Rev: 04

SYLLABUS

For

3 YEARS BSC PHYSICS PROGRAMME

(Revised Syllabus Approved by Academic Council)

Dept. of Physics

JUNE, 2018

UNIVERSITY OF SCIENCE &TECHNOLOGY, MEGHALAYA

Techno City, 9th Mile, Baridua, Ri-Bhoi, Meghalaya, 793101

DEPARTMENT OF PHYSICS
(SCHOOL OF APPLIED SCIENCES)
UNIVERSITY OF SCIENCE & TECHNOLOGY, MEGHALAYA
ACADEMIC YEAR: 2017-2018

About the Department:
The department of Physics was established in 2016 with the aim of educating students in the diverse fields of Physics and there by inculcating the scientific temperament for the overall development of the society through science, and technology.

About the Programme:
The aim of physics is to study the laws of nature at its most fundamental level. The application of natural laws governed by force and motion, matter and energy, space and time etc. leads to new discoveries in science. These discoveries in science generate the technological advances that continue to drive the economic engines of the world. It not only contributes to the development of scientific as well as technological infrastructure but also provides trained personnel needed to take advantage of such scientific advances and discoveries. In order to produce such skilled human resources we are providing Bachelor Degree in Physics at University of Science & Technology, Meghalaya (USTM). The curses under this programme cover diverse fields of Physics from Newtonian developments to the advanced recent day physics. The proramme is designed as per choice based credit system (CBCS), in order to meet the demand of the present day multidisciplinary/interdisciplinary learning and research environment. Efforts are exerted to update the courses time to time through consultation with experts from different national/international experts to meet the excellence.

Programme Details

Programme Name	**Duration**
Bachelor of Science (B.Sc.) in Physics	3 Years (Four Semesters)

Programme Objectives (PO):
The curriculum for the B.Sc. in Physics is designed to equip the students with advanced knowledge in diverse areas of physics. The duration of the progarmme is of six semesters. The primary theory and practical courses are Mathematical Physics, Waves and Optics, Electricity, Magnetism, Electronics, Thermal Physics, Nuclear physics, Quantum Mechanics, Solid state physics, Electromagnetic Theory and Statistical mechanics. In addition to these regular courses, optional courses, and courses offered by allied departments are also included. Almost for all the courses, the activities performed during the course delivery, are leading to skill, entrepreneurial, as well as personality developments. The intended outcome of a bachelor's degree course is to prepare a student for his/her brighter career in the field of study. The syllabus for this particular course caters to the said specific purpose for the students.

Programme Structure: The B.Sc. programme is a three year programme divided into six semesters. The programme is minimum of 140 credits. For the award of degree a student will be required to complete the credits as per the University norm.

Year	**Odd Semester**	**Even semester**
First Year	Semester I	Semester II
Second Year	Semester III	Semester IV
Third Year	Semester V	Semester VI

Course Content

SEMESTER-I

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
BSP-101	Mathematical Physics-I **(CC-1)**	4	T	30	70	100
BSP-102	Mechanics **(CC-2)**	4	T	30	70	100
BSP-103	Mathematical Physics-I Practical **(CC-1-P)**	2	P	15	35	50
BSP-104	Mechanics Practical**(CC-2-P)**	2	P	15	35	50
BSC-711	Organic, Inorganic and Physical Chemistry-I **(GE-1)**	4	T	30	70	100
BSC-712	Organic Chemistry Lab **(GE-1-P)**	2	P	15	35	50
BEN-711	Communicative English **(AECC-1)**	4	T	30	70	100
Total		**22**				**550**

SEMESTER-II

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
BSP-201	Electricity and Magnetism **(CC-3)**	4	T	30	70	100
BSP-202	Wave and Optics **(CC-4)**	4	T	30	70	100
BSP-203	Electricity and Magnetism Practical **(CC-3-P)**	2	P	15	35	50
BSP-204	Wave and Optics Practical**(CC-4-P)**	2	P	15	35	50
BSC-721	Organic, Inorganic and Physical Chemistry-II **(GE-2)**	4	T	30	70	100
BSC-722	Inorganic Chemistry Lab **(GE-2-P)**	2	P	15	35	50
*BEV-720	Environmental Science **(AECC-2)**	4	T	30	70	100
Total		**18**				**550**

SEMESTER-III

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
BSP-301	Mathematical Physics-II**(CC-5)**	4	T	30	70	100
BSP-302	Thermal Physics**(CC-6)**	4	T	30	70	100
BSP-303	Digital Systems and Applications**(CC-7)**	4	T	30	70	100
BSP-304	Mathematical Physics-II Practical **(CC-5-P)**	2	P	15	35	50
BSP-305	Thermal Physics Practical **(CC-6-P)**	2	P	15	35	50
BSP-306	Basic Instrumentation Skills **(SEC-1)**	2	T	15	35	50
BSM-731	Classical Algebra and Trigonometry **(GE-3)**	4	T	30	70	100
BSM-732	Vector Analysis **(GE-3-T)**	2	T	15	35	50
Total		**24**				**600**

CC: Core Course; **AECC:** Ability Enhancement Compulsory Course; **SEC:** Skill Enhancement Course; **DSE:** Discipline Specific Elective; **GE:** Generic Elective **(**Multidisciplinary Course)

SEMESTER-IV

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
BSP-401	Nuclear and Particle Physics **(CC-7)**	4	T	30	70	100
BSP-402	Elements of Modern Physics**(CC-8)**	4	T	30	70	100
BSP-403	Analog Systems and Applications **(CC-9)**	4	T	30	70	100
BSP-404	Nuclear Physics and Electronics Practical **(CC-7-P)**	2	P	15	35	50
BSP-405	Elements of Modern Physics Practical**(CC-8-P)**	2	P	15	35	50
BSP-406	Applied Optics **(SEC-2)**	2	T	15	35	50
BSM-741	Calculus **(GE-4)**	4	T	30	70	100
BSM-742	Abstract Algebra **(GE-4-T)**	2	T	15	35	50
Total		**24**				**600**

SEMESTER-V

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
BSP-501	Quantum Mechanics & Application **(CC-9)**	4	T	30	70	100
BSP-502	Solid State Physics **(CC-10)**	4	T	30	70	100
BSP-503	Discipline Specific Elective **(DSE-1)**					
A	Classical Dynamics	4	T	30	70	100
B	Applied Dynamics					
BSP-504	Discipline Specific Elective **(DSE-2)**					
A	Nanomaterials and Applications	4	T	30	70	100
B	Advanced Mathematical Physics					
BSP-505	Quantum Mechanics Practical **(CC-9-P)**	2	P	15	35	50
BSP-506	Solid State Physics Practical **(C-10-P)**	2	P	15	35	50
BSP-507	Discipline Specific Elective **(DSE-1-P/T)**					
A	Introduction to Biophysics	2	T	15	35	50
B	Applied Dynamics Practical		P			
BSP-508	Discipline Specific Elective **(DSE-2-P)**					
A	Nanomaterials and Applications Practical	2	P	15	35	50
B	Advanced Mathematical Physics Practical					
Total		**24**				**600**

CC: Core Course; **AECC:** Ability Enhancement Compulsory Course; **SEC:** Skill Enhancement Course; **DSE:** Discipline Specific Elective; **GE:** Generic Elective **(**Multidisciplinary Course)

SEMESTER-VI

Course Code	Title	Credit	Nature of course (T/P)	Marks Allotted		
				Internal	End Semester	Total
BSP-601	Electromagnetic Theory **(CC-9)**	4	T	30	70	100
BSP-602	Statistical Mechanics **(CC-10)**	4	T	30	70	100
BSP-603	Discipline Specific Elective **(DSE-3)**					
A	Mathematical Physics III	4	T	30	70	100
B	Introduction to Earth Science					
BSP-604	Discipline Specific Elective **(DSE-4)**					
A	Astronomy and Astrophysics	4	T	30	70	100
B	Physics of Devices and Instrumentation					
BSP-605	Electromagnetic Theory Practical **(CC-9-P)**	2	P	15	35	50
BSP-606	Statistical Mechanics Practical **(C-10-P)**	2	P	15	35	50
BSP-607	Discipline Specific Elective **(DSE-3-P/T)**					
A	Mathematical Physics III Practical	2	P	15	35	50
B	Basic Atmospheric Physics		T			
BSP-608	Discipline Specific Elective **(DSE-4-P/T)**					
A	Astronomy and Astrophysics Practical	2	P	15	25	50
B	Physics of Devices and Instrumentation Practical		T			
BSP-609	Dissertation **(Compulsory)**	4	P	15	35	50
Total		**28**				**650**

Non-Credit Compulsory course

HVP-760	Human Values and Professional Ethics	--	T	15	35	50

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Course Code: BSP-101
MATHEMATICAL PHYSICS-I
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know about 1st and 2nd order differential equation and then method of finding complementary functions and particular integrals. 2. Understand vector algebra. Scalar and vector fields. 3. Learn the differentiation and integration of vectors. 4. Understand different vector operations such as Del, gradient and curl. 5. Know about the Orthogonal Curvilinear Coordinates

Unit: 1

Calculus: Approximation: Taylor and binomial series (statements only). First order differential equations, exact differential equations, homogeneous, linear differential equations and integrating factor.

Second order differential equations: Homogeneous equations with constant coefficients, Wronskian and general solution, method of finding complementary functions and particular integrals. [16L]

Unit: 2

Vector Algebra: Properties of vectors, Scalar product and vector product, scalar triple product and their interpretation in terms of area and volume respectively, scalar and vector fields. [10L]

Unit: 3

Vector Calculus: Vector Differentiation: Directional derivatives and normal derivative, gradient of a scalar field and its geometrical interpretation, divergence and curl of a vector field, del and Laplacian operators, vector identities.

Vector Integration: Integration of vectors, notion of 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 verification (no rigorous proofs). [14L]

Unit: 4

Orthogonal curvilinear coordinates: Orthogonal curvilinear coordinates, derivation of gradient, divergence, curl and Laplacian in Cartesian, spherical and cylindrical coordinate systems. [10L]

Recommended Books:

1. Mathematical Physics, H. K. Dass & R. Verma, 2016, S. Chand Publication
2. Mathematical Physics, B. D. Gupta, 2014, Vikash Publication House
3. Mathematical Physics, Satya Prakash,
4. Mathematical Methods for Physicists, G. B. Arfken, H. J. Weber, F. E. Harris, 2013, Elsevier
5. Engineering Mathematics, S. Pal And S. C. Bhunia, 2015, Oxford University Press
6. Mathematical Physics, Goswami, 1st Edition, Cengage Learning.

