Faculty of Physical Sciences

Course Name: B.Sc. (H) - Physics

PDM University, Bahadurgarh, Haryana – 124507

Established under Haryana Private Universities

(Amendment), Act, 2015 (Haryana Act No.1 of 2016)

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (1st Semester)
PHYSICS: CORE

Module: Mathematical Physics-I	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS1105	**Total Marks: 100**
Credits: 04	**Duration of Examination : 3 hrs**

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

Unit: I Calculus:
Recapitulation: Limits, continuity, average and instantaneous quantities, differentiation. Plotting functions. Intuitive ideas of continuous, differentiable, etc. functions and plotting of curves. Approximation: Taylor and binomial series (statements only).
First Order and Second Order Differential equations: First Order Differential Equations and Integrating Factor. Homogeneous Equations with constant coefficients. Wronskian and general solution. Statement of existence and Uniqueness Theorem for Initial Value Problems. Particular Integral.
Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor, with simple illustration. Constrained Maximization using Lagrange Multipliers

Unit: II Vector Calculus:
Recapitulation of vectors: Properties of vectors under rotations. Scalar product and its invariance under rotations. Vector product, Scalar triple product and their interpretation in terms of area and volume respectively. Scalar and Vector fields.
Vector Differentiation: Directional derivatives and normal derivative. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators. Vector identities.
Vector Integration: Ordinary Integrals of Vectors. Multiple integrals, Jacobian. Notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of Vector fields. Flux of a vector field. Gauss' divergence theorem, Green's and Stokes Theorems and their applications (no rigorous proofs).

Unit: III Orthogonal Curvilinear Coordinates and Dirac's Delta Function
Orthogonal Curvilinear Coordinates. Derivation of Gradient, Divergence, Curl and Laplacian in Cartesian, Spherical and Cylindrical Coordinate Systems. Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Unit: IV Introduction to probability
Independent random variables: Probability distribution functions; binomial, Gaussian, and Poisson, with examples. Mean and variance. Dependent events: Conditional Probability. Bayes' Theorem and the idea of hypothesis testing.

Reference Books:
1. Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7th Edn., Elsevier.
2. An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning.
3. Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
4. Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
5. Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
6. Engineering Mathematics, Grewal

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (1st Semester)
PHYSICS: CORE

Module: Mathematical Physics-I Lab	**Sessional Marks: 15** **Practical Marks: 35**
Module Code: PHYS1106	**Total Marks: 50**
Credits: 02	

The aim of this Lab is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *The course will consist of lectures (both theory and practical) in the Lab*
- *Evaluation done not on the programming but on the basis of formulating the problem*
- *Aim at teaching students to construct the computational problem to be solved Students can use any one operating system Linux or Microsoft Windows*

Topics	**Description with Applications**
Introduction and Overview	Computer architecture and organization, memory and Input/output devices
Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflowemphasize the importance of making equations in terms of dimensionless variables, Iterative methods
Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
Review of C & C++ Programming fundamentals	Introduction to Programming, constants, variables and data types, operators and Expressions, I/O statements, scanf and printf, c in and c out, Manipulators for data formatting, Control statements (decision making and looping statements) (*If-statement. If-else Statement. Nested if Structure. Else-if Statement. Ternary Operator. Goto Statement. Switch Statement. Unconditional and Conditional Looping. While Loop. Do-While Loop. FOR Loop. Break and Continue Statements. Nested Loops*), Arrays (*1D & 2D*) and strings, user defined functions, Structures and Unions, Idea of classes and objects
Programs:	Sum & average of a list of numbers, largest of a given list of numbers and its location in the list, sorting of numbers in ascending descending order, Binary search
Random number generation	Area of circle, area of square, volume of sphere, value of pi **(π)**

Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson and Secant methods	Solution of linear and quadratic equation, solving $\alpha = \tan \alpha$; $I = I_0 \left[\frac{\sin \alpha}{\alpha}\right]^2$ in optics
Interpolation by Newton Gregory Forward and Backward difference formula, Error estimation of linear interpolation	Evaluation of trigonometric functions e.g. *sin θ, cos θ, tan θ, etc.*
Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	Given Position with equidistant time data to calculate velocity and acceleration and vice versa. Find the area of B-H Hysteresis loop
Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	First order differential equation Radioactive decay Current in RC, LC circuits with DC source Newton's law of cooling Classical equations of motion Attempt following problems using RK 4 order method: Solve the coupled differential equations $\frac{dx}{dt} = y + x - \frac{x^3}{3}$; $\frac{dy}{dx} = -x$ for four initial conditions x(0) = 0, y(0) = -1, -2, -3, -4. Plot x vs y for each of the four initial conditions on the same screen for $0 \le t \le 15$ The differential equation describing the motion of a pendulum is $\frac{d^2\theta}{dt^2} = -\sin\theta$. The pendulum is released from rest at an angular displacement α, i. e. $\theta(0) = \alpha$ and $\theta'(0) = 0$. Solve the equation for α = 0.1, 0.5 and 1.0 and plot θ as a function of time in the range $0 \le t \le 8\pi$. Also plot the analytic solution valid for small $\sin\theta$

Referred Books:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn. , 2012, PHI Learning Pvt. Ltd.
2. Schaum's Outline of Programming with C++. J. Hubbard, 2000, McGraw-Hill Pub.
3. Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal, 3rd Edn. , 2007, Cambridge University Press.
4. A first course in Numerical Methods, U.M. Ascher & C. Greif, 2012, PHI Learning.
5. Elementary Numerical Analysis, K.E. Atkinson, 3 r d Edn. , 2007, Wiley India Edition. Numerical Methods for Scientists & Engineers, R.W. Hamming, 1973, Courier Dover Pub. An Introduction to computational Physics, T.Pang, 2nd Edn. , 2006,Cambridge Univ. Press
6. Computational Physics, Darren Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
7. Numerical Methods: J.B. Dixit

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (1st Semester)
PHYSICS: CORE

Module: Advanced Mechanics	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS1107	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variablemass 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.

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.

Rotational Dynamics: Angular momentum of a particle and system of particles. Torque. Principle of conservation of angular momentum. Rotation about a fixed axis. Moment of Inertia. Calculation of moment of inertia for rectangular, cylindrical and spherical bodies. Kinetic energy of rotation. Motion involving both translation and rotation.

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

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

Gravitation and Central Force Motion: Law of gravitation. Gravitational potential energy. Inertial and gravitational mass. Potential and field due to spherical shell and solid sphere.
Motion of a particle under a central force field. Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).
Oscillations: SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time- average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.
Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Laws of Physics in rotating coordinate systems. Centrifugal force. Coriolis force and its applications. Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.
Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum.

Reference Books:

1. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
2. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
3. Feynman Lectures, Vol.-1; R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
4. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
5. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
6. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (1st Semester)
PHYSICS: CORE

Module: Adv. Mechanics Lab	**Sessional Marks: 15**
Module Code: PHYS1108	**Practical Marks: 35**
Practical : 4	**Total Marks: 50**
Credits: 2.0	

Practical

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.
2. To study the random error in observations.
3. To determine the height of a building using a Sextant.
4. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
5. To determine the Moment of Inertia of a Flywheel.
6. To determine **g** and velocity for a freely falling body using Digital Timing Technique
7. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8. To determine the Young's Modulus of a Wire by Optical Lever Method.
9. To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
10. To determine the elastic Constants of a wire by Searle's method.
11. To determine the value of g using Bar Pendulum.
12. To determine the value of g using Kater's Pendulum.

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
4. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
5. Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (2nd Semester)
PHYSICS: CORE

Module: Adv. Electricity and Magnetism	**Sessional Marks: 40**
Module Code: PHYS1109	**Theory Paper Marks:60**
Lectures : 4	**Total Marks: 100**
Credits: 4.0	**Duration of Exam : 03 Hrs.**

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

Unit: II
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 (1) Solenoid and (2) Toroid. Properties of **B**: curl and divergence. Vector Potential. Magnetic Force on (1) point charge
(2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.
Magnetic Properties of Matter: Magnetization vector (**M**). Magnetic Intensity(**H**). Magnetic Susceptibility and permeability. Relation between **B, H, M.** Ferromagnetism. B-H curve and hysteresis.

Unit: III
Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. Introduction to Maxwell's Equations. Charge Conservation and Displacement current.
Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity.
Electromagnetic damping. Logarithmic damping. CDR.

