and uncertainty principle to solve physics problems**
6	**Demonstrated ability to solve quantum mechanical eigenvalue equations for various operators and obtain expectation values of the corresponding observables**
7	**Demonstrated ability to solve 1-D quantum problems including the quantum particle in a box, a well, the simple harmonic oscillator, and the transmission and reflection of waves**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-274	ELEMENTS OF MODERN PHYSICS LAB	0	0	4	2

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

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

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

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

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-225	ANALOG SYSTEM AND APPLICATIONS	3	1	0	4

Course 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. Average c Ability to design a system, component, or process, and synthesize solutions to achieve desired needs. Strong d Ability to identify, formulate, research through relevant literature review, and solve engineering problems reaching substantiated conclusions. Average e Ability to use the techniques, skills, and modern engineering tools necessary for engineering practice with appropriate considerations for public health and safety, cultural, societal, and environmental constraints. Strong f Ability to communicate effectively. n.a. g Ability to recognize the need for, and have the ability to engage in life-long learning.

UNIT I SEMICONDUCTOR DIODES: 10 LECTURES

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: 09 LECTURES

(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 09 LECTURES

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 AMPLIFIER-II 09 LECTURES

Coupled Amplifier: Two stage RC-coupled amplifier and its Frequency response, Input Impedence, Output Impedance, Gain. Stability, Distortion, and noise

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

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground.

UNIT V APPLICATIONS OF OP-AMPS: 09 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)

TEXT BOOKS/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
- Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
- Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
- Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
- Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
- Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Course outcomes	
1	Design CMOS inverters, logic circuits and transmission gates to specifications. a, c, e
2	Design latches and flip-flops as the basic circuit for Random-Access- Memory (RAM) and Read-Only-Memory (ROM) cells. Understand the mechanism of sense amplifier and address decoder. a, c, d, e, g, h
3	Analyze the effects of ideal feedback network on gain sensitivity, noise, distortion, bandwidth and impedance. Understand the loading effect of feedback networks. a, c, e, g, h

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-275	ANALOG SYSTEM AND APPLICATION LAB	0	0	4	2

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.**

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

TEXT BOOKS/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, 4th 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**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BCS-201	WEB DEVELOPMENT	3	1	0	4

Course Objectives:
1) Understand the principles of creating an effective web page, including an in-depth consideration of information architecture.
2) Become familiar with graphic design principles that relate to web design and learn how to implement these theories into practice.

UNIT–1 : INTRODUCTION TO INTERNET: 10 LECTURES

World Wide Web and concepts of website, web pages etc. Client – Server Architecture, The idea of hypertext and hyper media: how the web works: HTTP, HTML and URLs; how the browser works: MIME types, plug-ins and helper applications, standards, Introduction to HTML, XML, XHTML and the W3C.

UNIT–2 : HYPERTEXT MARKUP LANGUAGE: 12 LECTURES

HTMLS: The anatomy of an HTML document; marking up for structure and style: basic page markup, ordered and unordered list, Structuring content with HTML using natural divisions, Marquee text with or without background with attributes, Working with Links Internal Links: Anchor Link, Email Link; embedding images, table creation: Table attributes Colspan, Rowspan, Table Border, Align, Valign, Table background image, Nesting tables, Frames and Nesting, iframes, forms, Semantic elements of HTMLS, Media tags in HTMLS.

UNIT–3 : CASCADING STYLE SHEET: 09 LECTURES

Introduction to Cascading Style Sheet: Selector, Declaration and declaration block. Types of CSS – Inline and Internal style specifications within HTML; external linked style specification using CSS, page and site design considerations. Types of Selector:Universal, Class and ID Selector, Building & Applying Class Selectors, ID Selector using Div Tags and span tag.

UNIT–4 : CLIENT SIDE PROGRAMMING: 10 LECTURES

Introduction to JavaScript syntax: output, Comments, variables, functions, operators, conditions, switch, loop. Java1Script object model: Window, Location and History object model; HTML DOM: Introduction to DOM: methods, event handling, navigation, Forms validation.

UNIT–5 : TESTING WEB APPLICATION: 10 LECTURES

Introduction, Fundamentals, Terminology, Quality characteristics, test objectives, test levels, Test Methods and Techniques, Link Testing, Browser Testing, Usability Testing Load, stress and continuous testing; Testing Security; Test automation; Benefits and drawbacks of automation testing.

TEXT BOOKS/REFERENCE BOOKS:

- **Web Design Complete Reference Subsequent Edition by Thomas A. Powell**
- **Web Designer's Reference; An Integrated Approach to Web Design with XHTML and CSS;** Grannell**, Craig**

Course outcomes:	
1.	Employ fundamental computer theory to basic programming techniques.
2.	Use fundamental skills to maintain web server services required to host a website.

SEMESTER-IV

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-223	MATHEMATICAL PHYSICS - III	3	1	-	4

Course Objectives:
The course aims to demonstrate the utility and limitations of a variety of powerful calculation techniques and to provide a deeper understanding of the mathematics underpinning theoretical physics. The course will review and develop the theory of: complex analysis and applications to special functions; asymptotic expansions; ordinary and partial differential equations, in particular, characteristics, integral transform and Green function techniques

UNIT-I COMPLEX ANALYSIS I: 09 LECTURES

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.

UNIT II COMPLEX ANALYSIS II : 09 LECTURES

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.

UNIT III INTEGRAL TRANSFORMS I 09 LECTURES

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.

UNIT IV INTEGRAL TRANSFORMS II 09 LECTURES

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.
Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem.

UNIT V LAPLACE TRANSFORM 09 LECTURES

LTs of 1st and 2nd order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Dirac Delta function, Periodic Functions. Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2nd order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1st order. Solution of heat flow along infinite bar using Laplace transform.

TEXT BOOKS/REFERENCE BOOKS:

- **Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press**
- **Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications**
- **Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press**
- **Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press**
- **Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill**
- **First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett**

Course outcomes:	
1.	define and derive convergent and asymptotic series
2.	apply techniques of complex analysis, such as contour integrals and analytic continuation, to the study of special functions of mathematical physics
3.	calculate approximations to integrals by appropriate saddle point methods
4	define and manipulate the Dirac Delta and other distributions and be able to derive their various properties
5	be fluent in the use of Fourier and Laplace transformations to solve differential equations and derive asymptotic properties of solutions

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-273	MATHEMATICAL PHYSICS-III LAB	3	1	-	4

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

1. Solve differential equations:

$$dy/dx = e^{-x} \text{ with } y = 0 \text{ for } x = 0$$
$$dy/dx + e^{-x}y = x^2$$
$$d^2y/dt^2 + 2\, dy/dt = -y$$
$$d^2y/dt^2 + e^{-t}dy/dt = -y$$

2. Dirac Delta Function, Evaluate

$$\frac{1}{\sqrt{2\pi\sigma^2}} \int e^{\frac{-(x-2)^2}{2\sigma^2}} (x+3)dx, \quad \text{for } \boldsymbol{\sigma} = 1,\ 0.1,\ 0.01$$

and show it tends to 5.

3. Fourier Series:

Program to sum $\sum_{n=1}^{\infty}(0.2)^n$

Evaluate the Fourier coefficients of a given periodic function (square wave)

4. Frobenius method and Special functions:

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

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

Show recursion relation

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

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

7. Evaluation of trigonometric functions e.g. *sin θ*, Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.

8. Compute the n^{th} roots of unity for *n* = 2, 3, and 4.

9. Find the two square roots of −5+12*j*.

10. Integral transform: FFT of

11. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.

12. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.

13. Perform circuit analysis of a general LCR circuit using Laplace's transform.

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

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

- **Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press**
- **Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications**
- **Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896**
- **A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press**
- **Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444**
- **Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company**
- **Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing**
- **<u>https://web.stanford.edu/~boyd/ee102/laplace_ckts.pdf</u>**
- **ocw.nthu.edu.tw/ocw/upload/12/244/12handout.pdf**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-227/320	QUANTUM MECHANICS AND APPLICATIONS	3	1	0	4

Course Objectives: After successfully completed course, students will be able to:
This course develops concepts in quantum mechanics such that the behaviour of the physical universe can be understood from a fundamental point of view. It provides a basis for further study of quantum mechanics. Content will include: Review of the Schrodinger equation, operators, eigenfunctions, compatible observables, infinite well in one and three dimensions, degeneracy; Fourier methods and momentum space; Hermiticity; scalar products of wave functions, completeness relations, matrix mechanics; harmonic oscillator in one and three dimensions; sudden approximation; central potentials, quantisation of angular momentum, separation of radial and anqular variables, spherical harmonics, hydroqen atom, spin.

UNIT-I TIME DEPENDENT SCHRODINGER EQUATION: 10 LECTURES

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: 11 LECTURES

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: 10 LECTURES

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: 12 LECTURES

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: 09 LECTURES

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).

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

- 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

Course outcomes:	
1.	Pinpoint the historical aspects of development of quantum mechanics
2.	Understand and explain the differences between classical and quantum mechanics
3.	Understand the idea of wave function
4	Understand the uncertainty relations
5	Solve Schroedinger equation for simple potentials
6	spot, identify and relate the eigenvalue problems for energy, momentum, angular momentum and central potentials explain the idea of spin

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-277/370	QUANTUM MECHANICS AND APPLICATION LAB	0	0	4	2

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:**

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

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:**

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

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

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

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**

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

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:**

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

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**

<u>Laboratory based experiments</u>

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.

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

- **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**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-228/32 1	SOLID STATE PHYSICS	3	1	0	4

Course Objectives:
The aim of this course is to give you an extended knowledge of the principles and techniques of solid state physics. The course covers the physical understanding of matter from an atomic view point. Topics covered include the structure, thermal and electrical properties of matter. Fundamental theories in solid state physics are introduced and then extended to show the irrelevance to important applications in current -day technology, industry, and research. The course has a theoretical lecture component and makes extensive use of examples and exercises to illustrate the material.

UNIT-I CRYSTAL STRUCTURE: 09 LECTURES
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: 09 LECTURES
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: 09 LECTURES
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. Clausius Mosotti 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: 09 LECTURES
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: 09 LECTURES
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)

TEXT BOOKS/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

Course outcomes: Students should gain basic knowledge of solid state physics. This implies that the student will:	
1.	Be able to account for interatomic forces and bonds and have a basic knowledge of crystal systems and spatial symmetries.
2.	Be able to account for how crystalline materials are studied using diffraction and be able to perform structure determination of simple structures.
3.	Understand the concept of reciprocal space and be able to use it as a tool.
4	Know the significance of Brillouin zones.
5	Know what phonons are, and be able to perform estimates of their dispersive and thermal properties.
6	Know the fundamental principles of semiconductors, including pn-junctions, and be able to estimate the charge carrier mobility and density.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-278/371	SOLID STATE PHYSICS LAB	0	0	4	2

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.

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

- **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**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BCH-223	PHYSICAL CHEMISTRY-IV	0	0	4	2

Course Objectives:
The various topics of the syllabus are grouped under different units in order to bring forth the importance of academic and laboratory skills for the undergraduate students.

UNIT-1 THERMODYNAMICS 12 LECTURES

Second law of thermodynamics. Need of the law, Concept of entropy, entropy as a state function of V and T, entropy as a function of P and T. Entropy change in physical processes. Entropy as criteria of Spontaneity and equilibrium. Entropy change in ideal gases and mixing of gases, work function, Gibb's free energy function. Gibbs function (G) and Helmholtz function (A) as thermodynamic function. Criteria of spontaneity of reversible processes in terms of enthalpy change, entropy change, work function and free energy function. Variation of G and A with P, V and T. Gibb Helmholtz equation and its application, Third law of thermodynamics and its applications. Partial molar quantities. Chemical potential. Gibb's Duhem equation. Gibb's adsorption equation and its application.

UNIT-II COLLOIDAL STATES **10 LECTURES**

Colloids, classification of colloids, solids in liquids (sols) properties: Kinetic, optical and Electrical, stability of colloids, protective colloids, Hardy-schulze Rule, gold number, Emulsion types of emulsion and their preparation, Emulsifier. Gels (liquid in solids): Classification and properties, General application of colloids.

UNIT-III CRITICAL PHENOMENON **10 LECTURES**

Critical temperature, critical pressure, critical volume and their determination. PV isotherms of real gases, continuity of states, the isotherms of Vander Waal's equation, relationship between critical constants and Vander Waal's constants. Critical compressibility factor, the law of corresponding states. Liquefaction of gases.

UNIT-IV NUCLEAR CHEMISTRY: **09 LECTURES**

Radioactivity, Properties of radiation, detection & measurement of radioactivity, types of radioactive decay, Group displacement law, rate of radioactive decay, half life, calculation of half life, radioactive dating, nuclear reactions: nuclear fission and nuclear fusion reaction. Nuclear binding energy.

UNIT-V CHEMICAL BONDING: **12 LECTURES**

Covalent bonding, valence bond and molecular orbital approaches, LCAO-MO treatment of H_2^+. Bonding and antibonding orbitals. Qualitative extension to H_2. Comparison of LCAO-MO and VB treatments of H_2 (only wavefunctions, detailed solution not required) and their limitations. Refinements of the two approaches (Configuration Interaction for MO, ionic terms in VB). Qualitative description of LCAO-MO treatment of homonuclear and heteronuclear diatomic molecules (HF, LiH). Localised and non-localised molecular orbitals treatment of triatomic (BeH_2, H_2O) molecules. Qualitative MO theory and its application to AH_2 type molecules.

Reference Books:

- **Atkins, P.W & Paula, J.D. *Physical Chemistry*, 9th Ed., Oxford University Press (2011).**
- **Castellan, G. W. *Physical Chemistry 4th Ed.*, Narosa (2004).**
- **Mortimer, R. G. *Physical Chemistry 3rd Ed.*, Elsevier: NOIDA, UP (2009).**
- **Barrow, G. M., *Physical Chemistry 5th Ed.*, Tata McGraw Hill: New Delhi (2006).**

- **Engel, T. & Reid, P. *Physical Chemistry 3rd Ed.*, Prentice-Hall (2012).**
- **Rogers, D. W. *Concise Physical Chemistry* Wiley (2010).**
- **Silbey, R. J.; Alberty, R. A. & Bawendi, M. G. *Physical Chemistry 4th Ed.*, John Wiley & Sons, Inc. (2005).**
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Course outcomes: Students will gain an understanding of:	
1.	The relationship between microscopic properties of molecules with macroscopic thermodynamic observables
2.	The differences between classical and quantum mechanics
3.	The fundamentals of nuclear decay
4	Probabilities, amplitudes, averages, expectation values, and observables

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BCH-273	PHYSICAL CHEMISTRY-IV	0	0	4	2

1. **To determine the enthalpy of neutralization of strong acid/ strong base.**
2. **To determine the enthalpy of ionization of ethanoic acid.**

3. **To determine the solubility of benzoic acid in water at room temperature.**
4. **Determination of enthalpy of hydration of $CuSO_4$.**
5. **Determination of basicity of polyprotic acid by thermochemical methods in terms of change of temperature observed in the graph.**
6. **Determination of heat capacity of calorimeter and integral enthalpy (Endothermic & Exothermic).**
7. **To determine parachor value of $–CH_2$ group.**
8. **To determine the viscosity index of given oil by Redwood viscometer-I**

REFERENCE BOOKS:

- **Khosla, B. D.; Garg, V. C. & Gulati, A.** ***Senior Practical Physical Chemistry,*** **R. Chand & Co.: New Delhi (2011).**
- **Garland, C. W.; Nibler, J. W. & Shoemaker, D. P.** ***Experiments in Physical Chemistry 8th Ed.;*** **McGraw-Hill: New York (2003).**
- **Halpern, A. M. & McBane, G. C.** ***Experimental Physical Chemistry 3rd Ed.;*** **W.H. Freeman & Co.: New York (2003).**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BA- 264A	MANAGERIAL SKILLS	0	0	4	2

Course Objectives:
The objective of this course is to develop a basic understanding about the management concepts as well as of human in various managerial processes in organization

UNIT-1: SKILL DEVELOPMENT – 12 LECTURES

Writing Business Letter, Official letters, 7C's & 4'S in Communication , Report writing , Skills, Presentation Skills , Communication : Concept, Types , process, barriers, making Communication effective.