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Course Code: BSP-102
MECHANICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn about various aspects of dynamics 2. Learn about work and energy 3. Learn about collisions 4. Learn about rotational dynamics 5. Learn about gravitational physics

Unit: 1

Fundamentals of dynamics: Reference frames, inertial frames, review of Newton's laws of motion. Galilean transformations, Galilean invariance, momentum of variable mass system: motion of rocket, motion of a projectile in uniform gravitational field, dynamics of a system of particles, centre of mass, principle of conservation of momentum, impulse.

Non-inertial systems: Non-inertial frames and fictitious forces, uniformly rotating frame, laws of physics in rotating coordinate systems, centrifugal force, coriolis force and its applications. [16L]

Unit: 2

Work and energy: 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.

Collisions: Elastic and inelastic collisions between particles centre of mass and laboratory frames. [14L]

Unit: 3

Rotational dynamics: Angular momentum of a particle and system of particles, torque, principle of conservation of angular momentum, rotation about a fixed axis, moment of inertia, calculation of moment of inertia for bodies of different shapes, acceleration of bodies rolling down an inclined plane, compound pendulums and determination of acceleration due to gravity. [16L]

Unit: 4

Gravitation: Law of gravitation, gravitational potential energy, inertial & gravitational mass, potential and field due to spherical shell and solid sphere.

Electricity: Relation between electric constant, cantilevers. [8L]

Recommended Books:

1. Mechanics, D.S. Mathur, S.Chand and Company Limited, 2000
2. Feynman Lectures, Vol.-I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
3. Properties of Matter, D. S. Mathur, S. Chand Publication
4. Mechanics, S. Hans, S. P. Puri
5. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley

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Course Code: BSP-103
MATHEMATICAL PHYSICS-I PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Understand the basics of scientific computing. 2. Know and compute different types of errors. 3. Know the basics of various programming languages such as C and C^{++} 4. Apply the programming language to calculate sum, average, and area.

Course Details:

Sl. No.	Topics	Description with Applications
1	Introduction and Overview	Computer architecture and organization memory and Input/output devices,
2	Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow and overflow - emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
3	Errors and error Analysis	Truncation and round-off errors, Absolute and relative errors, Floating point computations
4	Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, cin and cout ,Manupulators for data formatting, Control statements (decision making and looping statements) (if-statement, if-else statement, nested if statement, else-if statement, ternary operator, goto statement, switch statement, unconditional and conditional looping, while and do while loop, for loop,nested loops, break and continue statements)
5	Programs: using C/C++ language	Sum and average of a list of numbers, largest of agiven list of numbers and its location in the list, sortingof numbers in ascending descending order, Binary search
6	Random number generation	Area of circle, area of square, volume of sphere, value of pi

Recommended Books:

1. Let us C, E. Balaguruswami,
2. Introduction to Numerical Analysis, S.S. Sastry, 5thEdn., 2012, PHI Learning Pvt. Ltd.
3. Elementary Numerical Analysis , K.E. Atkinson,3rdEdn , Wiley India
4. A first course in Numerical Methods, U. M. Ascher & C. Greif, 2012, PHI Learning.

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Course Code: BSP-104
MECHANICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn about motion of spring 2. Learn about determination of moment of inertia by various methods 3. Learn about calculation of acceleration due to gravity by various methods 4. Learn to measure Young's modulus and modulus of rigidity

List of Experiments:

1. Study of Motion of Spring and calculation of (a) Spring constant, (b) 'g' and (c) Modulus of rigidity.
2. Determination of Moment of Inertia of a Flywheel.
3. Determination of Young's Modulus of a Wire by Optical Lever Method.
4. Determination of Modulus of Rigidity of a Wire by Maxwell's needle.
5. Determination of value of g using Bar Pendulum.
6. Determination of value of g using Kater's Pendulum.
7. Moment of Inertia of a body about different axes by Torsion balance.

Book Recommendation

1. B.Sc. Practical Physics, C. L. Arora, S.Chand and Company Publication
2. Mechanics, D.S. Mathur, S.Chand and Company Limited, 2000
3. Properties of Matter, D. S. Mathur, S. Chand Publication

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Course Code: BSP-201
ELECTRICITY AND MAGNETISM
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know the basic concept of Electric field and Potential. 2. Understand polarization and dielectric properties of matter. 3. Understand magnetic force, magnetic field and be able to calculate the same in current carrying conductors of different shapes. 4. Know about the magnetic properties of matter. 5. Have a clear picture of charge and energy conservation and the phenomena of electromagnetic induction.

Unit 1:
Electric Field and Electric Potential: Electric field: Electric field lines. Electric flux.Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.
Conservative nature of Electrostatic Field.Electrostatic Potential.Laplace's and Poisson equations.The Uniqueness Theorem.Potential and Electric Field of a dipole. Force and Torque on a dipole.
Electrostatic energy of system of charges.Electrostatic energy of a charged sphere.Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors.Parallel-plate capacitor.Capacitance of an isolated conductor. Method of Images and its application to: (1) Plane Infinite Sheet and (2) Sphere. [16L]

Unit 2:
Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges.Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Displacement vector D. Relations between E, P and D. Gauss' Law in dielectrics. [8L]

Unit 3:
Magnetic Field: Magnetic force between current elements and definition of Magnetic Field B. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric, Dipole). Ampere's Circuital Law and its application to Solenoid and Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on point charge current carrying wire between current elements, Torque on a current loop in a uniform Magnetic Field. [12L]

Unit 4:
Magnetic Properties of Matter: Magnetization vector (M), Magnetic Intensity(H), Magnetic Susceptibility andpermeability.Relation between B, H, M. Ferromagnetism, B-H curve and hysteresis. [8L]

Unit 5:
Electromagnetic Induction: Faraday's Law. Lenz's Law, Self Inductance and Mutual Inductance, Reciprocity Theorem. Energy stored in a Magnetic Field. Charge Conservation and Displacement current. Introduction to Maxwell's Equations.Wave equation for electric and magnetic field, Poynting Theorem. [10L]

Unit 6: Electrical Circuits: AC circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR circuit: Resonance, Power Dissipation and Quality factor, and Bandwidth. Parallel LCR circuit. [6L]

Book Recommendation:

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

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Course Code: BSP-202
WAVE AND OPTICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Have a deep concept of waves, harmonic motions etc.. 2. Acquire knowledge on different type of vibration like free, damped, force vibrations etc. 3. Get the knowledge of wave optics as well as ray optics. 4. Get the idea of defects in image formation through lenses. 5. Have deep knowledge on the concept of interference, diffraction, polarisation.

Unit: 1

Wave and Oscillations: wave motion**:** plane and spherical waves, longitudinal and transverse waves, plane progressive (travelling) waves, wave equation, particle and wave velocities, pressure of a longitudinal wave, energy transport, intensity of wave, inverse square law.

Velocity of Waves: velocity of transverse vibrations of stretched strings, velocity of longitudinal waves in fluid in a pipe, Newton's formula for velocity of sound, Laplace's correction.

Harmonic motion: simple harmonic motion, superposition of collinear harmonic oscillations, superposition of two perpendicular harmonic oscillations, Lissajous figures with equal and unequal frequency and their uses, free, damped and forced oscillations, resonance, and sharpness of resonance. [16L]

Unit: 2

Wave Optics: Electromagnetic nature of light, definition and properties of wave front, Huygens principle, temporal and spatial coherence. [5L]

Unit 3:

Geometrical Optics: Fermat's principle**:** Fermat's principle and its application in establishing laws of reflection and refraction at spherical and plane boundaries, focal length of two thin lenses separated by a distance.

Lens system: sign convention, conjugate foci, relation for refraction of paraxial rays at single spherical surface.

Defects of image: spherical aberration, minimization of spherical aberration by using suitable lens of different radii of curvature, by aplanatic surface, qualitative idea about coma, astigmatism and distortion, chromatic aberration, achromatic combination of lenses. [10L]

Unit 4:

Physical Optics: interference of Light: condition of sustained interference by analytical treatment, methods for production of interference fringes by biprism, Lloyd's mirror, measurement of thickness of thin films, Haidinger's fringe, theory of Newton's rings, determination of wavelength and refractive index using Newton ring apparatus.

Interferometer : Michelson's interferometer and its theory relating to the formation of circular fringe's, determination of wavelength of a source and small difference of wave lengths in D-lines by Michelson's interferometer.

Diffraction of light: Fresnel and Fraunhofer class of diffraction, zone plate, diffraction at straight edge, circular aperture, Fraunhofer diffraction at single slit, plane diffraction grating.

Polarisation of light: different methods of production of polarized light, Brewster's law, double refraction, Nicol prism, their uses in production and detection of elliptically and circularly polarized light. [18L]

Recommended Books:

1. Jenkins and White : Fundamentals of Optics (1981, McGraw Hill)
2. Ghatak A.K.: Optics(2008, Tata Mc Graw Hill).
3. Born and Wolf: Optics, (7th Edn., 1999, Pergamon Press).
4. Longhurs R.S.: Geometrical and Physical optics,(Longmans, 1975).
5. Puri S.K. : Vibration and Waves, (Tata Mc Graw Hill)
6. K G Majumder and B Ghosh: A Text Book of Light (Shreedhar Publications).
7. Eugene Hecht and A R Ganesan: Optics (Pearson Education, 2002).
8. N.K. Bajaj: The Physics of Waves and Oscillations (Tata McGraw-Hill, 1988).

9. Laud B.B.: Lasers and Non-linear Optics, (Wiley Eastern).

Course Code: BSP-203

ELECTRICITY AND MAGNETISM PRACTICAL

(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Have the experience of potentiometer and its practical applications. 2. Acquire knowledge of Carey Foster's bridge and its practical applications. 3. Have the idea of self induction and its application in real problems. 4. Have deep knowledge on LCR circuits and applications.

1. To determine an unknown low Resistance using Potentiometer.
2. To determine an unknown low Resistance using Carey Foster's Bridge.
3. Measurement of field strength B and its variation in a solenoid (determine dB/dx).
4. To determine self inductance of a coil by Anderson's bridge.
5. To study the response curve of a parallel LCR circuit and determine its (a) Antiresonant frequency and (b) Quality factor Q.

Books Recommendaion

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

Course Code: BSP-204
WAVE AND OPTICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know the experiments of Michelson interferometer, Newton rings, wavelength of Sodium light. 2. Acquire knowledge the experiments of wavelength measurements different sources like Na ,Hg etc. 3. Acquire knowledge the experiments of Fresnal Bi-prism. 4. Know the experiments of thin film, and know the experiments of measurement of dispersive power and resolving power of diffraction grating.