Unit: IV
Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series
LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. Parallel LCR Circuit.
Network theorems: Ideal Constant-voltage and Constant-current Sources. Network Theorems: Thevenin theorem, Norton theorem, Superposition theorem, Reciprocity theorem, Maximum Power Transfer theorem. Applications to dc circuits.

Reference Books:

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (2nd Semester)
PHYSICS: CORE

Module: Electricity & Magnetism Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS1110	**Total Marks: 50**
Credits: 2.0	

Practical

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

Reference Books

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. Engineering Practical Physics, S.Panigrahi and B.Mallick, 2015, Cengage Learning.
5. A Laboratory Manual of Physics for undergraduate classes, D.P.Khandelwal, 1985, Vani Pub.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (2^{nd} Semester)
PHYSICS: CORE

Module: Waves and Optics	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS1111	**Total Marks: 100**
Credits: 4.0	**Duration of Exam : 03 Hrs**

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

Unit: II Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Water Waves: Ripple and Gravity Waves.
Velocity of Waves: Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.
Superposition of Two Harmonic Waves: Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Phase and Group Velocities. Changes with respect to Position and Time. Energy of Vibrating String. Transfer of Energy. Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment. Longitudinal Standing Waves and Normal Modes. Open and Closed Pipes. Superposition of N Harmonic Waves.

Unit: III Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence.
Interference: Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index.
Interferometer: Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

Unit: IV Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only)
Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating.
Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave. Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.
Holography : Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

Reference Books

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (2nd Semester)
PHYSICS: CORE

Module: Waves and Optics Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS1112	**Total Marks: 50**
Credits: 2.0	

Practical

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ_2 –T law.
2. To investigate the motion of coupled oscillators.
3. To study Lissajous Figures.
4. Familiarization with: Schuster`s focusing; determination of angle of prism.
5. To determine refractive index of the Material of a prism using sodium source.
6. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
7. To determine the wavelength of sodium source using Michelson's interferometer.
8. To determine wavelength of sodium light using Fresnel Biprism.
9. To determine wavelength of sodium light using Newton's Rings.
10. To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
11. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
12. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: Mathematical Physics-II	**Sessional Marks: 40** **Theory Paper Marks:60**
Module Code: PHYS2105	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Unit: I Fourier Series: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Even and odd functions and their Fourier expansions. Application. Summing of Infinite Series. Term-by-Term differentiation and integration of Fourier Series. Parseval Identity.

Unit: II Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to differential equations. Legendre, Bessel, Hermite and Laguerre Differential Equations. Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_0(x)$ and $J_1(x)$)and Orthogonality.

Unit: III Some Special Functions and Theory of Errors: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. Error Function (Probability Integral).
Systematic and Random Errors. Propagation of Errors. Normal Law of Errors. Standard and Probable Error. Least-squares fit. Error on the slope and intercept of a fitted line.

Unit: IV Partial Differential Equations : Solutions to partial differential equations, using separation of variables: Laplace's Equation in problems of rectangular, cylindrical and spherical symmetry. Wave equation and its solution for vibrational modes of a stretched string, rectangular and circular membranes. Diffusion Equation.

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: M.P-II Lab	**Sessional Marks: 15**
	Practical Marks:35
Module Code: PHYS2106	**Total Marks: 50**
Credits: 2.0	

Practical

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

Topics	**Description with Applications**
Introduction to Numerical computation software Scilab	Introduction to Scilab, Advantages and disadvantages, Scilab environment, Command window, Figure window, Edit window, Variables and arrays, Initialising variables in Scilab, Multidimensional arrays, Subarray, Special values, Displaying output data, data file, Scalar and array operations, Hierarchy of operations, Built in Scilab functions, Introduction to plotting, 2D and 3D plotting (2), Branching Statements and program design, Relational & logical operators, the while loop, for loop, details of loop operations, break & continue statements, nested loops, logical arrays and vectorization (2) User defined functions, Introduction to Scilab functions, Variable passing in Scilab, optional arguments, preserving data between calls to a function, Complex and Character data, string function, Multidimensional arrays (2) an introduction to Scilab file processing, file opening and closing, Binary I/o functions, comparing binary and formatted functions, Numerical methods and developing the skills of writing a program (2).
Curve fitting, Least square fit, Goodness of fit, standard deviation	Ohms law to calculate R, Hooke's law to calculate spring constant
Solution of Linear system of equations by Gauss elimination method and Gauss Seidal method. Diagonalization of matrices, Inverse of a matrix, Eigen vectors, eigen values problems	Solution of mesh equations of electric circuits (3 meshes) Solution of coupled spring mass systems (3 masses)
Generation of Special functions using User defined functions in Scilab	enerating and plotting Legendre Polynomials Generating and plotting Bessel function