Managerial creativity- Business Process Re-engineering - Concept , Process, Redesign, BPR, experiences in Indian Industry , Total Quality Management(TQM) - Concept , Systems model of Quality, Deming's approach, TQM as a business Strategy .

UNIT-2: TECHNOLOGY LED DEVELOPMENT- 09 LECTURES

Knowledge Management (KM)- What , why, how, of Knowledge Management , KM process , approach, strategies, tools. E-commerce- Ideology, methodology, classification by application /nature of transactions , Driving Forces of EC, Impact of EC, Scope

UNIT-3: LEADERSHIP FOR MANAGERS- 09 LECTURES

Concept , Traits, Styles, Types of leadership, Leadership for man gers-varied case studies for identifying and imbibing leadership attributes.

Selling & Negotiation Skills-Types of Negotiation , Negotiation Strategies ,Selling skills – Selling to customers , Selling skills – Body language, Conceptual selling, Strategic selling

UNIT-4 : CONFLICT MANAGEMENT- 09 LECTURES

Conflict Management - Types of conflicts and Conflict Management, Coping strategies and Conflict Management, Conflict Management Styles

UNIT-5: POSITIVE THINKING 09 LECTURES

Attitudes, Beliefs, Positive thinking– Martin Seligman's theory of Learned Helplessness , Learned Optimism, Case Studies and Presentations

REFERENCES

1.Stoner, Freeman , Gilbert Jr. : Management (Pearson education)
2.Kootz,O'Donnell , Weighrich : Essentials of Management
3.Michael , J. Stahl : Management -Total Quality in a global environment (Blackwell Business)
4.Newman , Warren and Summer : The Process of Management , Concept, Behaviour & Practice.

Course outcomes: After studying this course, you should be able to:	
1.	Understand what is meant by management and managerial effectiveness
2.	Identify the roles which are fulfilled while working as a manager
3.	Identify managerial activities that contribute to managerial effectiveness
4	Identify a cause of stress in managerial life from a range covering mismatches between capabilites and role, player-manager tension and everyday stressors
5	Understand time pressures and the need for time management.

SEMESTER-V

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-322	PHYSICS OF DEVICE AND COMMUNICATION	3	1	-	4

Course Objectives:
• To understand the basic working of Electronic devices and Linear Integrated Circuits. • To give an emphasis to the student to know the various semiconductor devices and its working. • To give clear understanding of various fabrication techniques of electronic devices. • To introduce the basic building blocks of linear integrated circuits.

UNIT I: MEASUREMENT SCIENCE 09 LECTURES

**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 10 LECTURES

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 11 LECTURES

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: 10 LECTURES

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: 10 LECTURES

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.

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

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.

Course outcomes:	
1.	Understand the fundamentals of Electronics Device Physics
2.	Know the physical principles crucial to the functionality and operation of basic semiconductor devices.
3.	Enrich their knowledge in understanding the linear and non-linear applications of operational amplifiers.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-323	NUCLEAR AND PARTICLE PHYSICS	3	1	-	4

Course Objectives:
• introduce students to the fundamental principles and concepts governing nuclear and particle physics and have a working knowledge of their application to real-life problems; and • provide students with opportunities to develop basic knowledge and understanding of: scientific phenomena, facts, laws, definitions, concepts, theories, scientific vocabulary, terminology, conventions, scientific quantities and their determination, order of magnitude estimates, scientific and technological applications as well as their social, economic and environmental implications. • Knowledge of basic properties of nuclei and nuclear structure. Capability of elementary problem solving in nuclear and particle physics, and relating theoretical predictions and measurement results. Critical evaluation of results in nuclear and particle physics.

UNIT I: STRUCTURE OF NUCLEI AND RADIOACTIVITY 12 LECTURES

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 11 LECTURES

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 09 LECTURES

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 09 LECTURES

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 11 LECTURES

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,

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

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)

Course outcomes:	
1.	Understand the fundamental principles and concepts governing classical nuclear and particle physics and have a working knowledge of their application to real-life problems,
2.	Demonstrate knowledge and understanding of: scientific phenomena, facts, laws, definitions, concepts, theories, scientific vocabulary, terminology, conventions, scientific quantities and their determination, order-of-magnitude estimates, scientific and technological applications as well as their social, economic and environmental implications,
3.	Demonstrate comprehension of physical reality through estimation, approximation, and mathematical modeling, and understand how a small number fundamental physical principles underlie a huge variety of interconnected natural phenomena

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-324	ELECTROMAGNETIC THEORY	3	1	0	4

Course Objectives:
Obtain an understanding of Maxwell's equations and be able to apply them to solving practical electromagnetic fields problems. Fundamental concepts covered will include: laws governing electrodynamics, plane wave propagation in different media, power flow, polarization, transmission and relection at an interface, transmission lines, microwave networks, waveguides, radiation and antennas, wireless systems design and examples

UNIT-I: MAXWELL EQUATIONS 12 LECTURES

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.

UNIT-II: EM WAVE PROPAGATION IN UNBOUNDED MEDIA 11 LECTURES

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.

UNIT-III: EM WAVE IN BOUNDED MEDIA 11 LECTURES

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 12 LECTURES

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 10 LECTURES

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).

TEXT BOOKS/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 outcomes: Outcome: After study through lectures and assignments, students will be able to:	
1.	Apply vector calculus to static electric-magnetic fields in different engineering situations
2.	Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse engineering problems
3.	Examine the phenomena of wave propagation in different media and its interfaces and in applications of microwave engineering

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-374	**ELECTROMAGNETIC LAB**	0	0	4	2

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 diod**

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

TEXT BOOKS/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, Kitab Mahal.**
- **Electromagnetic Field Theory for Engineers & Physicists, G. Lehner, 2010, Springer**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-325	STATISTICAL MECHANICS	3	1	0	4

Course Objectives:
This course develops concepts in classical laws of thermodynamics and their application, postulates of statistical mechanics, statistical interpretation of thermodynamics, microcanonical, canonical and grant canonical ensembles; the methods of statistical mechanics are used to develop the statistics for Bose-Einstein, Fermi-Dirac and photon gases; selected topics from low temperature physics and electrical and thermal properties of matter are discussed.

UNIT-I: CLASSICAL STATISTICS

Macrostate & Microstate, Elementary Concept of Ensemble, Phase Space, Entropy and Thermodynamic Probability, Maxwell-Boltzmann Distribution Law, Partition Function, Thermodynamic Functions of an Ideal Gas, Classical Entropy Expression, Gibbs Paradox, Sackur Tetrode equation, Law of Equipartition of Energy (with proof) – Applications to Specific Heat and its Limitations, Thermodynamic Functions of a Two-Energy Levels System, Negative Temperature.

UNIT-II: CLASSICAL THEORY OF RADIATION

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

UNIT-III: QUANTUM THEORY OF RADIATION

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

UNIT-IV: BOSE-EINSTEIN STATISTICS

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

UNIT-V: FERMI-DIRAC STATISTICS

Fermi-Dirac Distribution Law, Thermodynamic functions of a Completely and strongly Degenerate Fermi Gas, Fermi Energy, Electron gas in a Metal, Specific Heat of Metals, Relativistic Fermi gas, White Dwarf Stars, Chandrasekhar Mass Limit.

TEXT BOOKS/REFERENCE BOOKS:

- **Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.**
- **Statistical Physics, Berkeley Physics Course, F. Reif, 2008, Tata McGraw-Hill.**
- **Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall.**
- **Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.**
- **Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer**
- **An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press**

Course outcomes: On completion of this course a student should be able to:	
1.	Define and discuss the concepts of microstate and macrostate of a model system
2.	Define and discuss the concepts and roles of entropy and free energy from the view point of statistical mechanics.
3.	Define and discuss the Boltdsmann distribution and the role of the partition function.
4	Apply the machinery of statistical mechanics to the calculation of macroscopic properties resulting from microscopic models of magnetic and crystalline systems
5	Discuss the concept and role of indistinguishability in the theory of gases; know the results expected from classical considerations and when these should be recovered
6	Define the Fermi-Dirac and Bose-Einstein distributions; state where they are applicable; understand how they differ and show when they reduce to the Boltsman distribution.
7	Apply the Fermi-Dirac distribution to the calculation of thermal properties of elctrons in metals
8	Apply the Bose-Einstein distribution to the calculation of properties of black body radiation.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-375	STATISTICAL MECHANICS LAB	3	1	-	4

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

1. **Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:**
    a) **Study of local number density in the equilibrium state (i) average; (ii) fluctuations**
    b) **Study of transient behavior of the system (approach to equilibrium)**
    c) **Relationship of large N and the arrow of time**
    d) **Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution.**
    e) **Computation and study of mean molecular speed and its dependence on particle mass.**
    f) **Computation of fraction of molecules in an ideal gas having speed near the most probable speed**

Computation of the partition function Z(□) for examples of systems with a finite

2. **Computation of the partition function Z(β) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose- Einstein statistics:**
    a) **Study of how Z(β), average energy <E>, energy fluctuation ΔE, specific heat at constant volume C_V, depend upon the temperature, total number of particles N and the spectrum of single particle states.**
    b) **Ratios of occupation numbers of various states for the systems considered above.**
    c) **Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.**

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

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

5. **Plot the following functions with energy at different temperatures**
    a) **Maxwell-Boltzmann distribution**
    b) **Fermi-Dirac distribution**
    c) **Bose-Einstein distribution**

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

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

- **Elementary Numerical Analysis, K.E.Atkinson, 3rd Edn. 2007, Wiley India Edition.**
- **Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.**
- **Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987.**
- **Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.**
- **Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.**
- **Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.**
- **Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896**
- **Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444**
- **Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 978- 6133459274**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
PD 293A	INTRA AND INTER PERSONAL SKILLS	3	1	-	4

Course Objectives:
To enable the students with an understanding of how to create self-development by equipping them with good inter-personal skills for effective social communication to succeed in maintaining professional and social environments. Group discussion, interviewing skills and simulation games will equip them for employability and professionalism.

UNIT1: HOW TO BE A CONVERSATIONALIST: 09 LECTURES

Creating and striking a conversation, basic communication skills – structure and theory, sustaining conversation, conversing across cultures, conflict management.

UNIT2: SELF – AWARENESS: 09 LECTURES

Creating and developing self – image, social comparison, self – esteem, self – confidence, Gallup Test for determining strengths.

UNIT 3: ASSERTIVE OR AGGRESSIVE: 09 LECTURES

Being confident, strategies to make assertive 'NO' acceptable, assertive and aggressive – difference, emotional intelligence – concept, application, emotional competency – definition and understanding.

UNIT 4: TEAM BUILDING AND TEAM WORK: 09 LECTURES

The concept of team, elements of teamwork, effective team, essential building blocks of effective teams, team games, team building exercises in groups.

UNIT 5: INTERVIEW SKILLS: 09 LECTURES

How to succeed in an interview, how to create an effective CV, preparation checklist – interview, interviewing skills, types of interview – exercises, common errors in interview, confident body language, mock interviews.

UNIT 6: GROUP DISCUSSION SKILLS: 09 LECTURES

Role of moderator, definition of a GD, do's and don'ts, types of GD, exercises – mock GD (general, knowledge based and abstract topics).

- **Self and Relationships: Connecting Intrapersonal and Interpersonal Processes Hardcover – March 16, 2006 by Kathleen D. Vohs (Editor), Eli J. Finkel (Editor)**
- **Communication and Interpersonal Skills by Erica Pavord and Elaine Donnelly**
- **Interpersonal Communication by Peter Hartley**

SEMESTER-VI

OURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-326	NANO-MATERIALS & APPLICATION	3	1	0	4

Course Objectives:
This course aims to provide a comprehensive overview of nanomaterials in terms of the synthesis, characterization, properties, and applications. It will cover the fundamental scientific principles for the different synthesis techniques, assembly of nanostructured materials and, new physical and chemical properties at the nanoscale. Existing and emerging applications will also be discussed through case studies.

UNIT I: NANOMATERIALS AND NANOTECHNOLOGY
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
Electronic Structure of Nanoparticles- Kinetics in Nanostructured Materials- Zero dimensional, one-dimensional and two dimensional nanostructures- clusters of metals and semiconductors, nanowires, nanostructured beams, and nanocomposites-artificial atomic clusters-Size dependent properties-size dependent absorption spectra-phonons in nanostructures.

UNIT III: PHYSICAL PROPERTIES OF NANOMATERIALS
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
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; HallPetch relation, microstructure – dislocation interactions at low and high temperatures; effects of diffusion on strength and flow of materials.

UNIT V: APPLICATIONS OF NANOMATERIALS
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.

<u>TEXT BOOKS/REFERENCE BOOKS:</u>
1. Joel I. Gersten, “The Physics and Chemistry of Materials”, Wiley, 2001.
2. A. S. Edelstein and R. C. Cammarata, “Nanomaterials: Synthesis, Properties and Applications”, Institute of Physics Pub., 1998.
3. Hari Singh Nalwa, “Nanostructured Materials and Nanotechnology”, Academic Press, 2002
4. S.Yang and P.Shen: “Physics and Chemistry of Nanostructured Materials”, Taylor & Francis, 2000.
.

Course outcomes: At the end of the course, the student will understand the following:	
1.	Understand the general physics and chemistry of nanomaterials
2.	Understand processing techniques for nanomaterials – both chemical and physical approaches
3.	Understand the important applications and properties of nanomaterials.
4	Understand the microstructure properties of Nanomaterials

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-327	BIO-PHYSICS	3	1	0	4

Course Objectives:
The objectives of this course are to impress on students that physical laws (laws of Physics) are valid in biological systems. To establish the relationship between structure and function at the molecular level. To prepare students for higher courses in environmental and medical biophysics, genomics and proteomics

UNIT-I: OPTICS IN BIOTECHNOLOGY:
Interference: Interference of light and its necessary conditions, path & Phase difference for reflected & transmitted rays, Interference in thin films (parallel and wedge shaped film), Newton's rings. Applications in bio technology.
Diffraction: Single, double and N- Slit Diffraction, Diffraction grating, Grating spectra, dispersive power, Rayleigh's criterion and resolving power of grating and their application in bio physics.