List of experiments:

1. To determine the frequency of an electric tuning fork by Melde's experiment.
2. To calculate unknown frequencies by using Lissajous Figures.
3. To determine refractive index of the material of a prism using sodium source.
4. To determine the wavelength of laser source using Michelson's interferometer.
5. To determine wavelength of sodium light using Newton's rings.
6. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
7. To measure small distances and angles using different Vernier scales attached to (i) travelling microscope (ii) polarimeter and (iii) spectrometer.
8. To determine wavelength of (i) Na source and (ii) spectral lines of Hg source using plane diffraction grating.
9. To determine dispersive power and resolving power of a plane diffraction grating.
10. To determine wavelength of sodium light using Fresnel biprism.

Recommended 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.

Course Code: BSP-301
MATHEMATICAL PHYSICS-II
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn about the matrices and their properties. 2. Get the knowledge of Forbenius method and special functions 3. Have the knowledge of different polynomials. 4. Acquire knowledge on special integrals (beta and gamma functions). 5. Know the partial differential equations and their methods of solutions.

Unit 1:
Matrix: Properties of matrices, Transpose matrix, complex conjugate matrix, Hermitian matrix, special square matrix, unit matrix, diagonal matrix, co-factor matrix, adjoint of a matrix, self-adjoint matrix, symmetric matrix, anti-symmetric matrix, unitary matrix, orthogonal matrix, trace of a matrix, inverse matrix, rank of a matrix. Eigen value problems. [14L]

Unit 2:
Frobenius Method and Special Functions: singular points of second order linear differential equations and their importance. Frobenius method and its applications to differential equations. Legendre equations, properties of Legendre polynomials, generating function, orthogonality, expansion of function in a series of Legendre polynomials. [16L]

Unit 3:
Some Special Integrals: beta and gamma functions and relation between them, expression of integrals in terms of gamma functions, error functions, least-squares fit. [10L]

Unit 4:
Partial Differential Equations: solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular geometry, solution of wave equation for vibrational modes of a stretched string, rectangular and circular membranes. [12L]

Book Recommendation:

- Mathematical Methods for Physicists: Arfken, Weber, 2005, Harris, Elsevier.
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole.
- Differential Equations, George F. Simmons, 2006, Tata McGraw-Hill.
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Mathematical methods for Scientists & Engineers, D.A.McQuarrie, 2003, Viva Books.

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Course Code: BSP-302
THERMAL PHYSICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn about basics of thermodynamics 2. Learn about various quantities related to thermodynamics, such as entropy and thermodynamic potentials 3. Learn about Maxwell's thermodynamic relations 4. Learn about kinetic theory of gases and molecular collisions 5. Learn about real gases

Unit: 1

Introduction to Thermodynamics: Zeroth and first law of thermodynamics: extensive and intensive thermodynamic variables, thermodynamic equilibrium, zeroth law of thermodynamics & concept of temperature, concept of work & heat, state functions, first law of thermodynamics and its differential form, internal energy, applications of first law: general relation between C_P and C_V, work done during isothermal and adiabatic processes, compressibility and expansion co-efficient.

Second law of thermodynamics**:** reversible and irreversible process with examples, conversion of work into heat and heat into work heat engines, Carnot's Cycle, Carnot engine & efficiency, refrigerator & coefficient of performance, 2nd law of thermodynamics: Kelvin-Planck and Clausius statements and their equivalence, Carnot's theorem, applications of second law of thermodynamics: thermodynamic scale of temperature and its equivalence to perfect gas scale. [16L]

Unit: 2

Entropy: concept of entropy, Clausius theorem, Clausius inequality, second law of thermodynamics in terms of entropy, entropy of a perfect gas, principle of increase of entropy, entropy changes in reversible and irreversible processes with examples, entropy of the universe, 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, magnetic work, cooling due to adiabatic demagnetization, first and second order phase transitions with examples, Clausius Clapeyron equation and Ehrenfest equations. [14L]

Unit: 3

Maxwell's Thermodynamic Relations: derivation of Maxwell's thermodynamic relations and their applications, Maxwell's relations: (1) Clausius Clapeyron equation, (2) value of C_p-C_v, (3) Tds equations.

Kinetic Theory of Gases: distribution of velocities: Maxwell-boltzmann law of distribution of velocities in an ideal gas and its experimental verification, mean, rms and most probable speeds, degrees of freedom, law of equipartition of energy (no proof required), specific heats of gases.

Molecular Collisions: mean free path, transport phenomenon in ideal gases: (1) viscosity, (2) thermal conductivity (3) diffusion, (4) Brownian motion and its significance. [14L]

Unit: 4

Real Gases: behavior of real gases: deviations from the ideal gas equation, virial equation, critical constants, continuity of liquid and gaseous state, 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, free adiabatic expansion of a perfect gas, Joule-Thomson porous plug experiment, Joule-Thomson cooling. [12L]

Recommended Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, MeghnadSaha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger 1988, Narosa.
5. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications

Course Code: BSP-303
DIGITAL SYSTEMS AND APPLICATIONS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Understand various number systems and their importance in digital design. 2. Understand and design different logic families. 3. Have fundamental concepts of sequential and combinational circuits. 4. Analyze and design clocked sequential circuits. 5. Understand active and passive components, integrated circuits and their importance in microprocessors.

Unit: 1
Digital Circuits: difference between analog and digital circuits, binary numbers, decimal to binary and binary to decimal conversion, BCD, octal and hexadecimal numbers.
Boolean algebra: De Morgan's theorems, Boolean laws, simplification of logic circuit using Boolean algebra, fundamental products.
Arithmetic Circuits: binary addition, binary subtraction using 2's complement, AND, OR and NOT gates (realization using diodes and transistor), NAND and NOR gates as universal gates, XOR and XNOR gates. [16L]

Unit: 2
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-flops, M/S JK flip-flops.
Data processing circuits: basic idea of multiplexers, De-multiplexers, decoders, encoders. [14L]

Unit: 3
Timers: IC 555: block diagram and applications: astable multivibrator and Monostable multivibrator.
Introduction to CRO: working and applications. [12L]

Unit: 4
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, introduction to microprocessors. [14L]

Recommended Books:

1. Digital Principles and Applications, A.P. Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw
2. Digital Logic and Computer Design, Moris Mano.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.

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Course Code: BSP-304
MATHEMATICAL PHYSICS-II PRACTICAL
(Credit-2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn the basic of Numerical computation software such as Scilab/MATLAB. 2. Learn Numerical methods and develop the skills of writing a program. 3. Learn different techniques such as Curve fitting, Least square fit, Goodness of fit, standard deviation using Scilab/MATLAB. 4. Find the solution of differential equations.

Topics	**Description with Applications**(withScilab/MATLAB)
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, sub-array, special values, displaying output data, data file, scalar and array operations, hierararchy of operations, built in Scilab functions, introduction to plotting, 2D and 3D plotting, branching statements and program design, relational and logical operators, the while loop, for loop, details of loop operations, break and continue statements, nested loops, logical arrays and vectorization, 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 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.
Curve fitting, Least square fit, Goodness of fit, standard deviation using Scilab/MATLAB	Ohms law calculate R, Hookes law, Calculate spring constant, given Bessel's function at N points find its value at an intermediate point.
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method, diagonalisation 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 (RK) second and fourth 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 o Transient and

Partial differential equations	○ Steady state solution • Apply above to LCR circuits also • Solve $x^2\frac{d^2y}{dx^2} - 4x(1+x)\frac{dy}{dx} + 2(1+x)y = x^3$ with the boundary conditions at $x = 1, y = \frac{1}{2}e^2, \frac{dy}{dx} = -\frac{3}{5}e^2 - 0.5$ 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 sine wave, square wave, saw tooth wave • Solution of harmonic oscillator • Study of heat phenomenon • Phase space plots

Book Recommendation:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas& M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn.,Cambridge University Press
- Getting started with Matlab, RudraPratap, 2010, Oxford University Press.
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientificand Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer

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Course Code: BSP-305
THERMAL PHYSICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn to determine mechanical equivalent of heat 2. Learn to determine thermal conductivity coefficient by various methods 3. Learn to determine temperature coefficient of resistance of platinum resistance thermometer 4. Learn to measure characteristics and various quantities related to a thermocouple

(At least 5 experiments from the following to be performed)*

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 a bad conductor by Lee and Charlton's disc method.
4. To determine the temperature coefficient of resistance by platinum resistance thermometer (PRT).
5. To study the variation of thermo-EMF of a thermocouple with difference of temperature of its two Junctions.
6. 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.

Recommended 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: BSP-306
BASIC INSTRUMENTATION SKILLS
(Credit: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Gain the concept of accuracy, precision, sensitivity and resolution of basic electronic instruments. 2. Have the advantage of multimeters over conventional voltmeter and ammeter. 3. Know in details of operation and working of CROs 4. Have an idea of different signal generators and their applications.

Unit: 1
Basic of Measurement: 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, ac current and resistance. [6L]

Unit:2
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. [4L]

Unit:3
Cathode Ray Oscilloscope: block diagram of basic CRO, construction of CRT, electron gun, electrostatic focusing and acceleration, brief discussion on screen phosphor, visual persistence & chemical composition, time base operation, synchronization, front panel controls. [6L]

Unit: 4
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, digital storage oscilloscope: block diagram and principle of working (preliminary idea only). [5L]

Unit: 5
Signal Generators and Analysis Instruments: block diagram, explanation and specifications of low frequency signal generators, pulse generator, and function generator. [4L]

Laboratory Exercises:

1. Converting the range of a given measuring instrument (voltmeter, ammeter)
2. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
3. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
4. Measurement of voltage, frequency, time period and phase angle using CRO.

Recommended Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, SubrataGhoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012,Tata Mc-Graw Hill
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk,2008, Springer
8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Course Code: BSP-401
NUCLEAR AND PARTICLE PHYSICS
(Credits: 4)

COURSE OUTCOMES (COs)
Upon successful completion of the course students will be able to 1. Understand the constituents and general properties of nuclei, and learn about different nuclear models and the condition for Nuclear Stability. 2. Know about the different types of radiation such as alpha, beta and gamma and their properties. 3. Know the different types of nuclear reaction and calculate the Q value of reaction. 4. Have a basic concept of different types of detection mechanism of nuclear radiations. 5. Know the basic of particle physics, types of particles and conservation laws.