Solution of ODE	
First order Differential equation Euler, modified Euler and Runge-Kutta second order methods	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 Fixed difference method	Second order Differential Equation Harmonic oscillator (no friction) Damped Harmonic oscillator Over damped Critical damped Oscillatory Forced Harmonic oscillator Transient and Steady state solution Apply above to LCR circuits also Solve ___ 4 1 2 1 with the boundary conditions at 1, $\frac{1}{2}$, ___ $\frac{3}{2}$ dy 0.5, in the range 1 3 . Plot y and ___ against x in the given range on the same graph.
Partial differential equations	Partial Differential Equation: Wave equation Heat equation Poisson equation Laplace equation
Using Scicos / xcos	Generating square wave, sine wave, saw tooth wave Solution to harmonic oscillator Study of beat phenomenon Phase space plots

Reference Books:

1. Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
2. Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
3. Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
4. A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
5. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering
6. Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
7. Scilab by example: M. Affouf 2012, ISBN: 978-1479203444
8. Scilab (A free software to Matlab): H.Ramchandran, A.S.Nair. 2011 S.Chand & Company
9. Scilab Image Processing: Lambert M. Surhone. 2010 Betascript Publishing
10. www.**scilab**.in/textbook_companion/generate_book/291

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: Thermal Physics	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS2107	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

Unit: I Introduction to Thermodynamics
Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between 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.

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

Unit: III Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations
Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) Clausius Clapeyron equation, (2) Values of C_p-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Unit: IV Kinetic Theory of Gases Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification. Doppler Broadening of Spectral Lines and Stern's Experiment. Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.
Molecular Collisions: Mean Free Path. Collision Probability. Estimates of Mean Free Path. Transport Phenomenon in Ideal Gases: (1) Viscosity, (2) Thermal Conductivity and (3) Diffusion. Brownian Motion and its Significance
Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation. Andrew's Experiments on CO2 Gas. Critical Constants. Continuity of Liquid and Gaseous State. Vapour and Gas. Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants. Law of Corresponding States. Comparison with Experimental Curves. P-V Diagrams. Joule's Experiment. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Porous Plug Experiment. Joule-Thomson Effect for Real

and Van der Waal Gases. Temperature of Inversion. Joule-Thomson Cooling.

Reference Books:

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: Thermal Physics Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS2108	**Total Marks: 50**
Credits: 2.0	

Practical

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

Reference Books

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: Digital Systems and Applications	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS2109	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

Unit: I- 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.
Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates and application as Parity Checkers.

Unit: II- Boolean algebra: De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map.

Unit: III -Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders.
Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor.
Sequential Circuits: SR, D, and JK Flip-Flops. Clocked (Level and Edge Triggered) Flip-Flops. Preset and Clear operations. Race-around conditions in JK Flip-Flop. M/S JK Flip-Flop.
Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator.
Shift registers: Serial-in-Serial-out, Serial-in-Parallel-out, Parallel-in-Serial-out and Parallel-in-Parallel-out Shift Registers (only up to 4 bits).
Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter.

Unit: IV -Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM).. Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map.
Intel 8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components. Pin-out diagram. Buses. Registers. ALU. Memory. Stack memory. Timing & Control circuitry. Timing states. Instruction cycle, Timing diagram of MOV and MVI. Introduction to Assembly Language**:** 1 byte, 2 byte & 3 byte instructions.