UNIT II: STRUCTURE & FUNCTIONS:
Intermolecular and surface forces relevant to bio-systems,(Vander Waals, hydration, steric, hydrophobic forces etc). Cell & its organelles - structure and function DNA, RNA and Protein - structure and function

UNIT III: EXPERIMENTAL TECHNIQUES IN BIO-PHYSICS-I:
Spectroscopic techniques: Introduction to spectroscopy, basic principles, instrumentation and applications of UV-VIS absorption, infrared, Raman, atomic absorption, fluorescence, Laser spectroscopy, electron spin resonance, acoustic spectroscopy; Fourier transform techniques; applications of Laser; mass spectroscopy

UNIT IV: EXPERIMENTAL TECHNIQUES IN BIO-PHYSICS-II:
Microscopy: Principle, instrumentation and application of Microscopy, a) Electron Microscopy (i) Scanning Electron Microscopy (ii) Transmission Electron Microscopy b) Confocal fluorescence microscopy

UNIT:V: BIO INSTRUMENTATION:
X-Ray Diffractometer (XRD), Dynamic Thermal Analyser/Thermogravimetric Analyzer (DTA/TGA),Ultrasound, nuclear magnetic resonance, positron emission topography whole body scanner, dose calibrators, gamma scintillation camera, digital imaging techniques, acquisition, analysis and processing of data from gamma camera, enhancement, topographic reconstruction, display and recording of image,

<u>TEXT BOOKS/REFERENCE BOOKS:</u>

1. Physical Chemistry for Life Sciences, Peter Atkins and Julio de Paula, 2006, Oxford Press
2. Introduction to Biophysics by Cortell
3. Tex Book of Biophysics , R N Roy, New Central Agency (P) Ltd, Culcutta
4. Methods in Molecular Biophysics, Igor N S, N Zaccai& J Zaccai, (2007) Cambridge
5. Principle of Biochemistry, D Voet, J Voet and CW Pratt, 3rd Ed,
6. Essential Biophysics, Narayanan, New Age Publications
7. Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley

Course outcomes: Upon successful completion of this course, the students will learn (knowledge based)	
1.	The major classes of biological macromolecules, their polymeric structures and role in the biological cell.
2.	Detailed chemical structure of the polymers and their constituent monomers
3.	Role of covalent and non-covalent bonds and experimental techniques used in Bio-Physics
4	Inter-and intramolecullar interactions and their contribution to the native conformation of biomolecules
5	Biophysical techniques and their application in understanding structure and conformation of biological macromolecules, structure – function relationships, molecular transport within the cell and across membranes.
6	Understanding of instrument used for bio-physics.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BPH-377	INDUSTRIAL TRAINING / DISSERTATION / PROJECT	0	0	10	10

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.**

School of Basic Science & Humanities

SCHEME OF STUDIES AND SYLLABUS

MASTER OF SCIENCE-PHYSICS

(2017-18 Batch Onwards)

Lingaya's Vidyapeeth, Faridabad

Deemed to be university (u/s of UGC act 1956)

(Approved By UGS, MHRD, AICTE, BCI, PCI & ACI)

SYLLABUS SCHEME

MASTER OF SCIENCE- PHYSICS

SEMESTER-I

S.N.	Code	Name	L	T	P	Credits
1	MPH-110	Mathematical Physics	3	1	0	4
2	MPH-111	Classical Mechanics	3	1	0	4
3	MPH-112	Quantum Mechanics-I	3	1	0	4
4	MPH-113	Electro-Optic Effects In Materials (EOEM)	3	0	2	5
5	MPH-114	Electronics	3	0	0	3
6	MPH-161	General Physics Laboratory	0	0	4	2
7	MCS-163	Electro-Optic Effects In Materials (EOEM) Lab	0	0	2	2
8	MPH-164	Electronics Lab	0	0	4	2
		Total Credits				26

SEMESTER-II

S.N.	Code	Name	L	T	P	Credits
1	MPH-115	Quantum Mechanics-II	3	1	0	4
2	MPH-116	Theory of Radiation & Statistical Mechanics	3	1	0	4
3	MPH-117	Numerical Methods and Computational Physics	3	1	0	4
4	MPH-118	Electromagnetic theory and Electromagnetism	3	1	0	4
5	MPH-119	Atomic and Molecular Physics	3	1	0	4
6	MPH-165	Advanced Physics Laboratory	0	0	4	2
7	MPH-167	Numerical Methods and Computational Physics Lab	0	0	2	1
		Summer Training	0	0	2	2
		Total Credits				25

SEMESTER-III

S.N.	Code	Name	L	T	P	Credits
1	MPH-210	Solid State Physics	3	1	0	4
2	MPH-211	Nuclear and Particle Physics	3	1	0	4
3	MPH-212	Fiber Optics & Laser	3	1	0	4
4	MPH-213	Electronics - I	3	1	0	4
5	MPH-214	Electronics - II	3	1	0	4
6	MPH-263	Electronics – I Lab	0	0	2	1
7	MPH-264	General Physics Laboratory-II	0	0	2	1
		Total Credits				22

SEMESTER-IV

S.N.	Code	Name	L	T	P	Credits
1	MPH-221	Measurement Techniques	3	1	0	4
2	MPH-222	Nano Science And Technology Departmental Elective paper-II	3	1	0	4
3	MPH-223	Electronic Communication System (Specialization Elective paper-III)	3	1	0	4
4	MPH-224	Electronic Devices (Specialization Elective paper-IV)	3	1	0	4
5	MPH-271	Measurement Techniques Lab	0	0	2	1
5	MPH-273	Electronic Communication System Lab	0	0	2	1
6	MPH-274	Project/ Dissertation	0	0	12	12
		Total Credits				30

SEMESTER-I

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-110	MATHEMATICAL PHYSICS	3	1	-	4

Course Objectives:
The main objective of this course is to familiarize students with a range of mathematical methods that are essential for solving advanced problems in theoretical physics.

UNIT 1.COMPLEX VARIABLES: 10 LECTURES

Introduction, Cauchy-Riemann conditions, Cauchy's Integral formula, Laurent expansion, singularities, calculus of residues, evaluation of definite integrals, Dispersion relation.

UNIT 2.DELTA AND GAMMA FUNCTIONS: 10 LECTURES

Dirac delta function, Delta sequences for one dimensional function, properties of delta function, Gamma function, factorial notation and applications, Beta function.

UNIT 3.DIFFERENTIAL EQUATIONS: 11 LECTURES

Partial differential equations of theoretical physics, boundary value, problems, Neumann & Dirichlet Boundary conditions, separation of variables, singular points, series solutions, second solution.

UNIT 4: SPECIAL FUNCTIONS: 12 LECTURES

Bessel functions of first and second kind, Generating function, integral representation and recurrence relations for Bessel's functions of first kind, orthogonality. Legendre functions : generating function, recurrence relations and special properties, orthogonality, various definitions of Legendre polynominals. Associated Legendre functions: recurrence relations, parity and orthogonality, Hermite functions, Laguerre functions.

UNIT5: ELEMENTARY STATISTICS: 10 LECTURES

Introduction to probability theory, random variables, Binomial, Poisson and Normal distribution Tutorials: Relevant problems given at the end of each section in Book 1.

TEXT BOOKS/REFERENCE BOOKS:

1. Mathematical Methods for Physicists: G. Arfken and H.J. Weber (Academic Press, San Diego) 7th edition, 2012.
2. Mathematical Physics: P.K. Chattopadhyay (Wiley Eastern, New Delhi), 2004.
3. Mathematical Physics: A.K. Ghatak, I.C. Goyal and S.J. Chua (MacMillan, India, Delhi),1986.
4. Mathematical Methods in the Physical Sciences – M.L. Boas (Wiley, New York) 3rd edition, 2007.
5. Special Functions: E.D. Rainville (MacMillan, New York), 1960.
6. Mathematical Methods for Physics and Engineering:K.F.Riley, M.P.Hobson and S.J. Bence (Cambridge University Press, Cambridge) 3rd ed., 2006.

Course outcomes: After successfully completed course, student will be able to	
1.	Use complex analysis in solving physical problems.
2.	Solve ordinary and partial differential equations of second order that are common in the physical sciences.
3.	Use the orthogonal polynomials and other special functions.
4	Use Fourier series and integral transformation.
5	Use the calculus of variations
6	Use Green functions.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-111	CLASSICAL MECHANICS	3	1	-	4

Course Objectives:
• To demonstrate knowledge and understanding of the following fundamental concepts in: 1. the dynamics of system of particles, 2. motion of rigid body, 3. Lagrangian and Hamiltonian formulation of mechanics • To represent the equations of motion for complicated mechanical systems using the Lagrangian and Hamiltonian formulation of classical mechanics. • To develop math skills as applied to physics.

UNIT 1. LAGRANGIAN FORMULATION: 12 LECTURES
Mechanics of a system of particles; constraints of motion, generalized coordinates, D'Alembert's Principle and Lagrange's velocity - dependent forces and the dissipation function, Applications of Lagrangian formulation.

UNIT 2.HAMILTON'S PRINCIPLES: 10 LECTURES
Calculus of variations, Hamilton's principle, Lagrange's equation from Hamilton's principle, extension to nonholonomic systems, advantages of variational principle formulation, symmetry properties of space and time and conservation theorems.

UNIT 3.HAMILTON'S EQUATIONS: 09 LECTURES
Legendre Transformation, Hamilton's equations of motion, Cyclicco-ordinates, Hamilton's equations from variational principle, Principle of least action.

UNIT 4.CANONICAL TRANSFORMATION AND HAMILTON-JACOBI THEORY: 10 LECTURES
Canonical transformation and its examples, Poisson's brackets, Equations of motion, Angular momentum, Poisson's Bracket relations, infinitesimal canonical transformation, Conservation Theorems. Hamilton Jacobi equations for principal and characteristic functions, Action-angle variables for systems with one-degree of freedom.

UNIT 5.RIGID BODY MOTIONAND SMALL OSCILLATIONS: 11 LECTURES
Independent co-ordinates of rigid body, orthogonal transformations, Eulerian Angles and Euler's theorem, infinitesimal rotation, Rate of change of a vector, Coriolis force, angular momentum and kinetic energy of a rigid body, the inertia tensor, principal axis transformation, Euler equations of motion, Torque free motion of rigid body, motion of a symmetrical top. Eigenvalue equation, Free vibrations, Normal Coordinates, Vibrations of a triatomic molecule.

Tutorials : Relevant problems given at the end of each chapter in different books.

TEXT BOOKS/REFERENCE BOOKS:

1. Classical Mechanics: H. Goldstein, C.Poole and J.Safko (Pearson Education Asia, New Delhi), 3rd ed 2002.
2. Classical Mechanics of Particles and Rigid Bodies: K.C. Gupta (Wiley Eastern, New Delhi), 1988. Q

Course outcomes:After successfully completed course, student will be able to	
1	Define and understand basic mechanical concepts related to discrete and continuous mechanical systems,
2	Describe and understand the vibrations of discrete and continuous mechanical systems,
3	Describe and understand planar and spatial motion of a rigid body,
4	Describe and understand the motion of a mechanical system using Lagrange-Hamilton formalism

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-112	QUANTUM MECHANICS – I	3	1	-	4

Course Objectives:
Connect the historical development of quantum mechanics with previous knowledge and learn the basic properties of quantum world.

UNIT 1 : MATHEMATICAL TOOLS OF QUANTUM MECHANICS: 10 LECTURES
Brief introduction to origins of quantum Physics. Wave packets. Dirac notation. Operators, their eigenvalues and eigen functions, orthonormality, completeness and closure. Generalized Uncertainty Principle. Unitary transformations, change of basis. Matrix Representation of operators. Continuous basis, position and momentum representation and their connection. Parity operator.

UNIT 2: FUNDAMENTAL CONCEPTS OF QUANTUMMECHANICS: 12 LECTURES
Basic postulates of quantum mechanics. Measurement. Time evolution of system's state. Properties of one dimensional motion, free particle, potential step, potential well and barrier , tunneling effect, infinite square well potential, simple harmonic oscillator by wave equation and operator method, charged particle in a uniform magnetic field.

UNIT 3: SPHERICALLY SYMMETRIC POTENTIAL: 10 LECTURES
Separation of variables in spherical & Polar coordinates, orbital angular momentum, parity, spherical harmonics, free particle in spherical polar coordinates, square well potential, hydrogen atom.radial solution and principal quantum number, orbital and magnetic quantum number. Electron probability density, radiative transition.

UNIT 4: ANGULAR MOMENTUM: 08 LECTURES
Orbital, Spin and total angular momentum operators. Pauli spin matrices, their Commutation relations. Eigen values and eigenfunctionsL^2 of *Lz.*

UNIT5: IDENTICAL PARTICLES: 08 LECTURES
Many particle systems, systems of identical particles, exchange degeneracy, symmetrization postulate, construction of symmetric and anti-symmetric wave functions from un-symmetrized functions. The Pauli Exclusion Principle.

TEXT BOOKS/REFERENCE BOOKS:

1. Franz Schwabl : Quantum Mechanics
2. J. J. Sakurai : Modern Quantum Mechanics
3. N. Zettili : Quantum Mechanics
4. P. A. M. Dirac :Priciples of Quantum Mechanics
5. Bohm : Quantum Mechanic

1.	Pinpoint the historical aspects of development of quantum mechanics
2.	Understand and explain the differences between classical and quantum mechanics
3.	Understand the idea of wave function
4	Understand the uncertainty relations
5	Solve Schrodinger equation for simple potentials
6	Spot, identify and relate the eigenvalue problems for energy, momentum, angular momentum and central potentials explain the idea of spin

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-113	ELECTRO-OPTIC EFFECTS IN MATERIALS (EOEM)	3	1	-	4

UNIT 1. PRINCIPLES OF ELECTRO-OPTICS LECTURE 8

Introduction, Fundamentals of Electro-optic effects, Pockels and Kerr effect. Electro-optic sensors and switches, spatial light modulators, phase retarders. Electro-optical materials: Inorganic crystals, organic crystals, liquid crystals, semiconductors, dye-doped polymers, dichroism in materials, field induced-anisotropy in materials.

UNIT 2. PROPAGATION OF LIGHT IN ANISOTROPIC OPTICAL MEDIA LECTURE 7

Electromagnetic Waves, Polarization, Monochromatic plane waves and their polarization states: Linear polarization states, Circular polarization states, Elliptical polarization states. Propagation of Light in Uniform Anisotropic Optical Media, Birefringence, ordinary and extraordinary waves, Eigenmodes, Orthogonality of eigenmodes, Energy flux, Special cases, Polarizers

UNIT 3 - LIQUID CRYSTALS – THE FOURTH PHASE OF MATTER LECTURE 11

Introduction, classification of liquid crystals, various mesophases of liquid crystals, polymer liquid crystals, chirality in liquid crystals, ferroelectric and antiferroelectric liquid crystals, discotic liquid crystals, lyotropic liquid crystals, applications.

UNIT 4 – ELECTRO-OPTICAL EFFECTS IN LIQUID CRYSTALS LECTURE 12

Order parameter, Anisotropy in liquid crystals, electrical anisotropy, optical anisotropy, deformations, electro-optic alignment, optical waveguiding, field-induced switching, Freedericksz transition, response time, confinement of liquid crystals for electro-optic effects, factors governing electro-optics.

UNIT 5 - LIQUID CRYSTAL DEVICES LECTURE 12

Display matrices, LCD, TN displays, STN displays, fast-switching devices, phase modulators, Guest-host displays, Liquid crystal-polymer dispersions, flexible displays, non-display devices.

TEXT BOOKS/REFERENCE BOOKS:

1. G. R. Elion and H. A. Elion, Electro-Optics Handbook, Marcel Dekker, New York,

I. P. Kaminow, An Introduction to Electrooptic Devices, Academic Press, New York,

2. The Physics of Liquid Crystals: P.G. de Gennes and J Prost. Oxford University press.
3. Liquid Crystals- Applications and Uses: B Bhadur (Vol.1,2,3)

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-114	ELECTRONICS	3	1	-	4

Course Objectives:
To introduce students to entire circuit designs, and to provide in-depththeoretical base of Digital Electronics. The Electronics course covers semiconductor physics, physical principles of devices and their basic applications, basic circuit analysis, first-order nonlinear circuits, Analysis of Passive and Active filters, OPAMP based analog circuits and introduction to various communication techniques.

UNIT I : SEMICONDUCTOR DEVICES-I 10 LECTURES

Semiconducting Materials, conduction in semiconductors, Charge densities in a semiconductors, PN junction, space charge and electric field distribution at junctions, forward and reverse biased conditions, Space charge capacitance, varactor diode, Zener and avalanche breakdowns, Zener diodes, Schottky barrier, tunnel diode, photodiode, LED, p-n-p-n devices and their characteristics, .

UNIT II : SEMICONDUCTOR DEVICES II: 12 LECTURES

Transistors: Bipolar junction Transistor (BJT), Analysis of CE amplifier using h-parameters, The T-network equivalentcircuit, constants of CB and CE amplifier using emitter, base, collector resistance, Biasingtechnique to BJT, stabilization factor, temperature stabilization, operating point, fixedbias, emitter feedback bias, voltage feedback bias. Field-Effect Transistors (FET) and MOSFET:Structure, Working, Derivations of the equations for I-V characteristics under differentconditions.

UNIT – III POWER AMPLIFIER AND OSCILLATORS **11 LECTURES**
Operating conditions for power amplifier, power relations, The ideal transformer, voltage limitations of the transformer, non-linear distortion, Idea of inter-modulation distortion, The class A power amplifier, The push-pull amplifier, Feedback requirements ofoscillations, Basic oscillator analysis, Hartley and Colpitt oscillators, Piezo-electric,frequency control , RC oscillators.

UNIT – IV BASICS OF DIFFERENTIAL AND OPERATIONAL AMPLIFIERS **10 LECTURES**
Differential amplifier, Differential amplifier circuit configuration, Dual input balanced output differential amplifier, Voltage gain, differential input resistance, inverting and non inverting inputs, common mode rejection ratio, Operational amplifier, input offset voltage,input offset currents, input bias currents, differential input resistance, input capacitance, offset voltage supply, rejection ratio, Ideal OP Amp, equivalent circuit of an OP Amp, ideal voltage transfer curve, inverting, dual and non-inverting amplifier, measurement of OPAmp parameters, frequency response

UNIT V COMMUNICATION SYSTEMS (BROAD ASPECTS): **10 LECTURES**
Digital transmission, ASK, FSK, PSK, Differential PSK, modulators and detectors, Broadband Communication Systems-Optical Fibre comm., Submarine cables, Satellite and cellular mobile systems, Integrated Services Digital Network

TUTORIALS : Relevant problems given in the recommended books.