Unit: 1
General Properties of Nuclei: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. [10L]

Unit: 2
Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of its various terms, condition of nuclear stability, two nucleon separation energies, evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of nuclear force. [10L]

Unit: 3
Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α- emission, Geiger-Nuttall law, α-decay spectroscopy. (b) β-decay: energy kinematics for γ-decay, positron emission, electron capture, neutrino hypothesis. (c) γ-decay: γ-rays emission & kinematics, internal conversion. [10L]

Unit: 4
Nuclear Reactions: Types of reactions, conservation laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, concept of compound and direct reaction, resonance reaction, Coulomb scattering (Rutherford scattering). [10L]

Unit: 5
Nuclear Detector: Ionization chamber and GM counter, scintillation detectors and photo-multiplier tube (PMT), semiconductor detectors (Si and Ge), neutron detector, accelerator: linear accelerator, cyclotron, betatron. [10L]

Unit: 6
Particle physics: Particle interactions; basic features, types of particles and its families, symmetries and conservation laws: energy and momentum, angular momentum, parity, baryon number, lepton number, isospin, Strangeness and charm, concept of quark model, colour quantum number and gluons. [10L]

Book Recommendation:

1. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
2. Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
3. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
4. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
5. Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
6. Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
7. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by
8. K. Heyde (IOP- Institute of Physics Publishing, 2004).
9. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
10. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
11. Theoretical Nuclear Physics, J.M. Blatt &V.F.Weisskopf (Dover Pub.Inc., 1991)

Course Code: BSP-402
ELEMENTS OF MODERN PHYSICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn basics of quantum mechanics 2. Learn about quantum mechanical wave equations 3. Learn about special theory of relativity 4. Learn about atomic physics 5. Learn about radioactivity

Unit: 1
An introduction to Quantum Mechanics: Blackbody radiation, Planck's law, Planck's constant, idea of photons; photo-electric effect and Compton scattering; De-Broglie hypothesis and matter waves, wave-particle duality; Davisson-Germer experiment; Heisenberg uncertainty principle. [10L]

Unit: 2
Wave equations: Schrödinger equations; stationary states; physical interpretation of a wave function, probabilities and normalization; infinite potential well, energy Eigen values and Eigen functions, normalization; quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier. [14L]

Unit: 3
Special Theory of Relativity: Postulates of special theory of relativity, length contraction, time dilation, velocity addition theory; variation of mass with time; mass- energy relation. [10L]

Unit: 4
Atomic Physics: Review of Rutherford-Bohr model, Somerfield-correction, Zeeman effect, Paschen-Back effect, Stark effect, LS-coupling, JJ-coupling, electron spin, Stern-Gerlec experiment, Bohr magnetron, 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. [14L]

Unit: 5
Radioactivity: Stability of the nucleus, law of radioactive decay, mean life and half-life; alpha decay, beta decay-energy released, spectrum and Pauli's prediction of neutrino, gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.
Fission and fusion: mass deficit, relativity and generation of energy, fission: nature of fragments and emission of neutrons, fusion and thermonuclear reactions driving stellar energy. [12L]

Recommended Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
6. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
7. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
8. Six Ideas that Shaped Physics:Particle Behave like Waves, T.A.Moore,2003, McGraw Hill

Course Code: BSP-403
ANALOG SYSTEMS AND APPLICATIONS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Understand the basic process in the formation and fabrication of PN junction devices. 2. Analyze BJT as amplifiers and bias circuits for CB, CC and CE configurations. 3. Understand the importance of feedback (both positive as well as negative) in amplifiers and their frequency response. 4. Understand versatile integrated circuits such as Op-Amp and its applications. 5. Analyze different oscillator circuits and the criteria for self sustained oscillations.

Unit-I:
Semiconductor Diodes: P and N type semiconductors, energy level diagram, conductivity and mobility, concept of drift velocity, fabrication of PN junction, barrier formation in PN junction diode, barrier potential and barrier width, current flow mechanism in forward and reverse biased diodes. [12L]

Unit-II:
Two-terminal devices and their applications: Half-wave rectifiers, full-wave rectifiers, bridge rectifiers, ripple factor and rectification efficiency, c-filter, Zener diode and voltage regulation, principle, structure and characteristics of LED, photodiode and solar cell, Schottky and tunnel diodes (qualitative idea). **[**7L]

Unit-III:
Bipolar Junction transistors: N-P-N and P-N-P transistors, I-V characteristics of CC, CB and CE configurations, current gains α and β and their relations, DC Load line and Q-point. **[**6L]

Unit-IV:
Amplifiers: Transistor biasing and stabilization circuits, hybrid equivalent circuit of CE amplifier, h-parameter, power amplifier, classification of class A, B & C Amplifiers.
Two stage RC-coupled amplifier and its frequency response,
Feedback in Amplifiers: Positive and Negative Feedback, effect of negative feedback on input and output impedances. [15L]

Unit-V:
Operational Amplifiers: Introduction, characteristics of an Op-Amp, common mode rejection ratio (CMRR), slew rate and concept of virtual ground.
Applications of Op-Amps: Inverting and non-inverting amplifiers, adder, subtractor, differentiator, integrator.
[12L]

Unit-VI:
Oscillators: Hartley & Colpitt's oscillators, Barkhausen's Criterion for self-sustained oscillations, phase shift oscillator. [5L]

Book Recommendation:

1. Basic Electronics – B.L. Thereja
2. Electronics fundamentals and applications –D. Chattopadhyay and P.C. Rakshit
3. A Text Book Of Electronics –S.L. Kakani & K.C. Bhandari
4. Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, PHI Learning

Course Code: BSP-404
NUCLEAR PHYSICS AND ELECTRONICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Carry out experiments using a GM counter and calculate the operating voltage of the counter. 2. Know the experimental procedure to detect alpha and gamma radiations, and know about the different radio-active sources and their hazards. 3. Gain the characteristics of PNP/NPN transistors. 4. Gain the knowledge of half-wave and full-wave rectifiers.

List of Experiments:

1. To draw the plateau curve for a GM counter and find out its operating voltage,
2. To verify the inverse square law of a GM counter,
3. To study the common base characteristics of a PNP/NPN transistor,
4. To study the common emitter characteristics of a PNP/NPN transistor,
5. To study OP-AMP as inverting and non-inverting amplifier,
6. To study voltage regulation and ripple factor of a
    a) Half-wave rectifier
    b) Full-wave rectifier

Book Recommendation:

Course Code: BSP-405
ELEMENTS OF MODERN PHYSICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn to study photoelectric effect and calculate Planck's constant, 2. Learn to determine e/m value by different methods, 3. Learn to measure I-V characteristics of a tunnel diode, 4. Learn to determine wavelength of a laser source by diffraction with single and double slits.

List of Experiments:

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 the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
4. To show the tunnelling effect in tunnel diode using I-V characteristics.
5. To determine the wavelength of laser source using diffraction of single slit.
6. To determine the wavelength of laser source using diffraction of double slits.

Reference Books:

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

Course Code: BSP-406
APPLIED OPTICS
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Deep understanding of the properties of lenses and mirrors. 2. Characteristics of LASERs and working of different LASER systems 3. Idea of Holography and their construction techniques and applications 4. Understanding of few spectroscopic instrumentations and the communication through Fiber Optics

Unit: 1
Reflection and refraction of plane waves by spherical surfaces, condition of achromatism, polarization and polarizing components, resolution and resolving power, concept of image and point spread function (PSF). [8L]

Unit: 2
Lasers, spontaneous and stimulated emissions, theory of laser action, Einstein's coefficients, He-Ne laser, semiconductor laser, characterization of laser beam, laser mode, Gaussian beams and their propagation through lenses. [8L]

Unit: 3
Basics of holography: construction and reconstruction of holography, amplitude and phase holograms, hologram recording materials. [6L]

Unit: 4
Microscopic imaging techniques: simple and compound microscopes, wide field and point scanning based imaging techniques, phase contrast microscopy, introduction to confocal and nonlinear optical microscopic techniques, super resolution imaging, near-field imaging techniques, adaptive optics, wave-front sensing and correction, reconstruction, Optical coherence tomography. [12L]

Unit: 5
Spectroscopic instrumentation: UV-Visible spectroscopy, Raman scattering, Infra-red spectroscopy. [4L]

Unit: 6
Fiber Optics: Optical fibers and their characterizations, light propagation through fibers, numerical aperture, attenuation in fibers, single mode and multi-mode fibers. [6L]

Recommended Books:

1. Optics-5th Edition, A. K. Ghatak, Mc Graw Hill
2. Optics-4th Edition, E. Hecht, Pierson
3. Optics and Optical Instruments, B. K. Johnson, Dover Publication,
4. Fundamentals of Optics, F.A. Jenkins and H.E. White, Mc Graw Hill.
5. Lasers-Theory and Applications, Thyagarajan and Ghatak, Macmillan (for Holography part)

Course Code: BSP-501
QUANTUM MECHANICS & APPLICATION
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to understand 1. Evolution of quantum mechanics as a new realm of nature 2. Theories and discoveries leading to the development of quantum mechanics 3. Solution of two-body problems through quantum mechanics (H-atom treatment), 4. Principles for determination of the shape and size of the atoms 5. Spectra of hydrogen and alkali elements and their usefulness.