Reference Books:

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: DSA Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS2110	**Total Marks: 50**
Credits: 2.0	

Practical

1. To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2. To test a Diode and Transistor using a Multimeter.
3. To design a switch (NOT gate) using a transistor.
4. To verify and design AND, OR, NOT and XOR gates using NAND gates.
5. To design a combinational logic system for a specified Truth Table.
6. To convert a Boolean expression into logic circuit and design it using logic gate ICs.
7. To minimize a given logic circuit.
8. Half Adder, Full Adder and 4-bit binary Adder.
9. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.
10. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
11. To build JK Master-slave flip-flop using Flip-Flop ICs
12. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
13. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.
14. To design an astable multivibrator of given specifications using 555 Timer.
15. To design a monostable multivibrator of given specifications using 555 Timer.
16. Write the following programs using 8085 Microprocessor

a) Addition and subtraction of numbers using direct addressing mode
b) Addition and subtraction of numbers using indirect addressing mode
c) Multiplication by repeated addition.
d) Division by repeated subtraction.
e) Handling of 16-bit Numbers.
f) Use of CALL and RETURN Instruction.
g) Block data handling.
h) Other programs (e.g. Parity Check, using interrupts, etc.).

Reference Books:

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module : Minor Group Project	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS2111	**Total Marks: 50**
Credits: 2.0	

The aim of this minor group Project is to teach the students

1. how to work in a team
2. how to do literature survey on the given topic(which will be decided by the supervisor).
3. how to make a proper use of research material.
4. how to prepare a project document in a prescribed form.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (4th Semester)
PHYSICS: CORE

Module: Mathematical Physics-III	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS2112	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03hrs**

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions. Singular functions: poles and branch points, order of singularity, branch cuts. Integration of a function of a complex variable. Cauchy's Inequality. Cauchy's Integral formula. Simply and multiply connected region. Laurent and Taylor's expansion. Residues and Residue Theorem. Application in solving Definite Integrals.

Integrals Transforms:
Fourier Transforms: Fourier Integral theorem. Fourier Transform. Examples. Fourier transform of trigonometric, Gaussian, finite wave train & other functions. Representation of Dirac delta function as a Fourier Integral. Fourier transform of derivatives, Inverse Fourier transform, Convolution theorem. Properties of Fourier transforms (translation, change of scale, complex conjugation, etc.). Three dimensional Fourier transforms with examples. Application of Fourier Transforms to differential equations: One dimensional Wave and Diffusion/Heat Flow Equations.

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

Reference Books:

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (4th Semester)
PHYSICS: CORE

Module: M.P.-III Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS2113	**Total Marks: 50**
Credits: 2.0	

Practical

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

1. Solve differential equations: $dy/dx = e^{-x}$ with y = 0 for x = 0 $dy/dx + e^{-x}y = x^2$ $d^2y/dt^2 + 2\, dy/dt = -y$ $d^2y/dt^2 + e^{-t}dy/dt = -y$
2. Dirac Delta Function:
   Evaluate $\frac{1}{\quad}\int e^{\overline{\ \ 2\sigma^2}}$ 3, for = 1, 0.1, 0.01 and show it
   √
   tends to 5.
3. Fourier Series:
   Program to sum ∑ 0.2
   Evaluate the Fourier coefficients of a given periodic function (square wave)
4. Frobenius method and Special functions: μ μ μ ,
   Plot ,
   Show recursion relation
5. Calculation of error for each data point of observations recorded in experiments done in previous semesters (choose any two).
6. Calculation of least square fitting manually without giving weightage to error. Confirmation of least square fitting of data through computer program.
7. Evaluation of trigonometric functions e.g. *sin θ,* Given Bessel's function at N points find its value at an intermediate point. Complex analysis: Integrate $1/(x^2+2)$ numerically and check with computer integration.
8. Compute the n^{th} roots of unity for *n* = 2, 3, and 4.
9. Find the two square roots of −5+12*j.*
10. Integral transform: FFT of
11. Solve Kirchoff's Current law for any node of an arbitrary circuit using Laplace's transform.
12. Solve Kirchoff's Voltage law for any loop of an arbitrary circuit using Laplace's transform.
13. Perform circuit analysis of a general LCR circuit using Laplace's transform.