TEXT BOOKS/REFERENCE BOOKS

1. Electronics Fundamentals and Application: J.D. Ryder
2. Solid State Electronic Devices: B.G.Streetman
3. Electronic Principals: Malvino
4. Principals of Microwave: Atwarter
5. Electromagnetic Wave and Radiating System: Jorden and Ballmon
6. Electronic Devices and Circuits: Millman and Halkias

Course outcomes: Learning Outcomes: Students will have understanding of:	
1.	**Logic circuits, digital systems and microprocessor and their peripheral devices.**
2.	**Operating and designing digital systems**
3.	**How to solve problems in design and/ or implementation of digital**

COURSE CODE	**COURSE TITLE**	**L**	**T**	**P**	**CREDITS**
MPH-161	**GENERAL PHYSICS LABORATORY**	**3**	**1**	**-**	**2**

Course Objectives:
The aim and objective of the course General Physics Laboratory is to expose the students of M.Sc. (H.S.) class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

List of Experiments:

1. G.M. Tube Characteristics & Absorption Coefficient

2. Study of high energy interaction in nuclear emulsion

3. Study of Hall effect in semiconductors:

(a) Determination of Hall voltage and Hall coefficient, and

(b) Determination of the mobility of charge

e carriers and the carrier concentration.

4. Study of Magnetic Susceptibility of MnCl2

5. To determine dissociation Energy of Iodine Molecule

6. To study of Hysteresis loop curve of Magnetic Materials

7. To study conductivity of a Semiconductor using Four Probe method

8. Determination of the energy gap of a semiconductor by four probe method.

9. To determine the response of silicon solar cells and the effect of prolonged irradiation and to calculate the efficiency and fill factors of a variety of solar cells.

10. To determine: a). the velocity of ultrasonic waves in a liquid and,

b). the compressibility of the liquid.

11. Dielectric constant of ice.

12. Elastic properties of a solid using piezoelectric oscillator.

13. Measurement of e/m by Thomson effect.

14. Michelson interferometer.

Note: Each student is required to perform at least 07 of the above experiments.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-163	Electro-Optic Effects In Materials (EOEM) Lab	0	0	4	2

1. **To examine the phase transition temperatures for LC materials.**
2. **To study the electro-optical behavior of a Liquid Crystal cell.**
3. **To study the Response Time characteristics of a PDLC cell.**
4. **To study the angular dependence of VT characteristics in a PDLC cell.**
5. **To examine the polarized effects of light through a Liquid Crystal device.**
6. **To study effects of various frequency-shapes on the EO properties and response time of liquid crystal device.**
7. **Structural and morphological changes in liquid crystal director configuration under effect of an applied electric field.**

Note: Each student is required to perform at least 7 of the above experiments.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-164	ELECTRONICS LAB	3	1	-	2

Course Objectives:
The aim and objective of the course electronics lab is to expose the students of M.Sc. (H.S.) class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment

LIST OF EXPERIMENTS:

1. **Design & Study of Common Emitter Amplifier**
2. **To draw the characteristics curve of PN junction diode.**
3. **To draw the characteristics curve of Zener diode.**
4. **To draw the characteristics curve of Schottky diode**
5. **To draw the characteristics curve of Tunnel diode**
6. **To draw the characteristics curve of Photo diode**
7. **Study of Operational Amplifier IC-741:**

    a. summer,

    b. Subtractor

    c. Inverter

    d. Non-inverter

    e. differentiator

    f integrator

Note: Each student is required to perform at least 7 of the above experiments.

TEXT BOOKS/REFERENCE BOOKS:

SEMESTER-II

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-115	QUANTUM MECHANICS – II	3	1	-	4

Course Objectives:
This course will introduce Dirac's bra-ket formulation of quantum mechanics and make students familiar with various approximation methods applied to atomic, nuclear and solid-state physics, and to scattering. Content will include: Dirac's formulation of quantum mechanics: kets and bras, quantum oscillator, angular momentum, measurement, Bell's inequality, generalised Uncertainty Principle, connection with wave and matrix mechanics. Time-independent and time-dependent perturbation theory, Schrodinger, Heisenberg and Interaction pictures, radiative transitions. Identical particles, atoms, exchange forces, periodic systems, energy bands in solids. Symmetries, translations in space and time, parity and time reversal, rotations and angular momentum, addition of angular momenta, fine structure of Hydrogen, L-S and j-j coupling in atoms and nuclei. Hartree-Fock and Thomas-Fermi approximations, variational and WKB methods. Scattering: Born approximation, S-matrix, partial waves.

UNIT 1. LINEAR VECTOR SPACE AND MATRIX MECHANICS: 12 LECTURES

Vector spaces, Schwarz inequality, Orthonormal basis, Schmidt ortho-normalisation method, Operators, Projection operator, Hermitian and Unitary operators, change of basis, Eigenvalue and Eigenvectors of operators, Dirac's bra and ket notation, commutators, Simultaneous eigenvectors, Postulates of quantum mechanics, uncertainty relation. Harmonic oscillator in matrix mechanics, Time development of states and operators, Heisenberg and Schrodinger representations, Exchange operator and identical particles. Density Matrix and Mixed Ensemble.

UNIT 2. SYMMETRY IN QUANTUM MECHANICS 10 LECTURES

Symmetry operations and unitary transformations, conservation principles, space and time translations, rotation, space inversion and time reversal, symmetry and degeneracy.

Rotation operators, angular momentum algebra, eigenvalues of J^2 and Jz, spinors and Pauli matrices, addition of angular momenta.Representation of general angular momentum operator, Addition of angular momenta, C.G. coefficients.

UNIT 3. TIME-INDEPENDENT & TIME-DEPENDENT PROBLEMSAPPROXIMATION METHODS 10 LECTURES

Non-degenerate perturbation theory, degenerate case, Stark effect, Zeeman effect and other examples, variational methods, WKB method, tunnelling.

Schrödinger and Heisenberg picture, time-dependent perturbation theory, transition probability calculations, golden rule, adiabatic approximation, sudden approximation, beta decay as an example.

UNIT 4. STATIONARY STATE APPROXIMATE METHODS: 08 LECTURES

Variational method with applications to the ground states of harmonic oscillator and other sample systems.

UNIT 5.. SCATTERING THEORY 10 LECTURES

Differential cross-section, scattering of a wave packet, integral equation for the scattering amplitude, Born approximation, method of partial waves, low energy scattering and bound states, resonance scattering.

TEXT BOOKS/REFERENCE BOOKS:

Same as in Quantum Mechanics I plus
1. C. Cohen-Tannoudji, B. Diu and F. Laloe, Quantum Mechanics (Volume II).
2. A. Messiah, Quantum Mechanics (Volume II).
3. S. Flügge, Practical Quantum Mechanics.
4. J.J. Sakurai, Modern Quantum Mechanics.
5. K. Gottfried, Quantum Mechanics.

Course outcomes: The completion of course will help students to:	
1.	Develop a knowledge and understanding of the concept that quantum states live in a vector space;
2.	Relate this abstract formulation to wave and matrix mechanics
3.	Develop a knowledge and understanding of perturbation theory, level splitting, and radiativetransitions;
4	Develop a knowledge and understanding of the relation between conservation laws and symmetries;
5	Develop a knowledge and understanding of the role of angular momentum in atomic and nuclear physics;
6	Develop a knowledge and understanding of the scattering matrix and partial wave analysis;
7	Solve quantum mechanics problems;

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-116	THEORY OF RADIATION & STATISTICAL MECHANICS	3	1	-	4

Course Objectives:
This course provides an introduction to the microscopic formulation of thermal physics, generally known as statistical mechanics. The course explores the general principles, from which emerge an understanding of the microscopic significance of entropy and temperature. The theory to develop machinery needed to form a practical tool linking microscopic models of many-particle systems with measurable quantities will be established. The course will cover a range of applications like models of crystalline solids, classical gases, quantum gases and blackbody radiation.

UNIT 1:THEORY OF RADIATION 10 LECTURES

Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure Temperature Dependence, Kirchhoff's Law, Stefan-Boltzmann Law and Wien's Displacement law. Saha's Ionization Formula.

UNIT 2 QUANTUM THEORY OF RADIATION: 12 LECTURES

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

UNIT 3. REVIEW OF THERMODYNAMICS 10 LECTURES

Extensive and intensive variables, laws of thermodynamics, Legendre transformations and thermodynamic potentials, Maxwell relations, applications of thermodynamics to (a) ideal gas, (b) magnetic material, and (c) dielectric material.

UNIT 4. FORMALISM OF EQUILIBRIUM STATISTICAL MECHANICS 11 LECTURES

Concept of phase space, Liouville's theorem, basic postulates of statistical mechanics, ensembles: microcanonical, canonical, grand canonical, and isobaric, connection to thermodynamics, fluctuations, applications of various ensembles, partition function, equation of state for a non-ideal gas, Van der Waals' equation of state, Meyer cluster expansion, virial coefficients

UNIT 5. QUANTUM STATISTICS 12 LECTURES

Transition from classical statistical mechanics to quantum statistical mechanics, Indistinguishability and quantum statistics, identical particles and symmetry requirements, Bose Einstein statistics, Fermi Dirac statistics, Maxwell Boltzmann statistics. Bose Einstein Condensation, Thermal properties of B.E. gas, liquid Helium, Energy and pressure of F-D gas, Electrons in metals, Thermionic Emission. Fermi-Dirac and Bose-Einstein statistics.

Applications of the formalism to:

(a) **Ideal Bose gas, Debye theory of specific heat, properties of black-body radiation, Bose- Einstein condensation, experiments on atomic BEC, BEC in a harmonic potential.**
(b) **Ideal Fermi gas, properties of simple metals, Pauli paramagnetism, electronic specific heat, white dwarf stars.**

TEXT BOOKS/REFERENCE BOOKS:

1.F. Reif, Fundamentals of Statistical and Thermal Physics.
2.K. Huang, Statistical Mechanics.
3.R.K. Pathria, Statistical Mechanics.
4.D.A. McQuarrie, Statistical Mechanics.
5.S.K. Ma, Statistical Mechanics.

Course outcomes:On completion of this course a student will be able to:	
1.	Define and discuss the concepts of microstate and macro state of a model system
2.	Define and discuss the concepts and roles of entropy and free energy from the view point of statistical mechanics
3.	Define and discuss the Boltzmann distribution and the role of the partition function`
4	Discuss the concept and role of indistinguishability in the theory of gases; know the results expected from classical considerations and when these should be recovered
5	Define the Fermi-Dirac and Bose-Einstein distributions; state where they are applicable; understand how they differ and show when they reduce to the Boltzmann distribution
6	Apply the Bose-Einstein distribution to the calculation of properties of black body radiation

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-117	**NUMERICAL METHODS AND COMPUTATIONAL PHYSICS**	**3**	**1**	**-**	**4**

Course Objectives:
This hands-on course provides an introduction to computational methods in solving problems in physics. It teaches programming tactics, numerical methods and their implementation, together with methods of linear algebra. These computational methods are applied to problems in physics, including the modelling of classical physical systems to quantum systems, as well as to data analysis such as linear and nonlinear fits to data sets. Applications of high performance computing are included where possible, such as an introduction to parallel computing and also to visualization techniques.

UNIT I: DIFFERENTIATION AND INTEGRATION (12 LECTURES)

Differentiation: Taylor series method, Numerical differentiation using Newton's forwarddifference formula, Backward difference formula, Stirling's formula, Cubic splines method;

Integration: Trapezoidal rule, Simpson's 1/3 rule, Gaussian Quadrature, Legendre–GaussQuadrature, Numerical double integration, Numerical integration of singular integrals.

UNIT II: SOLUTION OF DIFFERENTIAL EQUATIONS (12 LECTURES)

Numerical solution of ordinary differential equations: Taylor's series method, Euler's method,Forth-order RungeKutta method, Cubic splines method; Second order differential equations:Initial and boundary value problems, Numeric solution of Radial Schrodinger equation forHydrogen atom using Forth-order Runge-Kutta method(when eigen value is given), NumericalSolutions of Partial Differential Equations Using Finite Difference Method.

UNIT III: RANDOM NUMBERS AND CHAOS (12 LECTURES)

Random numbers: Random number generators, Mid-square methods, Multiplicative congruentialmethod, mixed multiplicative congruential methods, modeling radioactive decay. Hit and missMonte-Carlo methods, Monte-Carlo calculation of □□, Monte-Carlo evaluation of integration,Evaluation of multidimensional integrals; Chaotic dynamics: Some definitions, The simplependulum, Potential energy of a dynamical system. Portraits in phase space: Undamped motion,Damped motion, Driven and damped oscillator.

UNIT IV: SELECTED PHYSICS PROBLEMS (12 LECTURES)

Algorithms to simulate interference and diffraction of light, Algorithms of charging anddischarging of a capacitor, current in LR and LCR circuits, Computer models of LR and LCRcircuits driven by sine and square functions.

UNIT 5: FOURIER TRANSFORMATIONS: (10 LECTURES)

Fourier sine & cosine series, Analysis of a time series and search for periodicity. FFT (Fast Fourier transformation) and power spectrum and any other topics used in physics researches.

TEXT BOOKS/REFERENCE BOOKS

Course outcomes: On completion of this course, students will be able to:	
1.	**Identify modern programming methods and describe the extent and limitations of computational methods in physics**
2.	**Identify and describe the characteristics of various numerical methods**
3.	**Independently program computers using leading-edge tools,**
4	**Formulate and computationally solve a selection of problems in physics**
5	**Use the tools, methodologies, language and conventions of physics to test and communicate ideas and explanations.**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-118	ELECTROMAGNETIC THEORY & ELECTRODYNAMICS	3	1	-	4

Course Objectives:
In this course, the students will primarily learn how to solve the Maxwell's equations for various boundary conditions. Some emphasis will be on learning to use spherical harmonics and the Greens function methods for solving the Maxwell's equations. Towards the latter part of the course, the focus will be on issues such as dispersion in materials, energy and momentum transport by electromagnetic waves at various interfaces like conductors, dielectrics and application in antennas and transmission lines.

UNIT I: ELECTROSTATICS 12 LECTURES

Electric Field, Gauss Law, Differential form of Gauss Law, Electromagnetic scalar and vector potentials, Maxwell's equations in terms of scalar and vector potentials, Non uniqueness of Electromagnetic potentials and concept of Gauge. Lorentz gauge and coulomb gauge. Boundary
value problem, Poisson and Laplace equations, Solution of Laplace equation in Rectangularcoordinates, Green's Theorem, Dirichlet and Neumann boundary conditions, Formal solution ofboundary value problem with Green's function, Electrostatic potential energy and energydensity.

UNIT 2.MAGNETOSTATICS: 10 LECTURES

Biot-Savart law, differential equation for static magnetic field, vector potential, magnetic field from localized current distributions, examples of magnetostatic problems, Faraday's law of induction, magnetic energy of steady current distributions.

UNIT 3. MAXWELL'S EQUATIONS 09 LECTURES

Displacement current, Maxwell's equations, vector and scalar potentials, gauge symmetry, Coulomb and Lorentz gauges, electromagnetic energy and momentum, conservation laws, inhomogeneous wave equation and Green's function solution.

UNIT 4. ELECTROMAGNETIC WAVES 11 LECTURES

Plane waves in a dielectric medium, reflection and refraction at dielectric interfaces, frequency dispersion in dielectrics and metals, dielectric constant and anomalous dispersion, wave propagation in one dimension, group velocity, metallic wave guides, boundary conditions at metallic surfaces, propagation modes in wave guides, resonant modes in cavities.

UNIT 5. RADIATION & COVARIANT FORMULATION OF ELECTRODYNAMICS 12 LECTURES

Field of a localized oscillating source, fields and radiation in dipole and quadrupole approximations, antenna, radiation by moving charges, Lienard-Wiechert potentials, total power radiated by an accelerated charge, Lorentz formula.
Four-vectors relevant to electrodynamics, electromagnetic field tensor and Maxwell's equations, transformation of fields, fields of uniformly moving particles.
Concepts of Plasma Physics: Formation of plasma, Debye theory of screening, plasma oscillations, motion of charges in electromagnetic fields, magneto-plasma, plasma confinement, hydro magnetic waves.