Unit: 1

Time Dependent Schrödinger Equation: time dependent Schrödinger equation and dynamical evolution of a quantum state; properties of wave function, interpretation of wave function, probability and probability current densities in three dimensions; conditions for physical acceptability of wave functions, normalization, linearity and superposition principles, Eigen values and Eigen functions, position, momentum and energy operators; expectation values of position and momentum, wave function of a free particle. [14L]

Unit: 2

Time Independent Schrödinger Equation: Hamiltonian, stationary states and energy Eigen values, expansion of an arbitrary wave function as a linear combination of energy Eigen functions, general solution of the time dependent Schrödinger equation in terms of linear combinations of stationary states, application to a free particle in one dimension, wave packets, position-momentum uncertainty principle. [14L]

Unit: 3

Quantum Theory Of Hydrogen-like Atoms: Time independent Schrödinger equation in spherical polar coordinates, separation of variables for second order partial differential equation, angular momentum operator & quantum numbers, radial wave functions, shapes of the probability densities for ground & first excited states; orbital angular momentum quantum numbers l and m, s, p, d shells. [14L]

Unit: 4

Many Electron Atoms: Pauli's Exclusion Principle. Symmetric & anti-symmetric wave functions, periodic table, fine structure, vector model, Hund's rule, term symbols, spectra of hydrogen and alkali atoms (Na Etc.). [10L]

Book Recommendation:

1. A Text Book Of Quantum Mechanics, P.M. Mathews And K.Venkatesan, 2nded., 2010, Mcgraw Hill
2. Quantum Mechanics, Robert Eisberg And Robert Resnick, 2nd edn., 2002, Wiley.
3. Quantum Mechanics, Leonard I. Schiff, 3rd edn. 2010, Tata Mcgraw Hill.
4. Quantum Mechanics, G. Aruldhas, 2nd edn. 2002, PHI Learning Of India.
5. Quantum Mechanics, Bruce Cameron Reed, 2008, Jones And Bartlett Learning.
6. Quantum Mechanics: Foundations &Applications, Arno Bohm, 3rd edn., 1993, Springer
7. Quantum Mechanics For Scientists &Engineers, D.A.B. Miller, 2008, Cambridge University Press
8. Quantum Mechanics, Eugenmerzbacher , 2004, John Wiley And Sons, Inc.
9. Introduction To Quantum Mechanics, D. J. Griffith, 2nd Ed. 2005, Pearson Education
10. Quantum Mechanics,Walter Greiner, 4th edn., 2001, Springer

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Course Code: BSP-502
SOLID STATE PHYSICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to understand 1. Learn about crystal structure and phonons 2. Learn about magnetic properties of matter 3. Learn about dielectric properties of materials 4. Learn about electrical properties of materials 5. Learn about superconductivity

Unit: 1
Crystal Structure Solids: Amorphous and crystalline materials, lattice translation vectors, lattice with a basis, unit cell, atomic packing fraction, reciprocal lattice, types of lattices, Brillouin zones, lattice planes and miller indices, diffraction of x-rays by crystals, Bragg's law types of bonds, ionic bond, covalent bond, Van der Waal's bond. [10L]

Unit 2:
Elementary Lattice Dynamics Lattice Vibrations and Phonons: Linear monoatomic and diatomic chains, acoustical and optical phonons, qualitative description of the phonon spectrum in solids, Einstein and Debye theories of specific heat of solids. [8L]

Unit 3:
Magnetic Properties of Matter: Dia-, para-, ferri- and ferromagnetic materials, classical Langevin theory of dia– and paramagnetic domains, Curie's law, Weiss's theory of ferromagnetism and ferrimagnetisms, magnetic domains, discussion of B-H curve, hysteresis and energy loss. [10L]

Unit 4:
Dielectric Properties of Materials: Polarization, local electric field at an atom, dielectric constant, electric susceptibility, polarizability, classical theory of electric polarizability, normal and anomalous dispersion, complex dielectric constant. [8L]

Unit 5:
Electrical Properties of Materials: Drude model and transport property in metals, elementary band theory of solids, Bloch theorem, Kronig-Penney model, effective mass of electron, concept of holes, band gaps, energy band diagram and classification of solids, law of mass action, insulators, and semiconductors, hall effect in metal and semiconductors (qualitative discussion only). [10L]

Unit 6:
Superconductivity: 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): cooper pair and coherence length, variation of superconducting energy gap with temperature, Josephson effect. [10L]

Reference Books:
1. Charles Kittel, Introduction to Solid State Physics, 7th Edition, John Wiley and Sons, Inc.
2. A J Dekkar, Solid State Physics, Macmillan India Limited, 2000.
3. J. S. Blackmore, Solid State Physics, Cambridge University Press, Cambridge.
4. Gupta and Kumar, Solid state Physics, K. Nath and Co., Meerut, 9th Edition 2007.
5. M. Ali Omar, Elementary solid state physics: principles and applications, (Pearson Education, 1999)

Course Code: BSP-503 (A)
CLASSICAL DYNAMICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to understand 1. The concept of generalize theories of classical mechanics. 2. The concept of Lagrangian as well as Hamiltonian dynamics. 3. The concept of canonical transformations and bracket operators. 4. The concept of central force problem. 5. Understand the Special Theory of Relativity.

Unit: 1

Classical mechanics of point particles: Generalised coordinates and velocities, Hamilton's principle, Lagrangian and Euler-Lagrange equations, applications to simple systems such as harmonic oscillator.
Canonical momenta & Hamiltonian: Hamilton's equations of motion, applications: Hamiltonian for a harmonic oscillator, particle in a central force field. [14L]

Unit: 2

Canonical transformations, conditions for canonical transformation, Poisson brackets, angular momentum and Poisson brackets. [12L]

Unit: 3

Special Theory of Relativity: Postulates of special theory of relativity, Lorentz transformations, Minkowski space, the invariant interval, light cone and world lines, space-time diagrams, time-dilation, length contraction & twin paradox. [14L]

Unit: 4

Central Force Problem: reduction of two body central force problem to equivalent one body problem, central force and motion in a plane, inverse square law of force, Kepler's laws of planetary motion and their deduction. [10L]

Book Recommendation:

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
2. Classical Mechanics, J C Upadhyaya
3. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
4. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
5. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
6. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
7. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
8. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

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Course Code: BSP-503 (B)
APPLIED DYNAMICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know about the dynamical systems, the idea of phase space, trajectories and flows. 2. Compute and visualize trajectories on the computer using a software packages. 3. Understand Chaos in nonlinear finite-difference equations. 4. Learn the Nonlinear time series analysis and chaos characterization. 5. Understand Fluid Dynamics: the theoretical approach, experimental fluid dynamics, computational fluid dynamics.

Unit: 1
Introduction to dynamical systems: Definition of a continuous first order dynamical system, idea of phase space, flows and trajectories, simple mechanical systems as first order dynamical systems: free particle, particle under uniform gravity, simple and damped harmonic oscillator, examples of dynamical systems: in biology: population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics; in chemistry: rate equations for chemical reactions e.g. auto catalysis, bistability; in economics: game theory. [14L]

Unit: 2
Computing and visualizing trajectories on the computer using a software packages, discrete dynamical systems. [4L]

Unit: 3
Introduction to Fractals: examples of 2-dimensional billiard, projection of the trajectory on momentum space, Sinai billiard and its variants, computational visualization of trajectories in the Sinai billiard, randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of obstacle. [10L]

Unit: 4
Introduction to Chaos: Chaos in nonlinear finite-difference equations-logistic map: dynamics from time series, parameter dependence-steady, periodic and chaos states, Cobweb iteration, fixed points, defining chaos-aperiodic, bounded, deterministic and sensitive dependence on initial conditions, period-doubling route to chaos, nonlinear time series analysis and chaos characterization. [10L]

Unit: 5
Elementary Fluid Dynamics: Fluids in the pure sciences, fluids in technology, study of fluids: theoretical approach, experimental fluid dynamics, computational fluid dynamics, definition of a fluid-shear stress, fluid properties-viscosity, thermal conductivity, mass diffusivity, flow phenomena-flow dimensionality, steady and unsteady flows, uniform and non-uniform flows, viscous and inviscid flows, incompressible and compressible flows, laminar and turbulent flows, rotational and irrotational flows, separated and unseparated flows, flow visualization-streamlines, pathlines, streaklines. [14L]

Books Recommended:
1. Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007
2. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
3. An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
4. Fluid Mechanics, 2nd Edition, L. D. Landau and E. M. Lifshitz, Pergamon Press, Oxford, 1987.

Course Code: BSP-504 (A)
NANO MATERIALS AND APPLICATIONS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn about nanoscale systems 2. Learn about synthesis of nanostructured materials 3. Learn about various characterization methods of nanomaterials 4. Learn about properties of nanomaterials 5. Learn about applications of nanomaterials

Unit: 1
Nanoscale Systems: Length scales in physics, nanostructures: 1D, 2D and 3D nanostructures (nano-dots, thin films, nanowires, nanorods), band structure and density of states of materials at nanoscale, size effects in nano systems, quantum confinement. [8L]

Unit: 2
Synthesis of Nanostructure Materials: Top down and bottom up approach, lithography, ball milling, gas phase condensation, vacuum deposition, physical vapor deposition (PVD): E-beam evaporation, chemical vapor deposition (CVD), Sol-Gel, electro-deposition, spray pyrolysis, preparation through colloidal methods, molecular beam epitaxy. [10L]

Unit: 3
Characterization: Principles and uses of X-Ray diffraction, UV-VIS spectroscopy, scanning electron microscopy, transmission electron microscopy, atomic force microscopy, scanning tunnelling microscopy.
Properties: Coulomb interaction in nanostructures, concept of dielectric constant for nanostructures and charging of nanostructure, quasi-particles and excitons, excitons in direct and indirect band gap semiconductor nanocrystals, quantitative treatment of quasi-particles and excitons, general formalization-absorption, emission and luminescence, optical properties of heterostrctures and nanostructures. [16L]

Unit: 4
Nanoscience and its applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells), carbon-based materials: carbon nanotube, SWCNT, MWCNT, graphene CNT-based transistors, nanomaterial devices: quantum dots hetero-structurelasers, optical switching and optical data storage, magnetic dots-magnetic data storage. [10L]

Reference books:

1. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
2. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company)
3. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience andTechnology (PHI Learning Private Limited).
4. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio,2011, Cambridge University Press.
5. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

Course Code: BSP-504 (B)
ADVANCED MATHEMATICAL PHYSICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know about the vector spaces and sub spaces. 2. Analyze the basis and Dimensions of a Vector Space. 3. Calculate the Eigen-values and Eigen-vectors. 4. Learn about Euler's Equation, Variational Principle and its application to simple problems. 5. Understand the basics of Tensors and the algebra associated with it.

Unit: 1

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

Unit: 2

Matrices: Review of different matrices. Diagonalization of Matrices. Solutions of Coupled Linear Ordinary Differential Equations. Functions of a Matrix.

Unit: 3

Calculus of Variations: Variable Calculus: Variational Principle, Euler's Equation and its Application to Simple Problems. Concept of Lagrangian. Generalized co-ordinates. Definition of canonical moment, Euler-Lagrange's Equations of Motion and its Applications to Simple Problems (e.g., Simple Pendulum and One dimensional harmonic oscillator). Definition of Canonical Momenta. Canonical Pair of Variables. Definition of Generalized Force: Definition of Hamiltonian (Legendre Transformation). Hamilton's Principle. Poisson Brackets and their properties. Lagrange Brackets and their properties

Unit: 4

Tensors: Transformation of Co-ordinates. Einstein's Summation Convention. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Symmetric and Antisymmetric Tensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra

Book Recommended

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
3. Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press
4. Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
5. Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning
6. Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
7. Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press
8. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
9. Complex Variables, A.S.Fokas & M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
10. Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
11. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill

Course Code: BSP-505
QUANTUM MECHANICS & APPLICATIONS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Understand the simulation techniques for solving simple differentiation and integration problems, 2. Learn the analytical tool for solving differential equations arising in quantum mechanics, 3. Understand the simulation techniques for solving ordinary quantum mechanical problems, 4. Developing of software codes for solving real quantum mechanics problems.