Reference Books:

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (4th Semester)
PHYSICS: CORE

Module: Elements of Modern Physics	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS2114	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

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.**Unit: I** Planck's quantum, Planck's constant and light as a collection of photons; Blackbody Radiation: Quantum theory of Light; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. Wave description of particles by wave packets. Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions. Position measurement- gamma ray microscope thought experiment; Wave-particle duality, Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude.

Unit: II

Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunnelling in one dimension-across a step potential & rectangular potential barrier.

Unit: III

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. Fission and fusion- mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Unit: IV

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

Reference 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 toQuantum 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. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmilla

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (4th Semester)
PHYSICS: CORE

Module: EMP Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS2115	**Total Marks: 50**
Credits: 2.0	

Practical

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

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (4th Semester)
PHYSICS: CORE

Module: Analog Systems & Applications	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS2116	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

Unit: I
Semiconductor Diodes: P and N type semiconductors,Energy Level Diagram, Conductivity and Mobility, Drift velocity, Barrier Formation in PN Junction Diode, Static and Dynamic Resistance, Current Flow Mechanism in Forward and Reverse Biased Diode, Half-wave Rectifiers, Centre-tapped and Bridge Full-wave Rectifiers, zener diode as voltage regulator, Principle and structure of LED and Photodiode.

Unit: II
Bipolar Junction transistors: n-p-n and p-n-p Transistors, Characteristics of CB, CE and CC Configurations, Current gains α and β Relations between α and β, DC Load line and Q-point, Active, Cutoff and Saturation Regions.

Unit: III
Amplifiers: Classification of Class A, B & C Amplifiers, single-stage CE amplifier, distortion in amplifiers, Two stage RC-coupled amplifier and its frequency response, Feedback concept**,** negative feedback in Amplifiers**,** Effects of Negative Feedback on Input Impedance, Output Impedance, Gain Stability, Distortion and Noise.
Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations, RC Phase shift oscillator, Hartley and Colpitts oscillators.

Unit: IV
Operational Amplifiers : Introduction to op-amp, Block diagram of op-amp, pin diagram of 741 IC, Ideal and Practical Op-Amp, differential amplifier, CMRR, Slew Rate, Virtual ground.
Applications of Op-Amps: (1) Inverting and non-inverting amplifiers (2) Adder (3) Differentiator
(4) Integrator (5) Log amplifier (6) A/D Conversion**.**

References:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3. Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
4. Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
6. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
7. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
8. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
9. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
10. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (4th Semester)
PHYSICS: CORE

Module: ASA- Lab	**Sessional Marks: 15**
Module Code: PHYS2117	**Practical Marks: 35**
Credits: 2.0	**Total Marks: 50**

Practical

1. To Study of lab equipments and components**:** CRO, Multimeter, Function Generator, Power supply-
   Active, Passive Components & Bread Board.
2. To study V-I characteristics of PN junction diode.
3. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
4. To study and draw the characteristics of half wave and full wave rectifier.
5. To study the various biasing configurations of BJT.
6. To study the frequency response of voltage gain of a RC-coupled transistor amplifier.
7. To design a Wien bridge oscillator for given frequency using an op-amp.
8. To design an inverting amplifier using Op-amp.
9. To design non-inverting amplifier using Op-amp.
10. To verify the operation of op-Amp as summing amplifier.
11. To study the use of an op-amp as an Integrator.
12. To study the use of an op-amp as a Differentiator.
13. To study the use of Op-Amp as a logarithmic amplifier.

References

1. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc-Graw Hill.
2. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall.
3. Electronic Principle, Albert Malvino, 2008, Tata Mc-Graw Hill.
4. Electronic Devices & circuit Theory, R.L. Boylestad & L.D. Nashelsky, 2009, Pearson Education

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: Minor Individual Project	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS2118	**Total Marks: 50**
Credits: 2.0	

The aim of this Minor Individual Project is to train the student

1. how to work on a research topic
2. how to do literature survey on the given research topic(which will be decided by the supervisor).
3. how to make a proper use of research material and try to investigate/ analyze an open research problem.
4. how to prepare a project document in a prescribed form.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (5th Semester)
PHYSICS: CORE

Module: Quantum Mechanics & Applications	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS3101	**Total Marks: 100**
Credits: 4.0	

Unit: I

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

Unit: II

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

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

Unit: III

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells. **Atoms in Electric & Magnetic Fields**: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Zeeman Effect: Electron Magnetic Moment and Magnetic Energy, Gyromagnetic Ratio and Bohr Magneton.
Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only).