TEXT BOOKS/REFERENCE BOOKS:

1. J.D. Jackson, Classical Electrodynamics.
2. D.J. Griffiths, Introduction to Electrodynamics.
3. J.R. Reitz, F.J. Milford and R.W. Christy, Foundations of Electromagnetic Theory.
4. W.K.H. Panofsky and M. Phillips, Classical Electricity and Magnetism.
5. F.F. Chen, Introduction to Plasma Physics and Controlled Fusion.

Course outcomes:The completion of course will help students to:	
1.	Apply vector calculus to static electric-magnetic fields in different engineering situations.
2.	Analyze Maxwell's equation in different forms (differential and integral) and apply them to diverse science problems.
3.	Examine the phenomena of wave propagation in different media and its interfaces and in applications of wave engineering.
4	Analyze the nature of electromagnetic wave propagation in guided medium

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-119	ATOMIC & MOLECULAR PHYSICS	3	1	-	4

Course Objectives:
This course deals principally with atomic structure and the interaction between atoms and fields. It covers electronic transitions, atomic spectra, excited states, hydrogenic and multi-electron atoms. Emphasis will be given to learn more detailed concepts of binding of atoms into molecules, molecular degrees of freedom (electronic, vibrational, and rotational), elementary group theory considerations and molecular spectroscopy.

UNIT-1: ATOMIC PHYSICS **12 LECTURES**

Fine structure of hydrogen atoms-mass correction, Spin orbit term, Darwin term,Intensity of fine structure lines, ground state of two electron atoms-perturbation theoryand variation method. Many electron atoms- LS and jj coupling schemes, Lande intervalrule. Terms for equivalent & non-equivalent electron atom. Space Quantization: sternGerlach experiment, normal & anomalous Zeeman effect, Stark effect, Paschen-Backeffect; Intensities of spectral line: General selection rule, Hyperfine Structure, IsotopeShifts and Nuclear Size Effects.

UNIT-II: MOLECULAR STRUCTURE **08 LECTURES**

Born-Oppenheimer separation for diatomic molecules, rotation, vibration and electronicstructure of diatomic molecules. Description of Molecular Orbital and ElectronicConfiguration of Diatomic Molecules: H2, H2+. Co-relation diagram for heteronuclearmolecules.

UNIT-III: MOLECULAR SPECTRA **09 LECTURES**

Rotation, Vibration-rotation and electronic spectra of diatomic molecules.The FranckCondon Principle. Raman Spectroscopy: Introduction, pure rotational Raman Spectra,vibrational Raman spectra, Nuclear spin and intensity alternation in Raman spectra,Isotope effect and Raman spectrometer. Dissociation and pre dissociation, Dissociationenergy, Rotational fine structure of electronic bands.

UNIT-IV: RESONANCE SPECTROSCOPY **10 LECTURES**

NMR: Basic principles- classical and quantum description-Bloch Equation-spin-spin ansspin-lattice relaxation times-chemical shift and coupling constant- experimental methodssingleand double coil methods; ESR: Basic principles, ESR Spectrometer-nuclearinteraction and hyperfine structure-relaxation ects-g factor.

UNIT-V: ROTATION AND VIBRATION OF MOLECULES: **11 LECTURES**

Solution of nuclear equation; Molecular rotation: Non-rigid rotator, Centrifugal distortion, Symmetric top molecules, Molecular vibrations: Harmonic oscillator and the anharmonic oscillator approximation, Morse potential.

Spectra of Molecules: Transition matrix elements, Vibration-rotation spectra: Pure vibrational transitions, Pure rotational transitions, Vibration-rotation transitions,

TEXT BOOKS/REFERENCE BOOKS:

1.I.N. Levine, Quantum Chemistry.
2. R. McWeeny, Coulson's Valence.
3. L.D. Landau and E.M. Lifshitz, Quantum Mechanics.
4. M. Karplus and R.N. Porter, Atoms and Molecules: An Introduction for Students of Physical Chemistry.
5. P.W. Atkins and R.S. Friedman, Molecular Quantum Mechanics.
6. M. Tinkham, Group Theory and Quantum Mechanics.
7. L. Fetter and J. D. Walecka, Quantum Theory of Many-Particle Systems.
8. W.A. Harrison, Applied Quantum Mechanics.

Course outcomes:Upon successful completion of this course, the students will be able to:	
1.	Discuss the relativistic corrections for the energy levels of the hydrogen atom and their effect on optical spectra
2.	Derive the energy shifts due to these corrections using first order perturbation theory
3.	State and explain the key properties of many electron atoms and the importance of the Pauli exclusion principle
4	Explain the observed dependence of atomic spectral lines on externally applied electric and magnetic fields
5	State the formal properties of groups, characters and irreducible representations
6	State and justify the selection rules for various optical spectroscopies in terms of the symmetriesof molecular vibrations
7	Apply general considerations of quantum physics to atomic and molecular system; make general orders of magnitude of estimation of physical effects
8	Explain how light interacting with atom and effect of magnetic field on the spectrum.
9	Recognize the general features of Atomic/Molecular spectroscopy and its application in real world

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-165	ADVANCE PHYSICS LABORATORY	3	1	-	2

Course Objectives:
The aim and objective of the course General Physics Laboratory is to expose the students of M.Sc. (H.S.) class to experimental techniques in electronics, so that they can verify some of the things read in theory here or in earlier classes and develop confidence to handle sophisticated equipment.

1. UJT - characteristics and it's applications as relaxation oscillator
2. SCR - characteristics and it's applications as switching device
3. Study of Optoelectronic Devices
4. Study of Phase Shift Oscillator
5. Study of Negative & Positive Feedback Amplifier
6. FET - I/V characteristics, biasing and it's application as an amplifier
7. MOSFET - I/V characteristics, biasing and it's application as an amplifier
8. Study of Pulse Amplitude Modulation (PAM) & Demodulation
9. A/D and D/A converter
10. Design & study of regulated and stabilized power supply.
11. Design & study of triangular wave generator.
12. Study of IC - 555 as astable, mono-stable and bi-stable multivibrator
13. Active filters using op-amp
14. To determine the wavelength of a laser light
15. To determine the ridberg constant of hydrogen atom.
16. To determine the wavelength of used light by Michelson Interferometer
17. To determine the temparature coefficient of reisitance of a plattinum by using Callender&Grifith.
18. To draw the B-H curve of a ferromagnetic material.
19. To determine the Hall voltage & Hall coefficient of a semiconductor material
20. To determine the dielectreic constant of a dielectric material.
21. To find the thickness of a wire by Interference method.
22. To determine the Boltzmann constsnt.
23. Mini Project
24. Electron-spin resonance
25. Faraday rotation/Kerr effect.
26. Interfacial tension and Phase separation kinetics.
27. Reaction kinetics by spectrophotometer and conductivity.
28. Study of color centres by spectrophotometer.
29. Alpha, Beta and Gamma ray spectrometer.
30. Mössbauer spectrometer.
31. Sizing nano-structures (UV-VIS spectroscopy).
32. Magneto-resistance and its field dependence.
33. X-ray diffraction.
34. Compton scattering.
35. Adiabatic compressibility.
36. Solid-liquid phase diagram for a mixture.

Note: Each student is required to perform at least 12 of the above experiments.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-167	NUMERICAL METHODS AND COMPUTATIONAL PHYSICS LAB	3	1	-	4

List of Numerical Problems using "Classes":

1. Data handling: find standard deviation, mean, variance, moments etc. of at least 25 entries.

2. Choose a set of 10 values and find the least squared fitted curve.

3. Generation of waves on superposition like stationary waves and beats.

4. Fourier analysis of square waves.

5. To find the roots of quadratic equations.

6. Wave packet and uncertainty principle.

7. Find y for a given x by fitting a set of 9 values with the help of cubic spline fitting technique.

8. Find first order derivative at given x for a set of 10 values with the help of Lagrangeinterpolation.

9. To generate random numbers between (i) 1 and 0, (ii) 1 and 100.

10. Perform numerical integration on 1-D function using Simpson and Weddle rules.

11. To find determinant of a matrix - its eigen values and eigenvectors.

12. Use Monte Carlo techniques to simulate phenomenon of Nuclear Radioactivity. Modify your program to a case when the daughter nuclei are also unstable.

TEXT BOOKS/REFERENCE BOOKS

1. Numerical Mathematical Analysis, J.B. Scarborough (Oxford & IBH Book Co.) 6th ed., 1979.

2. A first course in Computational Physics: P.L. DeVries (Wiley) 2nd edition, 2011.

3. Computer Applications in Physics: S. Chandra (Narosa) 2nd edition, 2005.

4. Computational Physics: R.C. Verma, P.K. Ahluwalia and K.C. Sharma (New Age) 2000.

5. Object Oriented Programming with C++: Balagurusamy, (Tata McGrawHill) 4th edition 2008.

SEMESTER-III

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-210	SOLID STATE PHYSICS	3	1	-	4

Course Objectives:
The aim of this course is to give an extended knowledge of the principles and techniques of solid state physics.The course covers the physical understanding of matter from an atomic view point. Topics covered include the structure, thermal, magnetic and electrical properties of matter. Fundamental theories in solid state physics are introduced and then extended to show the relevance to important applications in current -day technology, industry, and research.

UNIT 1. LATTICE DYNAMICS AND THERMAL PROPERTIES: 12 LECTURES

Crystalline and amorphous solids. The crystal lattice. Basis vectors. Unitcell. Symmetry operations. Point, Three dimensional crystal systems. Miller indices. Directions and planes in crystals. Inter-planar spacings. Simple crystal structures: FCC, BCC, Nacl, CsCl, Diamond and ZnS structure, HCP structure., Binding in solids; Stress components, stiffness constant, elastic constants, elastic waves in crystals Rigorous treatment of lattice vibrations, normal modes; Density of states, thermodynamic properties of crystal, anharmonic effects, thermal expansion.

UNIT 2. ENERGY BAND THEORY : 10 LECTURES

The Bloch theorem. Bloch functions. Review of the Kroning-penney model. Brillouinzones. Number of states in the band.Band gap in the nearly free electron model.The tight binding model. The Fermi-surface. Electron dynamics in an electric field. The effective mass. Concept of hole. (elementary treatment) (8 lectures)

UNIT 3. TRANSPORT THEORY : 10 LECTURES

Quantized free electron theory. Fermi energy, wave vector, velocity and temperature, density of states.Electronic specific heats. Electronic transport from classical kinetic theory; Introduction to Boltzmann transportequation; electrical and thermal conductivity of metals; thermoelectric effects; Hall effect and magnetoresistance.

UNIT 4. DIELECTRIC PROPERTIES OF MATERIALS : 12 LECTURES

Diamagnetism, Langevin equation. Quantum theory of paramagnetism. Curie law. Hund's rules. Paramagnetism in rare earth and iron group ions. Elementary idea of crystal field effects. Ferromagnetism. Curie-Weiss law. Heisenberg exchange interaction. Mean field theory. Anti-ferro-magnetism. Neel point. Other kinds of magnetic order. Nuclear magnetic resonance.

UNIT 5.SUPERCONDUCTIVITY 08 LECTURES

Survey of important experimental results. Criticaltemperature.Meissnereffect.Type 1 and type II superconductors. Thermodynamics of superconducting transition. London equation. London penetration depth. Energy gap. Basic ideas of BCS theory. High-Tc superconductors.
Tutorials :Relevant problems given in the books listed below.

TEXT BOOKS/REFERENCE BOOKS:

1. Introduction to Solid State Physics: C. Kittel (Wiley, New York), 8th ed. 2005.
2. Quantum Theory of Solids : C. Kittel (Wiley, New York) 1987.
3. Principles of the Theory of Solids : J. Ziman (Cambridge University Press) 1972.
4. Solid State Physics : H. Ibach and H. Luth (Springer Berlin) 3rd. ed. 2002.

Course outcomes: After successfully completing this course students will be able to:	
1.	Explain the fundamental concepts of solid state physics such as what types of matter exist and the methods available to determine their structure and properties
2.	Outline the physical origins which govern the properties of matter in the solid state
3.	Apply the knowledge gained to solve problems in solid state physics using relevant mathematical tools.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-211	NUCLEAR & PARTICLE PHYSICS	3	1	-	4

Course Objectives:
The aim and objective of the course on Nuclear and Particle Physics is to familiarize the students of M.Sc. class to the basic aspects of nuclear and particle physics like static properties of nuclei, radioactive decays, nuclear forces, neutron physics, nuclear reactions the invariance principles and conservation laws, hadron-hadron interactions, relativistic kinematics, static quark model of hadrons and weak interactions so that they grasp the basics of fundamental particles in proper perspective, and equipped with the techniques used in studying these things.

UNIT 1: NUCLEAR SIZE AND SHAPE 08 LECTURES

General properties of nuclei: size, shape and charge distribution, spin and parity. muonic atoms and electron scattering, charge form factor, Magnetic dipole moment, electric quadruple moment and nuclear shape, Binding energy, semi-empirical mass formula.

UNIT 2: TWO-NUCLEON PROBLEM AND NUCLEAR FORCES 09 LECTURES

Deuteron problem, Deuteron ground state, excited states, two-nucleon scattering, n-p scattering, partial wave analysis, phase-shift, scattering length, p-p scattering (qualitative discussion),

Nature of the nuclear force, Charge symmetry and charge independence of nuclear forces. Exchange nature of nuclear forces, form of nucleon-nucleon potential, elementary discussion on Yukawa's theory.

UNIT 3. NUCLEAR MODELS 09 LECTURES

Liquid drop model, Bohr-Wheeler theory of fission, Experimental evidence for shell structure, single-particle Shell model, validity and limitations of Shell model., Spin-Orbit coupling, Magic numbers, Applications of Shell model like Angular momenta and parities of nuclear ground states.

UNIT 4. NUCLEAR DECAY 11 LECTURES

Elementary ideas of alpha decay and its selection rules, Beta and Gamma decay: Fermi's theory of beta decay, allowed and forbidden transitions, selection rules, non-conservation of parity in beta decay, direct evidence for the neutrino, gamma–decay and selection rules (derivation of transition probabilities not required). Fission and fusion. Nuclear reactions, reaction mechanism, compound nuclei and direct reactions.

UNIT 5. PARTICLE PHYSICS 11 LECTURES

Classification of fundamental forces. Elementary particles and their quantum numbers (charge, spin, parity, isospin, strangeness, etc.). Gellmann-Nishijima formula. Quark model, baryons and mesons. C, P, and T invariance. Application of symmetry arguments to particle reactions. Parity non-conservation in weak interaction. Relativistic kinematics

TEXT BOOKS/REFERENCE BOOKS:

1. Nuclear Physics : Irving Kaplan (Narosa), 2002.
2. Basic Ideas and Concepts in Nuclear Physics : K. Hyde (Institute of Physics) 2004
3. Introduction to High Energy Physics : D.H. Perkins (Cambridge University Press), 4th ed.2000.
4. Elementary Particles : I.S. Hughes (Cambridge University Press), 3rd ed. 1991.
5. Introduction to Quarks and Partons : F.E. Close (Academic Press, London), 1979.
6. Introduction to Particle Physics : M.P. Khanna (Prentice Hall of India, New Delhi),2004

Course outcomes:	
1.	Understand the fundamental principles and concepts governing classical nuclear and particle physics and have a working knowledge of their application to real-life problems,
2.	The students should be well versed by the end of the course by the basic building blocks of nature and the four fundamental interactions
3.	Students will get good theoretical basis of nuclear fission, nuclear fusion and energy production in stars.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-212	FIBER OPTICS & LASER DEPARTMENTAL ELECTIVE -I	3	1	-	4

Course Objectives:
This course will enable students to study the applications and operation of fiber optics and laser technology. The students will use a Fiber Optics and Lasers rainer to perform experiments and demonstrate basic fiber optic and laser communication. ➢ Demonstrate how codes, data, voice, radio and light are transmitted through optical fibers and over laser beams. ➢ Discuss the concepts of optics, optical repeaters, and attenuation, bending losses, optical coupling, optical terminations and the manufacture of optical fiber. ➢ Determine the characteristics and applications of laser light in modern technology. ➢ Perform experiments that demonstrate the principles of fiber optics and lasers. ➢ Generate communication techniques through the use of a fiber optic cable and a laser beam. ➢ Demonstrate advanced communication techniques using fiber optics and lasers.