Use C/C^{++}/Scilab/MATLAB 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:

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

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

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

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

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

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

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 = 0.511x10^6eV/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 an atom:

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

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 = 100MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}In these units, cħ = 197.3 MeV fm. The groundstate energy I expected to lie between 90 and 110 MeV for all three cases.

Book Recommendation:

1. Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-Hill Publication
2. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn.,2007, Cambridge University Press.
3. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific &Engineering Applications: A. VandeWouwer, P. Saucez,C. V. Fernández.2014 Springer.
5. Scilab(A Free Software to Matlab): H. Ramchandran, A.S. Nair. 2011 S. Chand & Co.
6. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn.,Cambridge University Press
7. Scilab Image Processing: L.M.Surhone.2010 Betascript Publishing ISBN:978-6133459274

Course Code: BSP-506
SOLID STATEPHYSICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn to measure magnetic susceptibility of solids 2. Learn to measure coupling coefficient of piezoelectric crystals 3. Learn to determine plasma frequency and complex dielectric constant of a metal by surface plasmon resonance technique 4. Learn to determine PE hysteresis loop of a ferroelectric crystal 5. Learn to measure resistivity and Hall coefficient of a semiconductor sample.

List of Experiments: *(At least 06 experiments from the following)*

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of given 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) technique.
6. To determine the refractive index of a dielectric using SPR technique.
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 (up to 150oC) by four-probe method and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

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

Course Code: BSP-507 (A)
INTRODUCTION TO BIOPHYSICS
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Understand the types of bonds in bio-molecules and molecular system. 2. Know the energy production mechanism in bio-systems 3. Understand different types of forces and flows governing the Intracellular and Intercellular cargo transport. 4. Have a clear concept of the electrical properties of membrane and gain the knowledge about fluid properties and its movement in biological systems.

Unit: 1

Introduction to biophysics: Electronic structure of atoms, types of bonds, biomolecules and molecular system, nucleic acids, nucleotides, primary- secondary- and tertiary- structure of DNA, ribonucleic acid (RNA), amino acids, primary structure of proteins, peptide bond, secondary, tertiary and quaternary structure of proteins.

Unit: 2

Diffusion and energy production in biosystems: Forces and flows, physiological diffusion of ions and molecules, molecular motors, ATP and Flagellar motors, actin and myosin, intracellular cargo transport and intercellular cargo transport.-importance, energetics of human performance - adenosine triphosphate (ATP) production, Glycolysis.

Unit: 3

Membrane electrical properties: Membrane biophysics - nerve cell- bioelectrical and biochemical conduction of nerve impulses - membrane potential - resting potential and action potential - gross bioelectrical phenomenon of ECG and EEG - membrane potential-action potential- Goldman and Nernst equation -ECG (Electrocardiogram)-EG (Electroencephalogram) –EMG (Electromyogram) - channel ion selectivity.

Unit: 4

Force and movement in biological systems: Skeletal length, tension relation, muscle contraction and relaxation, calcium dependence of muscle movement, smooth muscles, cardiac muscles, carrier transport across gated channels in different types of muscles, fluid properties, synovial fluid flow, arterial blood flow, arterial stenosis, Lymph-Amniotic fluid, peritoneal fluid, cerebrospinal fluid.

Recommended Books:

1. Patrick F. Dillon, Biophysics- A Physiological Approach-Patrick, 1 st Edition, Cambridge University Press, 2012.
2. Willian Bialek, Biophysics: Searching for Principles, 1st Edition, Kindle, 2012.

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Course Code: BSP-507 (B)
APPLIED DYNAMICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Compute and visualize trajectories using software (Scilab/MATLAB/Maple/Octave/XPPAUT) based on Applied Dynamics problems. 2. Compute coupling coefficients of pendulum and oscillators. 3. Compute visualization of trajectories, visualization of fractal formations, and Flow visualization. 4. To investigate rate equations for chemical reactions and study game theory

List of Experiments:

Computing and visualizing trajectories using software (Scilab/MATLAB/Maple/Octave/XPPAUT) based on Applied Dynamics problems like (At least 06 experiments are to perform)

1. To determine the coupling coefficient of coupled pendulums.
2. To determine the coupling coefficient of coupled oscillators.
3. To determine the coupling and damping coefficient of damped coupled oscillator.
4. To study population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics.
5. To study rate equations for chemical reactions e.g. auto catalysis, bistability.
6. To study examples from game theory.
7. Computational visualization of trajectories in the Sinai Billiard.
8. Computational visualization of fractal formations of Deterministic fractal.
9. Computational Flow visualization - streamlines, pathlines, Streaklines.

Books Recommended:

1. Nonlinear Dynamics and Chaos, Steven H. Strogatz, Levant Books, Kolkata, 2007
2. Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
3. An Introduction to Fluid Dynamics, G.K.Batchelor, Cambridge Univ. Press, 2002
4. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB:Scientific and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V.Fernández. 2014 Springer

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Course Code: BSP-508 (A)
NANOMATERIALS AND APPLICATIONS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Learn to synthesize metal and semiconductor nanoparticles 2. Learn to study surface plasmon resonance of metal nanoparticles by UV-visible absorption method 3. Learn to fabricate nanoparticle thin films by spin coating 4. Learn to study the effect of size on colour of nanomaterials

At least 04 experiments from the following:

1. Synthesis of metal nanoparticles by chemical route.

2. Synthesis of semiconductor nanoparticles.

3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.

4. XRD pattern of nanomaterials and estimation of particle size.

5. To study the effect of size on color of nanomaterials.

6. To prepare composite of CNTs with other materials.

7. Growth of quantum dots by thermal evaporation.

8. Prepare a disc of ceramic of a compound using ball milling, pressing andsintering, and study its XRD.

9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) andstudy transmittance spectra in UV-Visible region.

10. Prepare a thin film capacitor and measure capacitance as a function oftemperature or frequency.

11. Fabricate a PN diode by diffusing Al over the surface of N-type Si and study itsV-I characteristic.

Recommended Books:

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

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Course Code: BSP-508 (B)
ADVANCED MATHEMATICAL PHYSICS PRACTICAL
(Credit: 02)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Perform Scilab/C++ based simulations experiments based on Mathematical Physics. 2. Able to calculate Eigen value and Eigen vectors of dynamical systems. 3. Able to understand classical constraints and determination of moment of inertia of moving bodies 4. Estimate the ground state energy and wave function of a quantum system.

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

1. Linear algebra:
   a) Multiplication of two 3 x 3 matrices.
   b) Eigenvalue and Eigenvectors of

$$\begin{pmatrix} 2 & 1 & 1 \\ 1 & 3 & 2 \\ 3 & 1 & 4 \end{pmatrix}; \begin{pmatrix} 1 & -i & 3+4i \\ i & 2 & 4 \\ 3-4i & 4 & 3 \end{pmatrix}; \begin{pmatrix} 2 & -i & 2i \\ +i & 4 & 3 \\ -2i & 3 & 5 \end{pmatrix}$$

2. Orthogonal polynomials as Eigenfunctions of Hermitian differential operators.
3. Determination of the principal axes of moment of inertia through diagonalization.
4. Lagrangian formulation in Classical Mechanics with constraints.
5. Estimation of ground state energy and wave function of a quantum system.

Book Recommended:

1. 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
2. Scilab by example: M. Affouf, 2012, ISBN: 978-1479203444
3. Scilab Image Processing: L. M. Surhone. 2010, Betascript Pub., ISBN: 978-6133459274

Course Code: BSP-601
ELECTROMAGNETIC THEORY
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Will gain a clear understanding of Maxwell's equations and electromagnetic boundary conditions. 2. Know that laws of reflection, refraction are outcomes of electromagnetic boundary conditions. 3. Students will grasp the idea of electromagnetic wave propagation in free space. 4. Able to describe and analyze transmission lines, wave guide, and understand the basic of fiber optics. 5. Students will extend their understanding of special theory of relativity by including the relativistic electrodynamics.

Unit: 1
Maxwell equations and their derivations, Displacement current, Vector and Scalar potentials, Boundary conditions at interface between two different media, Propagation of electromagnetic wave (Basic idea, no derivation), Poynting vector and Poynting theorem.
[12L]

Unit: 2
Wave equation for the EM fields in vacuum: transverse nature, Energy and momentum carried by EM waves, Propagation through linear media: reflection and transmission coefficients, Fresnel formula. EM waves in conductors: attenuation and skin depth, reflection and transmission. Dispersion in Nonconductors: The damped driven radiator, normal and anomalous dispersion, Cauchy's formula, Rayleigh scattering.
[18L]

Unit: 3
Polarization of Electromagnetic Waves: Description of linear, circular and elliptical polarization, propagation of EM waves in anisotropic media, uniaxial and biaxial crystals, double refraction, Nicol prism, production & detection of plane, circularly and elliptically polarized light.
[14L]

Unit: 4
Wave Guides: Planar optical wave guides, condition of continuity at interface, phase and group velocity of guided waves, field energy and power transmission. [8L]

Reference Books:

1. Perspective of Modern Physics, (Tata McGraw Hill); A. Beiser
2. Introduction to Electrodynamics, D. J. Griffiths, 3rd Ed., 1998, Benjamin Cummings
3. "Electricity and Magnetism" (Tata McGraw Hill.); A. S. Mahajan and A. Rangwala
4. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press
5. Electromagnetic field theory fundamentals, B. Guru and H. Hiziroglu, 2015, Cambridge University Press
6. Engineering Electromagnetic, Willian H. Hayt, 8th Edition, 2012, McGraw Hill.
7. The Feymann Lectures In Physics Vol.-II, R. Feynmann.

Course Code: BSP-602
STATISTICAL MECHANICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Converse with correct concepts of thermodynamics and statistical mechanics. 2. Understand the need to use statistics to describe systems containing huge numbers of particles. 3. Know the 3 Laws of Thermodynamics & understand their statistical foundations and applications. 4. Have a basic understanding of the phase transitions. 5. Understand the quantum statistical physics of Fermions & Bosons.

Unit: 1

Classical Statistics: Macrostate and microstate, phase space, elementary concept of ensemble, entropy and thermodynamic probability, Maxwell-Boltzmann distribution Law, partition function, thermodynamic functions of an ideal gas, classical entropy, expression, law of equipartition of Energy (with proof), applications to specific heat and its limitations, thermodynamic functions of a two-energy levels system, negative temperature. [12L]

Unit: 2

Classical theory of radiation: Properties of thermal radiation, blackbody radiation, pure temperature dependence, radiation pressure, Kirchhoff's law, Stefan-Boltzmann law: thermodynamic proof, Wien's displacement law, Wien's distribution law, Rayleigh-Jean's law.

Quantum Theory of Radiation: Spectral distribution of black body radiation, Planck's quantum postulates. Planck's law of blackbody radiation, experimental verification. [12L]

Unit: 3

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's derivation of Planck's law.

[12L]

Unit: 4

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. [12L]

Recommended Books:

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

Course Code: BSP-603 (A)
MATHEMATICAL PHYSICS-III
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Apply the concept of complex function to solve Integrals. 2. Learn the expansion of periodic functions. 3. Learn to expand a function in Fourier series 4. Learn Laplace transformation of elementary function. 5. Solve heat flow equation using Laplace transformation.

Unit: 1

Complex Analysis: Brief revision of complex numbers and their graphical representation, Euler's formula, De Moivre's theorem, roots of complex numbers, functions of complex variables, analyticity and Cauchy-Riemann conditions, examples of analytic functions, Cauchy's inequality, Cauchy's integral formula, simply and multiply connected region. [10L]

Unit: 2

Fourier series: Periodic functions, orthogonality of sine and cosine functions, Dirichlet conditions (Statement only), expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients, even and odd functions and their Fourier expansions, application, summing of infinite series. [10L]

Unit: 4

Fourier Transforms: Fourier integral theorem, Fourier transform, examples, Fourier transform of trigonometric, Gaussian, finite wave train and other functions, Inverse Fourier transform, convolution theorem, properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). [8L]

Unit: 5

Laplace Transforms: Laplace Transform (LT) of elementary functions, properties of LTs: change of scale theorem, shifting theorem, LTs of 1st and 2nd order, derivatives and integrals of functions, derivatives and integrals of LTs, application of Laplace transforms to 2nd order, differential equations, solution of heat flow along semi infinite bar using Laplace transform. [10L]

Book Recommendation:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J.Bence, 3rd ed., 2006, Cambridge University Press
2. Fourier Analysis by M.R. Spiegel, 2004, Tata McGraw-Hill.
3. Mathematics for Physicists, P. Dennery and A.Krzywicki, 1967, Dover Publications
4. Complex Variables, A.S.Fokas&M.J.Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
5. Complex Variables, A.K. Kapoor, 2014, Cambridge Univ. Press
6. Complex Variables and Applications, J.W. Brown & R.V. Churchill, 7th Ed. 2003, Tata McGraw-Hill
7. First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett

Course code: BSP-603 (B)
INTRODUCTION TO EARTH SCIENCE
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Understand the basic concepts of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography. 2. Know about The solid earth: dimensions, shape and topography, internal structure, magnetic field, geothermal energy. 3. Understand the basic of Plate tectonic theory and the origin of earthquake and earthquake belts. 4. Knowing a wide range of earth surface processes. 5. Understand the scope of geomorphology from landform to landscape to mega geomorphology.

Unit: 1
The Earth and the universe: (a) Origin of universe, creation of elements and earth, a holistic understanding of our dynamic planet through astronomy, geology, meteorology and oceanography, introduction to various branches of Earth Sciences, (b) General characteristics and origin of the universe, The milky way galaxy, solar system, Earth and Moon's orbit and spin, The terrestrial and Jovian planets, Meteorites & Asteroids, earth in the solar system. (c) Energy and particle fluxes incident on the Earth. (d) The cosmic microwave background. [14L]

Unit: 2
Structure: (a) The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy, how do we learn about Earth's interior, (b) The hydrosphere: The oceans, their extent, depth, volume, chemical composition, river systems, (c) The Atmosphere: variation of temperature, density and composition with altitude, clouds, (d) The Cryosphere: Polar caps and ice sheets, mountain glaciers, (e) The Biosphere: Plants and animals, chemical composition, mass, marine and land organisms. [14L]

Unit: 3
Dynamical Processes: (a) The Solid Earth: Source of geothermal energy, convection in Earth's core and production of its magnetic field, mechanical layering of the Earth, introduction to geophysical methods of earth investigations, concept of plate tectonics, sea-floor spreading and continental drift, Geodynamic elements of Earth: Mid oceanic ridges, trenches, transform faults and island arcs, origin of oceans, continents, mountains and rift valleys, earthquake and earthquake belts. Volcanoes: types products and distribution. (b) The Hydrosphere: Ocean circulations, oceanic current system and effect of coriolis forces, concepts of eustasy, tend, air-sea interaction, wave erosionand beach processes, tides, tsunamis. (c) The Atmosphere: Atmospheric circulation, weather and climatic changes, Earth's heat budget, cyclones, climate: Earth's temperature and greenhouse effect, paleoclimate and recent climate changes, Indian monsoon system.(d) Biosphere: Water cycle, Carbon cycle, Nitrogen cycle, Phosphorous cycle, the role of cycles in maintaining a steady state. [18L]

Unit: 4
Evolution: Nature of stratigraphic records, introduction to the concept of time in geological studies, introduction to geochronological methods in their application in geological studies, history of development inconcepts of uniformitarianism, catastrophism and neptunism, law of superposition and faunal succession, introduction to the geology and geomorphology of Indian subcontinent. [10L]

Unit: 5
Disturbing the Earth – Contemporary dilemmas
i. Human population growth.
ii. Atmosphere: Greenhouse gas emissions, climate change, air pollution.
iii. Hydrosphere: Fresh water depletion.
iv. Geosphere: Chemical effluents, nuclear waste.
v. Biosphere: Biodiversity loss, deforestation, robustness and fragility of ecosystems. [5L]

Books Recommended:
1. Planetary Surface Processes, H. Jay Melosh, Cambridge University Press, 2011.
2. Consider a Spherical Cow: A course in environmental problem solving, John Harte.University Science Books
3. Holme's Principles of Physical Geology. 1992. Chapman & Hall.
4. Emiliani, C, 1992. Planet Earth, Cosmology, Geology and the Evolution of LifeandEnvironment. Cambridge University Press.

Course Code: BSP-604 (A)
ASTRONOMY AND ASTROPHYSICS
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know about the astronomical scale of distance, mass and time, 2. Get the idea of astronomical coordinates and measurements of astronomical distances 3. Know the ideas of brightness and temperature of the stars, also the astronomical telescopes 4. Learn the process of evolution of the universe, galaxies and stars, 5. Get the details of the solar family and its origin.

Unit: 1
Astronomical Scales: Astronomical distance, mass and time, scales, brightness, radiant flux and luminosity,
Basic concepts of positional astronomy: Celestial sphere, geometry of a sphere, astronomical coordinate systems, geographical coordinate systems, concepts and measurement of time, basic parameters of stars: determination of distance by parallax method, brightness and luminosity, apparent and absolute magnitude, determination of temperature and radius of a star, determination of masses from binary orbits, stellar spectral classification, Hertzsprung-Russell diagram. [12L]

Unit: 2
Astronomical techniques: Basic optical definitions for astronomy: magnification, light gathering power, resolving power and diffraction limit, atmospheric windows;
Optical telescopes: types of reflecting telescopes, telescope mountings, space telescopes. [8L]

Unit-3:
Galaxies: Galaxy morphology, Hubble's classification of galaxies, elliptical, spiral and lenticular galaxies (bulges, disks, galactic halo) the Milky Way galaxy, gas and dust in the galaxy, spiral arms. [8L]

Unit: 4
The Milky Way: Basic Structure and properties of the Milky way, nature of rotation of the milky way, stars and star clusters of the milky way. [4L]

Unit: 5
The solar family: Solar System, facts and figures, origin of the solar system: the nebular model, tidal forces and planetary rings, extra-solar planets.
The sun: Solar parameters, solar photosphere, solar atmosphere, chromosphere, corona, solar activity) [6L]

Books Recommended:

1. Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4thEdition, Saunders College Publishing.
3. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
4. Baidyanath Basu, An introduction to Astrophysics, Second printing, Prentice - Hall of India Private limited, New Delhi, 2001,
5. Introduction to Astrophysics, H. Duorah and K. Duorah.

Course Code: BSP-604 (B)
PHYSICS OF DEVICES AND INSTRUMENTATION
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to understand 1. The qualitative and quantitative aspects of analysis, and evolution of analytical data 2. The idea of different detectors viz. PMT, CMOS, CCD etc. and their associated electronic circuitry. 3. The knowledge of transducer and sensors, and signal transformation techniques 4. The spectroscopic instrumentation and microscopic imaging techniques. 5. The knowledge of instruments for optical and structural investigations

Unit: 1
Qualitative and quantitative aspects of analysis: Sampling, evaluation of analytical data, errors: standard errors, accuracy and precision, methods of their expression, statistical test of data: F, Q and t test, rejection of data, and confidence intervals. [8L]

Unit: 2
Detectors: PMT, avalance photo diode, CMOS and CCD, ionization chamber, GM detector, linear accelerator, cyclotron, scintillation counter. [6L]

Unit: 3
Power supply and Filters: Block diagram of a power supply, qualitative idea of C and L filters, active and passive filters, low pass, high pass, band pass and band reject filters. [8L]

Unit: 4
Transducers and sensors (working principle, efficiency, applications): active and passive transducers, characteristics of transducers, transducers as electrical element and their signal conditioning, temperature transducers, position transducer, piezoelectric transducer, magnetoresistive transducer. [10L]

Unit: 5
Introduction to communication systems: Block diagram of electronic communication system. modulation: basic idea of amplitude, frequency, phase, pulse and digital modulation, modulation index, analysis of amplitude modulated wave, modulators, demodulation of AM wave using diode detector. [10L]

Unit: 6
Optical methods of analysis: Origin of spectra, interaction of radiation with matter, fundamental laws of spectroscopy and selection rules, validity of Beer-Lambert's law. UV-Visible Spectrometry: Basic principles of instrumentation; Raman spectroscopy, Basics of microscopy: fluorescence and confocal microscopy. [12L]

Unit: 7
Material property analysis: Chometography, X-ray diffraction instrumentation, AFM, SEM, TEM, mass spectroscopy. [4L]

Books Recommended:

1. Introduction to Measurements & Instrumentation, A.K.Ghosh, 3rd Ed.,2009,PHI Learning Pvt.Ltd.
2. Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
3. Instrumental methods of analysis; Willard, Hobart H.; Merritt, Lynne L., Dean, John A. Edition: 2012, CBSPublishing.