UNIT-I: FIBER OPTICS 10 LECTURES

Optica1 fiber modes and configuration, fiber types, Ray optics, representation, mode of the circular waveguide, Waveguide equation, Wave equation for Step index fiber, Model equation, modes in step index fiber, power flow in step index fiber.

UNIT –II: LOSSES & WAVE GUIDE 10 LECTURES

Fiber Material fabrication attenuation, Absorption, Scattering losses. Radiative losses, Core & Cladding Losses, Signal distortion in optical waveguide, Information capacity determination, Group delay, Material Dispersion, Wave Guide Dispersion.

UNIT III: BASIC LASER THEORY 10 LECTURES

Historical background of laser, Einstein coefficients and stimulated light amplification: population inversion, creation of population inversion in three level & four level lasers.

UNIT IV: LASER AMPLIFIER 10 LECTURES

Interaction of photons with electrons and holes in a semiconductor, Rates of emission and absorption, Condition for amplification by stimulated emission, the laser amplifier.

UNIT-V LASER & ITS TYPES 10 LECTURES

Light Emitting Diode, Light source Material, Internal Quantum Efficiency, Modulation capability, Transient Response, Power band width product, LASER diode, LASER -diode structure and Threshold Conditions, Model properties and radiation pattern modulation.

TEXT BOOKS/REFERENCE BOOKS:

1. Optics Fibre: G. Keiser
2. Opto-e1ectronics: Ghatak
3. Introduction of Fiber Optics: Ajay Ghatak& K. Tyagrajan

Course outcomes:	
1.	To provide adequate knowledge about the Industrial applications of optical fibers
2.	To learn the basic elements of optical fiber transmission link, fiber modes configurations and structures
3.	To understand the different kind of losses, signal distortion in optical wave guides and other signal degradation factors.
4	To learn the various optical source materials, LED structures, quantum efficiency, Laser diodes
5	To expose the students to the Laser fundamentals
6	To provide adequate knowledge about basic principles of Laser
7	To provide adequate knowledge about Industrial application of lasers.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-213	ELECTRONICS -I	3	1	-	4

Course Objectives:
1. To acquire the basic knowledge of digital logic levels and application of knowledge to understand digital electronics circuits. 2. To prepare students to perform the analysis and design of various digital electronic circuits. 3. Design latches and flip-flops asthe basic circuit for Random-Access-Memory (RAM) and Read-Only-Memory (ROM) cells. Understand the mechanism ofsense amplifier and address decoder

UNIT I BASIC LOGIC CIRCUIT 10 LECTURES
Introduction of basic gates, universal gates, number systems and codes, Boolean algebra, switching characteristics of semiconductor devices. logic gate characteristics, Logic families- RTL, DTL, TTL, ECL interfacing , ECL and TTL, MOS logic MOSFET NAND and NOR gates, CMOS - NAND and NOR gates.

UNIT-II LOGIC DESIGN10 LECTURES 10 LECTURES
Minimization of Boolean functions, Karnaugh Map and Applications, Analysis and Synthesis of combinational circuit Simplification of boolean algebra using K-map, minterm and maxterm, design of binary adder, substractor , digital comparator, parity generator/checkers, priority encoder, BCD to 7segments decoder.

UNIT III. COMBINATIONAL LOGIC CIRCUITS: 10 LECTURES
arithmetic circuits – Half adders, Full adders; Digital Comparators, Encoders, Decoders, multiplexer, multiplexer tree, demultiplexer and demultiplexer tree.

UNIT IV SEQUENTIAL CIRCUIT DESIGN – I 10 LECTURES
Excitation table of flip flops – S-R, J-K , Master-Slave – JK, D and T flip flops, clocked flip flop design – conversion of one form of flip flop to another type. Different types of Counters: Ripple Counter, Asynchronous and Synchronous Counters, UP/Down Counters, Modulo (MOD) Counters.

UNIT V SEQUENTIAL CIRCUIT DESIGN-II 10 LECTURES
Shift Registers: Serial in ,Serial out, Parallel in Serial out Shift Registers, Parallel in Parallel out Shift registers, Bi directional Shift Registers, Shift register counters, Shift Register Application, Application of Counters. Introduction to Synchronous sequential Machines.

TEXT BOOKS/REFERENCE BOOKS:

Text Books
1. Thomas L Floyd “ Digital Fundamentals ”

Reference Books
1. M. Morris Mano. “Digital Logic and Computer Design”,
2. M . Morris Mano, “Digital Design”, Pearson Education Asia,

Course outcomes: After studying this course the students would gain enough knowledge	
1.	Have a thorough understanding of the fundamental concepts and techniques used in digital electronics.
2.	To understand and examine the structure of various number systems and its application in digital design
3	The ability to understand, analyze and design various combinational and sequential circuits
4	Ability to identify basic requirements for a design application and propose a cost effective solution.
5.	The ability to identify and prevent various hazards and timing problems in a digital design
6	To develop skill to build, and troubleshoot digital circuits.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-214	ELECTRONICS -II	3	1	-	4

Course Objectives: After completing this course the students should be able to:
1. Use transmission line analysis techniques.
2. Analyze waveguides structures propagating TE, TM or TEM modes, e.g., rectangular or circular waveguides, coaxial lines, surface wave lines, strip line, and microstrip lines.
3. Understand the concepts of microwave network analysis

UNIT-I MICROWAVE & OPTICAL DEVICES: 10 LECTURES

Microwave Electronics. Characteristics. feature of microwave Application of microwave, Generation of microwave by tubes, Limitation of conventional tubes, Klystron ,Reflex Klystron, Magnetron, Travelling wave tube.

Optical Devices: Laser and Laser resonator, LEDs, Semiconductor photo detectors; PINs and APDs, Photodiodes, APD, Photo conductor.

UNIT- II MICROWAVE MEASUREMENTS (FREQUENCY, POWER, IMPEDANCE). 10 LECTURES

Optical modulator: Electro optics modulation (amplitude and phase). Optical coupler: Coupling of light from one fiber to other with the use of evanescent wave, directional couplers, optical switch, phase and amplitude modulator.

UNIT- IV WAVE GUIDE AND TRANSMISSION NETWORKS: 10 LECTURES

Wave guides coaxial, rectangular and cylindrical; resonators; filters; couplers; branching networks. Antennas-dipole, array; reflectors, steering strip, microstrip and coplanar structure.

Feed back control systems: Feed back system, stability, performance criteria, servo systems, automatic control principle.

UNIT I: 8085 MICROPROCESSOR: - 10 LECTURES

Microprocessor and its architecture and its operation , Memory interfacing, Addressing Modes ,Memory Mapped I/O , Introduction to 8085/8080A Instructions , Data Transfer Operation , Arithmetic Operation , Logic Operations, Branch Operation , Writing Assembly Language programs , Interrupts , Timing Diagram and instruction execution in 8085.

UNIT II: INTERFACING I/O DEVICES: - 10 LECTURES

Basic interfacing concept , Interfacing output Displays , Interfacing Input Devices, Intel 8212 I/O port, Programmable Peripheral Interface Intel 8255 , Programmable Interrupt Controller Intel 8259A , Direct Memory Access (DMA) and 8257 DMA Controller. D/A Converter and A/D Converter.

TEXT BOOKS/REFERENCE BOOKS:

1. P. Bhattacharya - Semiconductor opto electronics devices.
2. R E Collin - Foundations of Microwave engineering.
3. S.Y.Liao – Microwave Devices on circuits.
4. J. Ryder – Networks, Lines and Field.
5. A. Papoulis – Signal Analysis
6. Electronic and Radio Engineering – F. E Terman.
7. Digital Electronics ByGoathmann.
7. Microwave: K.C. Gupta
2. Microwave circuits: A. Y. Liyo
9.Electronics communication system; George Kenedy

Course outcomes: This course supports the achievement of the following outcomes:	
1.	Ability to apply knowledge of advanced principles to the analysis of electrical problems.
2.	Ability to apply knowledge of advanced techniques to the design of electrical systems
3.	Ability to apply the appropriate industry practices, emerging technologies, state-of-the-art design techniques, software tools, and research methods for solving electrical problems

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-263	Electronics – I Lab	0	0	4	1

1. **To verify the truth table of Logic gates.**
2. **To verify the truth table of Universal Logic gates.**
3. **To study half adder**
4. **To study full adder**
5. **To study S-R flip flop**
6. **To study JK flip flop**
7. **To study JKMS flip flop**
8. **To study counters**
9. **To study Registers**
10. **Study of IC - 555 as astable Stable multivibrator**
11. **Study of IC - 555 as mono-stable multivibrator**
12. **Study of IC - 555 as bi-stable multivibrator**
13. **Design and study of an ECL OR- NOR circuit**

Note: Each student is required to perform at least 07 of the above experiments.

TEXT BOOKS/REFERENCE BOOKS

1. **Practical Digital Electronics by Nigel P. Cook - Goodreads**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-264	GENERAL PHYSICS LABORATORY-II	0	0	4	1

List of experiments:

Design and study of an active band pass filter

Design and study of an active phase shifter

Design and study of an active phase shifter

Write the following programs using 8085 Microprocessor

a) Addition of numbers using direct addressing mode

b) Subtraction of numbers using direct addressing mode

c) Addition of numbers using indirect addressing mode

d) 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) Arranging data in Ascending order

h) Arranging data in Descending order

i) Finding largest number

j0 Finding smallest number

Note: Each student is required to perform at least 07 of the above experiments.

TEXT BOOKS/REFERENCE BOOKS

1. **Microprocessor Architecture, Programming, and Applications with the 8085" by R Gaonkar**
2. **"The 8051 Microcontroller and Embedded Systems : Using Assembly and C" by Muhammad Ali Mazidi**
3. **"Advanced Microprocessors and Peripherals" by A K Ray and K M Bhurchandi**
4. **"Fundamentals of Microprocessors And Microcontrollers" Ram B**
5. **"Introduction to Microprocessors and Microcontrollers" by Crisp John Crisp**

SEMESTER-IV

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-221	MEASUREMENT TECHNIQUE	3	1	-	4

Course Objectives: After reading this syllabus readers should be able to:
This course is to get exposure with various aspects of instruments and their usage through hands on mode. Experiments listed below are to be done in continuation of the topics • Define and understand the basic elements of measuring behavioral outcomes. • Identify different types of behavioral outcomes and the measurement procedures for assessing them. • List and give examples of methods of constructing measures, along with the problems and biases that may arise when assessing constructs. • Identify and define different types of reliability, distinguishing among types of reliability and their unique insights into the assessment of outcomes. • Understand the basic knowledge of multimeter, voltmeter. • Understand the basic knowledge of CRO (Cathode ray oscilloscope). • Understand the basic knowledge of Signal Generators (function generator, pulse generator)

UNIT-I: BASIC OF MEASUREMENT: 10 LECTURES

Instruments accuracy, precision, sensitivity, resolution range etc.Errors in measurements and loading effects.Multimeter: Principles of measurement of dc voltage and dc current, ac voltage.

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

UNIT-II CATHODE RAY OSCILLOSCOPE: 10 LECTURES

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.

UNIT-III SIGNAL GENERATORS AND ANALYSIS INSTRUMENTS: 10 LECTURES

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.

UNIT-IV: IMPEDANCE BRIDGES & Q-METERS: 10 LECTURES

Block diagram of bridge. working principles of basic (balancing type) RLC bridge. Specifications of RLC bridge. Block diagram & working principles of a Q- Meter. Digital LCR bridges.

UNIT-V: DIGITAL INSTRUMENTS: 10 LECTURES

Principle and working of digital meters.Comparison of analog & digital instruments.Characteristics of a digital meter.Working principles of digital voltmeter.

Digital Multimeter: Block diagram and working of a digital multimeter. Working principle of time interval, frequency and period measurement using universal counter/ frequency counter, time- base stability, accuracy and resolution.

TEXT BOOKS/REFERENCE BOOKS:

Instruments & Instrumentation by A K Sawney

Course outcomes:After reading this syllabus readers should be able to:	
1.	The student will demonstrate an understanding of the basic principles, theories, and laws of physics through the description of physical systems and understanding of the physical environment in terms of the concepts listed in the course content.
2.	Students will demonstrate basic experimental skills by setting up laboratory equipment safely and efficiently, plan and carry out experimental procedures, and report verbally and in written language the results of the experiment.
3.	Students will demonstrate basic communication skills by working in groups on laboratory experiments and the thoughtful discussion and interpretation of their results and observations

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-222	NANO SCIENCE AND TECHNOLOGY DEPARTMENTAL ELECTIVE-II	3	1	-	4

Course Objectives:
Introduction to the underlying principles and applications of the emerging field of nanotechnology and nano-science along with able to practically synthesize and characterize the nano material. Moreover this course introduces tools and principles which are relevant at the nanoscale dimension. Current and future nanotechnology applications in engineering, materials, physics etc will be discussed.

UNIT-1: INTRODUCTION TO NANO SCIENCE AND NANO TECHNOLOGY 10 LECTURES

Introduction to nanomaterials, Properties of materials &nanomaterials, role of size in Nanomaterials: nanoparticles, semiconducting nanoparticles, nanowires, nanoclusters, quantum wells, thin films, nano-compositor and advantages. Introduction to Carbon Nanostructures: Graphene, fullerenes, Carbon Nanotubes.

UNIT-II: QUANTUM MECHANICS FORNANOSCIENCE 10 LECTURES

Electronic structure of 0-D, 1-D, 2-D, 3-D. Resonant tunneling quantized energy levels, Reflection and transmission by a potential step and by a rectangular barrier, band structure anddensity of states at Nanoscale. Semiconductor and metallic dots, optical spectra, Discrete chargestates, Electrical transport in 0-D, coulomb blockade phenomena.

UNIT-III: GROWTH TECHNIQUES OF NANOMATERIALS 10 LECTURES

Top-Down & Bottom-Up, Lithographic techniques, Non lithographic techniques, Fabrication ofNanomaterials by different Methods: -Inert gas condensation, Arc discharge, Sputtering, Laserablation, Laser pyrolysis, Ball Milling, Molecular beam epitaxy, Chemical vapour deposition,Electro deposition , chemical precipitation, Sol gel and green synthesis.

UNIT-IV: CHARACTERIZATION TOOLS OF NANOMATERIALS AND APPLICATIONS 10 LECTURES

X-ray diffraction, Scanning Electron Microscopy (SEM), Scanning Probe Microscopy (SPM),TEM, Scanning Tunneling Microscopy (STM), Atomic force Microscopy (AFM). UV-visible,FTIR and Raman spectroscopy.Nano sensors: biology and environment: Quantum dot, hetero structure laser and single electrondevices.

UNIT- V: CERAMIC MATERIALS 10 LECTURES

Refractories, silica and silicates, glasses, glass-forming constituents, types of glasses, perovskitestructure of mixed oxides, lime, cement, cement concrete, reinforced cement concrete (RCC),pre-stressed concrete, rocks and stones, clay and clay based ceramics, chemically bondedceramics.

TEXT BOOKS/REFERENCE BOOKS:

1. Poole and Owens: Introduction to Nanotechnology
2. Nanoscale materials -Liz Marzan and Kamat
3. Nanoscience& Technology: Novel structure and phenomea by Ping Sheng (Editor)
4. Nano Engineering in Science & Technology: An introduction to the world of nano design by Michael Rieth.
5. Nanotubes and Nanowires- CNR Rao and AGovindaraj RCS Publishing
6. Nalva (editor): Handbook of Nanostructured Materials and NanotechnologyOn successful completion of this course, students should be able to
Explain the nanoscale paradigm in terms of properties at the nanoscale dimension

Course outcomes: On successful completion of this course, students should be able to
Explain the nanoscale paradigm in terms of properties at the nanoscale dimension byapply key concepts in materials science, chemistry, physics, biology and engineering tothe field of nanotechnology and identification of current nanotechnology solutions indesign, engineering and manufacturing.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-223	ELECTRONIC COMMUNICATION SYSTEM (SPECIALIZATION ELECTIVE PAPER-III)	3	1	0	4

Course Objectives:
• To understand the building blocks of communication system. • To prepare mathematical background for communication signal analysis. • To understand and analyze the signal flow in a digital communication system. • To analyze error performance of a digital communication system in presence of noise and other interferences. • To understand concept of spread spectrum communication system.

UNIT I: INTRODUCTION TO COMMUNICATION SYSTEM **10 LECTURES**

Information transmitter, channel noise, receiver, need for modulation bandwidth requirements, noise and its types, representation of AM, frequency spectrum, power relations in AM wave, techniques for generation of AM, AM transmitter, AM receiver types, single and multi-super hetrodyne receivers, communication receivers

UNIT II: FREQUENCY MODULATION AND RADAR SYSTEM **10 LECTURES**

Description of FM systems, mathematical representation, comparison of wide band and narrow band FM, FM generation techniques, FM demodulators, FM receivers

UNIT-III: ANALOG MODULATION **10 LECTURES**

Fundamentals of modulation, Frequency spectra in AM modulation, power in AM modulated. class C amplifier, Efficiency modulation, linear demodulation of AM waves, frequency conversion, SSB system, Balanced modulation, filtering the signal for SSB, phase shift method, product detector,

UNIT IV: PULSE COMMUNICATION **10 LECTURES**

Information theory, Pulse modulation: PAM, PTM, PWM, PPM, PCM(in brief), pulse modulation, types of pulse modulation, pulse amplitude modulation (PAM), pulse width modulation (PWM), pulse position modulation (PPM) and pulse code modulation (PCM), PCM transmission system, telegraphy.

UNIT V: BROADBAND COMMUNICATION SYSTEM **10 LECTURES**

Frequency division multiplex (FDM), Time division multiplex (TDM), coaxial cables, fiber optics links, microwave links, tropospheric scatter links, submarine cables, satellite communication systems, elements of long distance telephony

TEXT BOOKS/REFERENCE BOOKS:

1. Haykin: Communication System
2. Kennedy: Electronics and communication system
3. Kulkarni: Microwave and radar engineering
4. Roddy and Coolen: Electronics Communication

Course outcomes:	
1.	After successfully completing the course students will be able to analyze the performance of a baseband and pass band digital communication system in terms of error rate and spectral efficiency
2.	Perform the time and frequency domain analysis of the signals in a communication system.
3.	Select the blocks in a design of digital communication system.
4.	Analyze Performance of spread spectrum communication system
5.	Gain knowledge and understanding of microwave analysis.
6.	Be able to apply analysis methods to determine circuit devices.
7.	Have knowledge of basic communication link design
8.	Have knowledge of how a transmission and waveguide element works in impedance matching and filter circuits.
9	Gain knowledge and understanding of microwave analysis
10	Be able to apply analysis methods to determine circuit devices.
11	Have knowledge of basic communication link design
12	Have knowledge of how a transmission and waveguide element works in impedance matching and filter circuits.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-224	ELECTRONIC DEVICES	3	1	0	4

Course Objectives: The aim of the course is to provide students with a thorough knowledge of Semiconductor
To understand operation of semiconductor devices. To understand DC analysis and AC models of semiconductor devices. To apply concepts for the design of Regulators and Amplifiers To verify the theoretical concepts through laboratory and simulation experiments. To implement mini projects based on concept of electronics circuit concepts

UNIT I: SEMICONDUCTOR DEVICES 12 LECTURES
Review of p-n junction, metal semiconductor and metal oxide semiconductor junctions, review of JFET, MESFET and MOSFET- their frequency limits. Noise: Signal to noise ratio (SNR) and enhancement of SNR in instrumentation and communication

UNIT II: MICROWAVE DEVICES 12 LECTURES
Tunnel diode, transfer electron devices (Gunn diode), Avalanche transit time devices (Reed, Impact diodes, parametric devices), vacuum tube devices, reflex klystron and magnetron.

UNIT III: MEMORY DEVICES 12 LECTURES
Volatile static and D-RAM, CMOS and NMOS, non volatile-NMOS, ferroelectric semiconductors, optical memories, magnetic memories, charge coupled devices (CCD), Piezoelectric, pyroelectric and magnetic devices, SAW and integrated devices.

UNIT IV: EXTERNAL PHOTOELECTRIC EFFECT DETECTOR: 12 LECTURES
Vacuum photodiode, photo-multipliers, micro-channels, Internal Photoelectric Effect detectors: PN junction photodiode, solar cell (open circuit voltage, short circuit current, fill factor), pin photodiode, avalanche photodiode, Photo-transistor, Light emitting diode.

UNIT V: RADAR SYSTEMS: 12 LECTURES
Basics principals, pulsed radar systems, moving targets indication, radar beacons, CW Doppler radar, frequency modulated CW radar, phased array radars, planar array, radar

TEXT BOOKS/REFERENCE BOOKS:

1. Integrated Electronics By Millman&Halkias.
2. Electronic Devices & Circuits By Millman&Halkias .
3. Electronic Circuits –Discrete And Integrated By Schilling Belov .
4. Micro Electronics ByMillman And Grabel.
5. Electronic Devices and Circuits – T.F. Bogart Jr., J.S.Beasley and G.Rico, Pearson Education, 6 th edition, 2004.

Course outcomes:	
1.	Maintain digital and analog devices and circuits.
2.	Analyze components associated with digital and analog electronic systems.
3.	Demonstrate proficiency in the use of electronic equipment and devices.
4.	Assist in the design, operation, and troubleshooting of electronic systems.
5.	Analyzing electronics devices and circuits using computer simulations.
6.	Solve electronic devices and systems using mathematical concepts.
7.	Accept professional and ethical responsibilities of the engineering technology profession.
8.	Communicate effectively in technical and non-technical environments

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-271	MEASUREMENT TECHNIQUE LAB	3	1	-	4

The test of lab skills will be of the following test items:

1. Use of an oscilloscope.

2. CRO as a versatile measuring device.

3. Circuit tracing of Laboratory electronic equipment,

4. Use of Digital multimeter/VTVM for measuring voltages

5. Circuit tracing of Laboratory electronic equipment,

6. Winding a coil / transformer.

7. Study the layout of receiver circuit.

8. Trouble shooting a circuit

9. Balancing of bridges

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.

6. Measurement of rise, fall and delay times using a CRO.

7. Measurement of distortion of a RF signal generator using distortion factor meter. 8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope

2. Converting the range of a given measuring instrument (voltmeter, ammeter)

Note: Each student is required to perform at least 07 of the above experiments.

TEXT BOOKS/REFERENCE BOOKS:

- **A text book in Electrical Technology - B L Theraja - S Chand and Co.**
- **Performance and design of AC machines - M G Say ELBS Edn.**
- **Electronic Devices and circuits, S. Salivahanan & N. S. Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk,2008, Springer Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
MPH-273	**ELECTRONIC COMMUNICATION SYSTEM (SPECIALIZATION ELECTIVE PAPER-III) Lab**	**3**	**1**	**0**	**4**

1. **Study of Amplitude modulation & demodulation.**
2. **Study of frequency modulation & demodulation.**
3. **Study of phase modulation & demodulation.**
4. **Study of Amplitude shift kaying.**
5. **Study of Phase shift kaying.**
6. **Study of Frequency shift kaying.**
7. **Study of Pulse Amplitude modulation & demodulation.**
8. **Study of Pulse frequency modulation & demodulation.**
9. **Study of pulse phase modulation & demodulation.**
10. **Study of pulse code modulation & demodulation.**

Note: Each student is required to perform at least 07 of the above experiments.

TEXT BOOKS/REFERENCE BOOKS

1. **Communication Systems Engineering (2nd Edition): John G. Proakis**
2. **Electronics Engineer's Reference Book - 6th Edition - Elsevier**
3. **Electronic Communication System by- Kennedy**

School of Basic Science & Humanities

SCHEME OF STUDIES AND SYLLABUS

DOCTOR OF PHILOSOPHY-PHYSICS

(2017-18 Batch Onwards)

Lingaya's Vidyapeeth, Faridabad

Deemed to be university (u/s of UGC act 1956)

(Approved By UGS, MHRD, AICTE, BCI, PCI & ACI)

SYLLABUS SCHEME

Ph.D. COURSE WORK

SN	COURSE NO.	COURSE NAME	L-T-P	CREDITS
1	GE 501	RESEARCH METHODOLOGY		4
2	DPH101-DPH106	ELECTIVE PAPER-I		4
3	DPH101-DPH106	ELECTIVE PAPER-II		4
4	DPH107	REVIEW WRITING AND PRESENTATION/SEMINAR		Audit Course

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
GE 501	RESEARCH METHODOLOGY	0	0	0	4

UNIT-I RESEARCH METHODOLOGY:
Introduction, Objectives of Research, Types of Research, Criteria of good research, research process, necessity of defining the problem, hypothesis.

UNIT-II RESEARCH DESIGN:
Needs of research design, features of a good design, different research designs, dependent and independent variables, extraneous variables, developing a research plan.

UNIT-III: SAMPLING DESIGN:
Steps in sample design, Criteria of selecting a sample procedure, types of sample designs, non probability sampling, probability sampling, random sampling, cluster sampling.

UNIT-IV MEASUREMENT AND SCALING TECHNIQUES:
Measurement scales, sources of error in measurement, test of validity, test of reliability, scaling, scaling techniques – rating scales, scale construction techniques.

UNIT-V DATA COLLECTION:
SourcesofData collection, observation method, interview method, methods of data collection, difference between survey and experiment, Data Processing - Editing, Coding, classification and tabulation.

UNIT-VI DATA INTERPRETATION AND ANALYSIS:
Chi-Square test, ANOVA, Coding method, two-way ANOVA, Sign test, Run test, Wilcoxon- Mann-Whitney test, measurement of central tendency, measurement of dispersion, normal probability curve, Correlation.

UNIT-VII REPORT WRITING:
Types of reports, contents of report, style of reporting and steps in drafting of report

Reference Books

1) **R. Panneerselvam, Research Methodology, 3rd edition, Prentice Hall of India, 2004**
2) **Kotare C. K. Research methodology – Methods and Techniques, 2nd edition, New Age International, New Delhi, 2004**
3) **Montgomery, Douglas C. &Runder, George C., Applied Statistics & Probability for Engineers, 3rd Edition, Wiley India, 2007**
4) **Ranjit Kumar, Research Methodology, 2nd Edition, Pearson Publications, 2005**
5) **A. B.I.M. Hasouneh, Research Methodology, Sublime Publications**

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COURSE CODE	COURSE TITLE	L	T	P	CREDITS
DPH101	COMPUTATIONAL MODELLING AND NUMERICAL TECHNIQUES	0	0	0	4

UNIT-I: FUNDAMENTALS OF COMPUTERS:
Computer fundamentals, hardwares and softwares, different operating systems, application programmes, some tips on PC maintenance and servicing of PC.

UNIT-II: COMMON APPLICATIONS OF COMPUTERS:
Working in a Linux environment, basic Linux commands, writing scientific documents with Latex, graphic and visualization, gnuplot;

UNIT-III: SOFTWARE TOOLS FOR PROGRAMING:
introduction to other useful software tools e.g. mathematica, MATLAB.Programming language(s): C and C++.

UNIT IV: BASIC NUMERICAL METHODS:
Numerical integration (trapezoidal and Simpson's method), numerical differentiation; Diagonalization and inverse of symmetric and non-symmetric matrices, Eigenvalues and eigenvectors; Root finding (bisection and Newton-Raphson method); Interpolation techniques; Solution of ordinary differential equations (Euler and Runge-Kutta methods)

UNIT V: STATISTICS AND TREATMENT OF EXPERIMENTAL DATA:
Data acquisition system, error propagation, curve fitting, Least square method, Sampling and parameter estimation, the maximum likelihood method.

UNIT VI: FOURIER TRANSFORMATIONS:
Analysis of a time series and search for periodicity. FFT (Fast Fourier transformation) and power spectrum and any other topics used in physics researches.

UNIT VII: SIMULATION AND MONTE CARLO METHOD:
Simulation of Random variables, discrete and continuous. Calculation of integrals.Monte Carlo evaluation ofpi. Simulation of simple processes: coin tossing or dice throwing game. Examples and applications.

REFERENCES:

1. **Numerical methods for Scientific and Engineering Computation: M.K.Jain, S.R.K.Iyengar and R.K.Jain. (Wiley Eastern Limited),**
2. **Fortran 77 and Numerical Methods: C.Xavier (New Age International Publishers),**
3. **Techniques for Nuclear and Particle Physics Experiments, A How to approach: W.R.Leo (Narosa Publishing House)**
4. **Numerical Recipes: W.Presset.al., (Cambridge University Press).**
5. **Data reduction and error analysis for the Physical Sciences, 3e, Philip R Bevington& D. Keith Robinson . McGraw Hill (2003).**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
DPH102	CONDENSED MATTER PHYSICS	0	0	0	4

UNIT I: PHYSICAL APPLICATIONS OF GROUP THEORY IN CRYSTALS:
Theory of group representation,crystal symmetry operators; Crystallographic point groups. Representation of threedimensional rotation group. Crystal field splitting and other related problems.

UNIT II: ELASTIC SCATTERING OF WAVES:
Interference of Waves, Elastic scattering by Crystals,Experimental Techniques, Scattering from surfaces, Scattering from amorphous solids.

UNIT III: LATTICE DYNAMICS AND THIN FILM:
Band theory and band structure, Lattice dynamics, Thin Films, different methods of film preparation, condensation, nucleation andgrowth, defects, characterization, Size effect on transport properties, thin film semiconducting devices.

UNIT IV: MAGNETIC PROPERTIES:
Background, Quantum theory of magnetism, Diamagnetism and Para magnetism, Ferromagnetism, Ferri and anti ferromagnetism, Spin waves, Magnetic resonance Phenomenon, Magnetic thin films

UNIT V: THEORETICAL TECHNIQUES IN CONDENSED MATTER PHYSICS:
Theory of NMR techniques, Theory of Anharmonic solids, Theory of Liquid state, BCS theory.

UNIT VI: SYNTHESIS AND MEASUREMENT TECHNIQUES IN CONDENSED MATTER PHYSICS:

- i. **High Vacuum: Diffusion Pump, Turbo Molecular Pump, Gauges for measuring high vacuum.**
- ii. **Preparation of Materials: Crystal Growth, Amorphous materials, Nano materials, Polymers by different techniques.**
- iii. **Device Fabrication: Oxidation Diffusion, Ion Implantation, Metallization, Lithography and Etching, Bipolar and MOS device fabrication.**

UNIT VII: MEASUREMENT TECHNIQUES IN CONDENSED MATTER PHYSICS:

- i. **Characterization Techniques: Impedance, TEP, AFM, TEM, SIMS, micro-Raman, Luminescence, Ellipsometry.**
- ii. **Applications of Condensed Matter Physics to LED, DSSC, SENSORS, TRANSISTORS, Flexible electronics, Organic electronics, printing electronics, 3D Printing.**

REFERENCES:

1. **Introduction to Solid State Physics by C Kittel**
2. **Solid State Physics by N W Ashcroft and N D Mermin**
3. **Solid State Physics by A.J. Dekker M. Tinkham, Group Theory and Quantum Mechanics, Dover Publications, 2003**
4. **N.W.Ashcroft and N.D. Mermin, Solid State Physics, Brooks Cole, 1976**
5. **J. Richard Christman, Solid State Physics, John Wiley, 1988**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
DPH103	ADVANCE OPTICS	0	0	0	4

UNIT I: FOURIER OPTICS:
Propagation of light in free space- transfer function of free space, Optical Fourier Transform, Fourier transform using a lens, image formation and spatial frequency filtering, Fourier Transform Holography.

UNIT II: POLARIZATION OPTICS:
Polarization of Light, Optics of anisotropic media: The index ellipsoid. Optical activity and Faraday effect. Polarization devices: Wave retarders, rotators and optical isolators.

UNIT III: STATISTICAL OPTICS:
Statistical properties of Light, Temporal Coherence and Spectrum, Degree of Coherence, Spatial coherence, Mutual coherence function, longitudinal coherence. Interference and Transmission of Partially Coherent Light.

UNIT IV: LIGHT PROPAGATION:
Brief review of electromagnetic waves; Light propagation through anisotropic media, Propagation of light in dense optical medium, Electromagnetism in dielectrics, Electromagnetism fields and Maxwell equation.