4. Fundamentals of light microscopy and electronic imaging, Douglas B. Murphy, Wiley-Liss publishing.

Course Code: BSP-605
ELECTROMAGNETIC THEORY PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to understand 1. Learn the concept of Law of Malus and to verify it for Plane Polarized Light. 2. Learn the technique to determine the Specific Rotation of cane sugar using Polarimeter. 3. Understand the method to verify the Brewster's law and to find the Brewster's angle. 4. Will have a basic concept of optical fibers and learn to measure the acceptance angle and Numerical Aperture of an Optical Fibre.

1. To verify the Law of Malus for Plane Polarized Light.
2. To determine the Specific Rotation of cane sugar using Polarimeter.
3. To verify the Brewster's law and to find the Brewster's angle.
4. To measure the Acceptance angle and Numerical Aperture of an Optical Fibre.
5. To determine the wavelength of monochromatic source by Fresnel's biprism.

Books Reccomended:

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

Course Code: BSP-606
STATISTICAL MECHANICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to understand 1. Use numerical simulation for solving different problems in Statistical mechanics 2. Compute physical quantities at large and small temperature 3. Compute velocity distribution of particles. 4. Plot different function viz., Maxwell-Boltzmann distribution, Fermi-Dirac distribution and Bose-Einstein distribution with energy.

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

1. Computational analysis of the behaviour of a collection of particles in a box thatsatisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
   Study of local number density in the equilibrium state (i) average; (ii)fluctuations
   Study of transient behaviour of the system (approach to equilibrium)c) Relationship of large N and the arrow of time.
   Computation of the velocity distribution of particles for the system andcomparison with the Maxwell velocity distribution.
   Computation and study of mean molecular speed and its dependence onparticle mass
   Computation of fraction of molecules in an ideal gas having speed nearthe most probable speed.
2. Computation of the partition function Z(β) for examples of systems with a finitenumber of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number ofnon-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose Einsteinstatistics:
   Study of how Z(β), average energy <E>, energy fluctuation ∇E, C_v,depend upon the temperature, total number of particles N and thespectrum of single particle states.
   Ratios of occupation numbers of various states for the systems considered above.
   Computation of physical quantities at large and small temperature T andcomparison of various statistics at large and small temperature T.
   Plot Planck's law for Black Body radiation and compare it with Raleigh-JeansLaw at high temperature and low temperature.
   Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distributionfunction, Debye distribution function for high temperature and lowtemperature and compare them for these two cases.
   Plot the following functions with energy at different temperaturesa) Maxwell-Boltzmann distributionb) Fermi-Dirac distributionc) Bose-Einstein distribution

Recommended Books:

1. Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W.Sears and Gerhard L. Salinger, 1986, Narosa.
2. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
3. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.
4. Elementary Numerical Analysis, K.E.Atkinson, 3r d E d n. 2 0 0 7 , Wiley India Edition.
5. Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, OxfordUniversity Press.
6. Introduction to Modern Statistical Mechanics, D.Chandler, Oxford University Press, 1987

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Course Code: BSP-607 (A)
MATHEMATICAL PHYSICS III PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to understand 1. Able to perform Scilab/C++ /MATLAB based simulations experiments based on Mathematical Physics. 2. Able to solve differential equations. 3. Able to solve integral problems. 4. Able to evaluate the Fourier coefficients of a given periodic function.

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

1. Solve differential equations:

   $\frac{dy}{dx} = e^{-x}$ with $y = 0$ for $x = 0$

   $\frac{dy}{dx} + e^{-x} y = x^2$

   $\frac{d^2y}{dt^2} = \frac{2dy}{dt} = -y$

   $\frac{d^2y}{dt^2} + e^{-t}\frac{dy}{dt} = -y$

2. Dirac Delta Function:

   Evaluate $\frac{1}{\sqrt{2\pi\sigma^2}}\int e^{\frac{-(x-2)^2}{2\sigma^2}}(x+3)dx$ for $\sigma = 1, 0.1, 0.01$ and show ittends 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: Integrate1/(x^2+2) numerically and check with computer integration.
8. Compute the nth roots of unity for n = 2, 3, and 4.
9. Find the two square roots of −5+12j.
10. Integral transform: FFT of e^{-x^2}
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.

Book Recommendation:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Mathematics for Physicists, P. Dennery and A. Krzywicki, 1967, Dover Publications
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB:Scientific and Engineering Applications: A. VandeWouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896
1. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press

2. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
3. Scilab(A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand& Company
4. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing

Course Code: BSP-607 (B)
BASIC ATMOSPHERIC PHYSICS
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know the structures and composition of the earth's atmosphere. 2. Understand the instruments for meteorological observations. 3. Understand the dynamics of the earth's atmosphere which includes the fundamental forces, conservation laws and atmospheric oscillations etc. 4. Know various types of atmospheric radars and its applications, and know several types of aerosols, its production and removal.

Unit: 1
General features of Earth's atmosphere: Thermal structure of the earth's atmosphere, composition of atmosphere, hydrostatic equation, potential temperature, atmospheric thermodynamics, greenhouse effect, local winds, monsoons, fogs, clouds, precipitation, atmospheric boundary layer, sea breeze and land breeze, instruments for meteorological observations, meteorological processes and convective systems, fronts, cyclones and anticyclones, thunderstorms. [10L]

Unit: 2
Atmospheric dynamics: Fundamental forces, basic conservation laws, the vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, circulations and vorticity, atmospheric oscillations, tropical dynamics. [8L]

Unit: 3
Atmospheric waves: Surface water waves, wave dispersion, acoustic waves, buoyancy waves, propagation of atmospheric gravity waves (AGWs) in a nonhomogeneous medium, Lamb wave, Rossby waves and its propagation in three dimensions and in sheared flow, wave absorption, non-linear consideration [8L]

Unit: 4
Atmospheric Radar and Lidar: Radar equation and return signal, various type of atmospheric radars and its application to study atmospheric phenomena, Lidar and its applications, data analysis tools and techniques.

Unit: 5
Atmospheric Aerosols*:* Spectral distribution of the solar radiation, classification and properties of aerosols, production and removal mechanisms, radiative and health effects, observational techniques for aerosols, Rayleigh scattering and Mie scattering, Beer-Lambert law, optical phenomena in atmosphere, aerosol studies using Lidars.

Books Recommended:

1. Fundamental of Atmospheric Physics, M.L Salby; Academic Press, Vol 61, 1996
2. The Physics of Atmosphere – John T. Houghton; Cambridge University press;3rd edn. 2002.
3. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
4. Radar for meteorological and atmospheric observations – S Fukao and KHamazu, Springer Japan, 2014

Course Code: BSP-608 (A)
ASTRONOMY AND ASTROPHYSICS PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know how different types of telescope works, 2. Gain the knowledge of lunar craters 3. Gain the knowledge of magnitudes of the stars 4. Knowledge of Stellarium software

List of Experiments: (Any 5 among the given list are to perform)

1. Calibration of plate scale of a given astronomical telescope,
2. Determination of Lunar craters and Maria.
3. Determination of magnitude of different stars in star field by using image processing software (IRAF/Epoch 2002),
4. Plotting of heavenly bodies in main sequence of H-R diagram by using Stellarium software,
5. Recording of Sun-Spot and study of its variation,
6. Determination of intensity of solar Fraunhofer lines with spectrometer

Books Recommendation:

Course Code: BSP-608 (B)
PHYSICS OF DEVICES AND INSTRUMENTATION PRACTICAL
(Credits: 2)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. Know how zener diode can be applied as a voltage regulator. 2. Gain the knowledge of low pass and high pass filters 3. Gain the knowledge of amplitudes and frequency modulations 4. Have the knowledge of Linear Variable Differential Transformer

List of Experiments:

1. To set up a power supply using a zener diode as a voltage regulator and to calculate the percentage of regulation.
2. Study the transfer function and phase shift of a low pass and high pass RC filter network.
3. To perform the amplitude modulation and demodulation using AM kit.
4. To study a Linear Variable Differential Transformer (LVDT) and use it in a simple experimental set up to measure a small displacement.
5. Measurement of speed of D.C motor by photoelectric pick up.

Books Recommendation:

Course Code: BSP-609
DISSERTATION
(Credits: 4)

COURSE OUTCOMES
Upon successful completion of the course students will be able to 1. To develop skills in research and methods available, towards addressing specific project objectives. 2. To identify noble research area and carry out literature survey. 3. Able to analyze research literatures, and able to learn different software packages depending upon the nature of project. 4. Would be able to design the methods and carry out the procedure as per the project. 5. To produce clear and concise written dissertation and present a research-level seminar..

Course Code: HVP-760
Fundamentals of Human Values and Professional Ethics
(Non-Credit Compulsory Course)

Course Description: The course aims at introducing the Undergraduate students with the fundamentals concepts and ideas on morality and ethics. It is also aimed to give basic understanding and an insight to the diverse elements and aspects relating to cultural and religious values, human virtues, and professional ethics in local and global context. On successful completion of the course students will be able to learn and maintain a good interpersonal relation in social and professional space.

Course Objectives:

1) To introduce the students to the fundamentals of human values and professional ethics and make its significance in the present day context.
2) To understand the ethical concerns in professional and personal space.

Unit-1: Ethics and Human Values [8 L]

Fundamentals of Ethics.
Fundamentals of Values:
Values embedded in different religions; Religious Tolerance.

Unit-2: Basic Human Virtues [8 L]

Concept of Human Virtues
Gender Equality, Diversity in ability, Cultural acceptability.
Social Concerns: Evils of Dowry & Caste System, Racial Discrimination, Depression

Unit-3: Introduction to Professional Ethics [8 L]

Fundamentals of Professional Ethics.
Professional crimes
Professional Rights

Unit-4: Ethics in Professional and Global Space [5 L]

Cyber Ethics and Etiquette.
Ethics in cyber and professional space.
Environmental Ethics; Ethics in Research.

Suggested Readings:

1. Jayashree Suresh and B S Raghavan- *Human Values and Professional Ethics: Values and Ethics of Profession.* S Chand, 2005.
2. Martin, Clancy, Wayne Vaught, and Robert Solomon (eds.)-*Ethics Across the Professions: A Reader for Professional Ethics*. Oxford: Oxford University Press, 2010.
3. R.R. Gaur, R. Sangal and G.P. Bagaria- *A Foundation Course in Human Values and Professional Ethics* (Paperback). Excel Books, 2010
4. Terrence M. Kelly- *Professional Ethics: A Trust-Based Approach.* Lexington Books, 2018.
5. R. S. Naagarazan- *Professional Ethics and Human Values.* New Age International (Second ed.), 2019.