UNIT V: NON-LINEAR OPTICS:
Pockels and Kerr Effect- Electro-optics of Anisotropic media, Phaseand amplitude modulators. Non-linear optical media, second order non-linear optics- SHG, Threewave mixing. Third order non-linear optics, THG and self-phase modulation. Four wave mixing and Optical Phase conjugation; Frequency conversion, Parametric Amplification and Oscillation; Self-focusing of light.

UNIT VI: LASERS AND SPECTROSCOPY:
Molecular band absorption, spectroscopic characterization techniques: Infra red,Raman and Fluorescence spectroscopy; Threshold condition of laser oscillation: variation of laser power around threshold, ultimate line width oflasers, Modern atomic spectroscopy – cold atoms and Doppler free spectroscopy etc; single atomspectroscopy etc.

UNIT VII: QUANTIZATION OF ELECTROMAGNETISM:
Quantization of the electromagnetic field; Number states; Coherent states and their properties; Squeezed states of light and their properties; Application of optical parametric processes to generate squeezed states of light; Entangled states and their properties.

REFERENCES:

1. A. Ghatak& K. Thyagarajan : Optical Electronics (Cambridge University Press)
2. Fundamentals of Photonics: B.E.A. Saleh and M.C. Teich
3. A. Yariv : Quantum Electronics (Wiley, New York)
4. M. Young : Optics and Lasers (Springer Verlag)

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
DPH104	BIO-PHYSICS	0	0	0	4

UNIT I: STRUCTURE & FUNCTIONS:
Intermolecular and surface forces relevant to bio-systems,(Vander Waals, hydration, steric, hydrophobic forces etc). Cell & its organelles - structure and function DNA, RNA and Protein - structure and function

UNIT II: PHYSICO-CHEMICAL &PHOTOBIOLOGICAL PROCESSES:
Diffusion,Osmosis,Centrifugation/,Viscosity,Columnchromatography,Gel-electrophoresis,Autoradiography etc Photosynthesis , Two Photochemical Systems , Chloroplasts , The Mechanism of Photosynthesis , The Molecular Mechanism of Photosynthesis , Bacteriorhodopsin

UNIT III: PHYSICS OF MEMBRANES AND NERVE IMPULSE:
Cell Membranes and their structure, Measurement of mechanical properties of membranes using micropipette aspiration, Effect of additives, such as cholesterol, peptides etc on the membranes, Active membranes. , Conformational Properties of Membranes, Passive Membrane Transport, Active Membrane Transport, Transport of Charged Particles through Membranes , Molecular Reception.

Physics of the Nerve Impulse: The Axon and the Nerve Impulse, Propagation of the Nerve Impulse Generation of the Nerve Impulse , Ionic Channels, Synaptic Transmission.

UNIT IV: EXPERIMENTAL TECHNIQUES IN BIO-PHYSICS-I:

Spectroscopic techniques: Introduction to spectroscopy, basic principles, instrumentation and applications of UV-VIS absorption, infrared, Raman, atomic absorption, fluorescence, Laser spectroscopy, electron spin resonance, acoustic spectroscopy; Fourier transform techniques; applications of Laser; mass spectroscopy

UNIT V: EXPERIMENTAL TECHNIQUES IN BIO-PHYSICS-II:

Microscopy: Principle, instrumentation and application of Microscopy, a) Electron Microscopy (i) Scanning Electron Microscopy (ii) Transmission Electron Microscopy b) Confocal fluorescence microscopy

UNIT VI: EXPERIMENTAL TECHNIQUES IN BIO-PHYSICS-III:

Separation techniques: Electro-kinetics methods: electrophoresis, electrophoretic mobility (EPM), factors affecting EPM, Paper, PAGE, Capillary, Iso-Electric focusing, applications in biology and medicine. HPLC: mobile phase systems, modes of operations, application, Hydrodynamics method:

UNIT VII: BIO INSTRUMENTATION:

X-Ray Diffractometer (XRD), Dynamic Thermal Analyser/Thermogravimetric Analyzer (DTA/TGA),Ultrasound, nuclear magnetic resonance, positron emission topography whole body scanner, dose calibrators, gamma scintillation camera, digital imaging techniques, acquisition, analysis and processing of data from gamma camera, enhancement, topographic reconstruction, display and recording of image,

REFERENCES:

1. **Physical Chemistry for Life Sciences, Peter Atkins and Julio de Paula, 2006, Oxford Press**
2. **Introduction to Biophysics by Cortell**
3. **Tex Book of Biophysics , R N Roy, New Central Agency (P) Ltd, Culcutta**
4. **Methods in Molecular Biophysics, Igor N S, N Zaccai& J Zaccai, (2007) Cambridge**
5. **Principle of Biochemistry, D Voet, J Voet and CW Pratt, 3rd Ed,**
6. **Essential Biophysics, Narayanan, New Age Publications**
7. **Handbook of Molecular Biophysics (Methods & Application), 2009, HG Bohr, Wiley**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
DPH105	NANO SCIENCE & NANO TECHNOLOGY	0	0	0	4

UNIT I: CONCEPT OF NANOMATERIALS:

Foundations of Quantum and Statistical Mechanics for nanomaterials, idea of tunneling, bound state and scattering, notion of quasiparticles, Light matter interaction; DOS, Bose-Einstein and Fermi-Dirac Statistics; Properties of individual nanostructures; Bulk nanostructured materials; Selection rules

UNIT II: NANOSCALE MEASUREMENT & ANALYSIS-I:

Thermocouple and thermistor as temperature sensor (sensor calibration and PID control), LVDT characteristics, Strain gauge: Calibration and signal conditioning, B-H loop of nanomaterials (SQUID-VSM), Magnetoresistance of thin films and nanocomposite, electrical measurements (I-V, C-V, R-T characteristics) and transient response, Design of Ferrite core for transformer and its performance evaluation.

UNIT III: NANOSCALE MEASUREMENT & ANALYSIS-II:

XRD, Phase analysis of binary mixture; indexing of XRD peaks and lattice structure refinement.Selective area electron diffraction: Software based structural analysis based on TEM based experimental data from published literature, Surface Morphological study (AFM, MFM, STM, SEM, Kelvin Probe). Compositional Analysis (EDX, RBS), Optical Characterization (UV-Visible, Raman, Fluoroscence, phosphorescence, FTIR), Luminescence.

UNIT IV: THIN FILM TECHNOLOGY:

Introduction to thin films, Technology as a drive and vice versa; Structure, defects, thermodynamics of materials, mechanical kinetics and nucleation; grain growth and thin film morphology; Basics of Vacuum Science and Technology, Kinetic theory of gases; gas transport and pumping; vacuum pumps and systems; vacuum gauges; oil free pumping; aspects of chamber design from thin film growth perspectives; various Thin film growth techniques with examples and limitations.

UNIT V: DATA FITTING METHODS IN NANOSCIENCE:
Programming fundamentals, Flow Chart, plotting, fitting data, building new functions, and making iterations and loops; Application on elementary numerical methods (e.g., Taylor-series summations, roots of equations, roots of polynomials, systems of linear and nonlinear algebraic equations, integration);

UNIT VI: MATHEMATICAL TOOLS FOR NANOSCIENCE:
Ordinary differential equations with constant coefficients, Boundary value problems and applications to quantum mechanics, Numerical solution of ordinary differential equations, Numerical solution of partial differential equations.

UNIT VII: THEORY AND MODELLING IN NANOSCIENCE:
Molecular Dynamics, Monte Carlo Methods;Computations of Phase Transition under Confinement;General Basis for predicting physical properties of nanocrystals and large clusters;Quantum Confined Systems & computational techniques; Computational Electrodynamics Methods;Large Scale Electronic Transport Calculations;Density Functional Calculations in Carbon Nanotubes;Time Dependent Density Functional Theory;Computational Study of Nanotubes; Excited State Properties (GW, BSE).

REFERENCES:

1. **Nanotechnology, By Lynn E. Foster, Pearson (2011).**
2. **Fundamentals and Applications of Nanomaterials, by Z. Guo and Li Tan.**
3. **Neutron and X- Ray Spectroscopy (Paperback) By Francoise Hippert, Erik Geissler, Jean Louis Hodeau, Springer, 2001.**
4. **Scanning Electron Microscopy and X-ray Microanalysis by Joseph Goldstein, Dale E. Newbury, David C. Joy and Charles E. Lyman (Feb 2003), Springer.**
5. **Handbook of Thin Film Deposition (Materials and Processing Technology), Krishna Seshan.**
6. **Handbook of Physical Vapor Deposition, D. M. Mattox.**
7. **Handbook of Theoretical and Computational Nanotechnology, M. Rieth and W. Schommers.**
8. **Computational Nanoscience (RSC Theoretical and Computational Chemistry) yr. 2011.**
9. **Nano Structures: Theory & Modeling, year 2004**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
DPH106	HIGH ENERGY PARTICLE PHYSICS	0	0	0	4

UNIT I: ELEMENTARY PARTICLES:
Elementary particles (quarks, baryons, mesons, leptons); Spin and parity assignments, isospin, strangeness; Gell-Mann-Nishijima formula; C, P, and T invariance and applications of symmetry arguments to particle reactions, parity non-conservation in weak interaction; Relativistic kinematics.

UNIT II: ACCELERATORS:
Introduction to Accelerators; Types of Accelerators: High voltage dc and r. f. accelerators, Cyclotron, Betatron , Synchrotron and Linear accelerators, Van de Graaff generator, Tandem accelerator, Pelletron accelerator.

UNIT III: ION SOURCES:
Freemen ion beam source, Penning ion source, Sputtered ion source, Duoplasmatron ion source, Negative ion beam sources, Electron Cyclotron Resonance (ECR) ion beam sources, LASER ion source. Beam switch yard: conventional magnet and superconducting magnet Beam optics, Beam profile monitor, Faraday cup, Quadrupole. Accelerator driven systems: Injection and extraction, Vacuum systems.

UNIT IV: APPLICATION OF ACCELERATORS:
Ion implantation, Surface modifications and research, Materials analysis, Nuclear physics, High energy Physics studies, Production of medical isotopes, Radiotherapy, Radiation and Safety.

UNIT V: THEORETICAL TECHNIQUES IN PARTICLE PHYSICS:
Covariant Perturbation theory, Feynman Rules for spin 0 and spin ½ particles and their applications; Like groups: SU(2), SU(3) and SU(5) and theirapplications : HiggsMechanism and Goldstonetheorem and its application in gauge theories.

UNIT VI: EXPERIMENTAL TECHNIQUES IN PARTICLE PHYSICS:
Relativistic kinematics, Four vectors & invariants, some practical examples for use of invariants. Transformation of differential cross-section; Monte Carlo calculations and its applications, typical uses of Monte Carlo techniques to High Energy particle physics.

UNIT VII: SCOPE AND TRENDS IN HIGH ENERGY RESEARCH:
Recent trends of research in particle Physics, Scope of the High Energy research, Future advantages of High Energy Research

REFERENCES:

1. **Accelerator Physics by Y Lee, [World Scientific 1999]**
2. **An Introduction to Particle Accelerators by Edmund Wilson, [Oxford University Press 2001]**
3. **Handbook of Accelerator Physics and Engineering by Alex Chao, [World Scientific 1999]**
4. **An Introduction to the Physics of Particle Accelerators by Mario Conte and William W McKay, [World Scientific 1991]**
5. **Techniques for Nuclear and Particle Physics Experiments, W R Leo**
6. **Radiation Detection and Measurement, G F Knoll**

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
DPH107	REVIEW WRITING AND PRESENTATION/SEMINAR	0	0	0	4

The scholar has to prepare one seminar paper for presentations in power point (which includes text, graphs, picture, tables, reference etc.); oral in power-point/poster; development of communication skills in presentation of scientific seminars- eyeto eye contact, facing to audience, question & answer sessions etc. will be observed by expert (internal/external) for satisfactory completion of the course work with a significance that the scholar is in position to communication his research work to scientific journals for publication.

LINGAYA'S VIDYAPEETH
choose to know
(u/s 3 of UGC Act 1956)

School of Basic Science & Humanities

SCHEME OF STUDIES AND SYLLABUS

B. TECH.- PHYSICS

(2017-18 Batch Onwards)

Lingaya's Vidyapeeth, Faridabad

Deemed to be university (u/s of UGC act 1956)

(Approved By UGS, MHRD, AICTE, BCI, PCI & ACI)

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BSC 101	PHYSICS	3	1	0	-

Course Objective
The Engineering Physics program provides Engineering Physics majors with a quality undergraduate education in liberal studies, mathematics, science and engineering to prepare them to, within a few years after graduation: • have attained positions as professionals in industry, government, or academia; • have become responsible, accountable, current professionals who work effectively in multidisciplinary teams, readily adapt to broad technical challenges, and demonstrate leadership.

UNIT I: ELECTROSTATICS AND MAGNETOSTATICS (12 LECTURES)

Calculation of electric field and electrostatic potential for a charge distribution; Divergence and curl of electrostatic field; Laplace's and Poisson's equations for electrostatic potential, Boundary conditions of electric field and electrostatic potential; method of images; energy of a charge distribution and its expression in terms of electric field.

Bio-Savart law, Divergence and curl of static magnetic field; vector potential and calculating it for a given magnetic field using Stokes' theorem; the equation for the vector potential and its solution for given current densities.

UNIT II: MECHANICS (8 LECTURES)

Transformation of scalars and vectors under Rotation transformation; Forces in Nature; Newton's laws and its completeness in describing particle motion; Form invariance of Newton's Second Law; Solving Newton's equations of motion in polar coordinates; Problems including constraints and friction; Extension to cylindrical and spherical Coordinates

UNIT III: QUANTUM MECHANICS (8 LECTURES)

Introduction to Quantum mechanics, Wave nature of Particles, Time-dependent and time independent Schrodinger equation for wave function, Born interpretation, probability current, Expectation values, Free-particle wave function and wave-packets, Uncertainty principle.

UNIT IV: WAVE OPTICS (10 LECTURES)

Huygens' principle, superposition of waves and interference of light by wave front splitting and amplitude splitting; Young's double slit experiment, Newton's rings, Michelson interferometer, Mach-Zehnder interferometer.

Fraunhauffer diffraction from a single slit and a circular aperture, the Rayleigh criterion for limit of resolution and its application to vision; Diffraction gratings and their resolving power.

UNIT V: LASERS (8 LECTURES)

Einstein's theory of matter radiation interaction and A and B coefficients; amplification of light by population inversion, different types of lasers: gas lasers (He-Ne, CO2), solid-state lasers (ruby, Neodymium), dye lasers; Properties of laser beams: mono-chromaticity, coherence, directionality and brightness, laser speckles, applications of lasers in science, engineering and medicine.

TEXT/REFERENCE BOOKS

(i) David Griffiths, Introduction to Electrodynamics.
(ii) W. H. Hayt and J. A. Buck. Engineering Electromagnetics.
(iii) Engineering Mechanics, 2nd ed. — MK Harbola.
(iv) Introduction to Mechanics — MK Verma
(v) Eisberg and Resnick, Introduction to Quantum Physics
(vi) D. J. Griffiths, Quantum mechanics.
(vii) A. Ghatak, Optics
(viii) O. Svelto, Principles of Lasers

Course Outcomes
Physics is one of the foundation subjects to all engineering disciplines and the study in engineering physics is aimed at blending a strong physics component with relevant engineering backgrounds. The core objective is to provide a coherent foundation of physics for all majors that are usually necessary to work in areas such as computer science, electronic industry, mechanical domains and communication

technologies. The contents are based on the static and dynamic state of elementary physics resulting in the field theory and wave mechanics the matter.

COURSE CODE	COURSE TITLE	L	T	P	CREDITS
BSC 151	PHYSICS LAB	0	0	2	-

1) **To study response curve of a series LCR circuit.**
2) **To determine the Planck's constant using LEDs.**
3) **To determine the Rydberg's constant of Hydrogen atom.**
4) **To find the refractive index and Cauchy's constants of a prism.**
5) **To find the wavelength of light by Newton's rings experiment.**
6) **To determine the thickness of a thin wire by interference.**
7) **To determine the wavelength of LASER using diffraction grating.**
8) **To determine the resolving power of a telescope.**
9) **To find the numerical aperture of an optical fiber cable.**
10) **To find the wavelength of light using Michelson's interferometer.**