Unit: IV

Many electron atoms: Pauli's Exclusion Principle. Symmetric & Antisymmetric Wave Functions. Periodic table. Fine structure. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Model. Spin-orbit coupling in atoms- L-S and J-J couplings. Hund's Rule. Term symbols. Spectra of Hydrogen and Alkali Atoms (Na etc.).

References

1. A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
2. Introduction to Quantum Mechanics, D.J. Griffith, 2nd Ed. 2005, Pearson Education
3. Quantum Mechanics: Theory & Applications, A.K.Ghatak & S.Lokanathan, 2004, Macmilla
4. Concepts of Modern Physics, Arther Beiser, 2002 Tata McGraw Hill

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (5th Semester)
PHYSICS: CORE

Module: Quantum Mechanics Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS3102	**Total Marks: 50**
Credits: 2.0	

Practical

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:
   , where
   Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of the hydrogen atom is □-13.6 eV. Take e = 3.795 $(eVÅ)^{1/2}$, ħc = 1973 (eVÅ) and m = 0.511×10^{6} eV/c^{2}.

2. Solve the s-wave radial Schrodinger equation for an atom:
   where m is the reduced mass of the system (which can be chosen to be the mass of an electron), for the screened coulomb potential
   /
   Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wave function. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511×10^{6} eV/c^{2}, and a = 3 Å, 5 Å, 7 Å. In these units ħc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

3. Solve the s-wave radial Schrodinger equation for a particle of mass m:
   ,
   For the anharmonic oscillator potential
   $\frac{1}{2}$ $\frac{1}{3}$
   for the ground state energy (in MeV) of particle to an accuracy of three significant digits. Also, plot the corresponding wave function. Choose m = 940 MeV/c^{2}, k = 100 MeV fm^{-2}, b = 0, 10, 30 MeV fm^{-3}In these units, cħ = 197.3 MeV fm. The ground state energy I expected to lie between 90 and 110 MeV for all three cases.

4. Solve the s-wave radial Schrodinger equation for the vibrations of hydrogen molecule:
   ,
   Where □ is the reduced mass of the two-atom system for the Morse potential
   ,
   Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.
   Take: m = 940×10^{6} eV/C^{2}, D = 0.755501 eV, α = 1.44, r_o = 0.131349 Å

Laboratory based experiments:

5. Study of Electron spin resonance- determine magnetic field as a function of the resonance frequency
6. Study of Zeeman effect: with external magnetic field; Hyperfine splitting
7. To show the tunneling effect in tunnel diode using I-V characteristics.
8. Quantum efficiency of CCDs

References:

1. Schaum's outline of Programming with C++. J.Hubbard, 2000,McGraw-Hill Publication Numerical Recipes in C: The Art of Scientific Computing, W.H. Pressetal., 3rd Edn., 2007, Cambridge University Press.
2. An introduction to computational Physics, T.Pang, 2nd Edn.,2006, Cambridge Univ. Press
3. Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific & Engineering
4. Applications: A. Vande Wouwer, 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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (5th Semester)
PHYSICS: CORE

Module: Solid State Physics	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS3103	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

Unit: I Crytal Structure and Lattice Dynamics
Crystal Structure: Solids: Amorphous and Crystalline Materials. Lattice Translation Vectors. Lattice with a Basis – Central and Non-Central Elements. Unit Cell. Miller Indices. Reciprocal Lattice. Types of Lattices. Brillouin Zones. Diffraction of X-rays by Crystals. Bragg's Law. Atomic and Geometrical Factor.
Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T_3 law

Unit: II
Magnetic Properties of Matter: Dia-, Para-, Ferri- and Ferromagnetic Materials. Classical Langevin Theory of dia– and Paramagnetic Domains. Quantum Mechanical Treatment of Paramagnetism. Curie's law, Weiss's Theory of Ferromagnetism and Ferromagnetic Domains. Discussion of B-H Curve. Hysteresis and Energy Loss.

Unit: III Dielectric and Ferroelectric Properties of Materials
Dielectric Properties of Materials: Polarization. Local Electric Field at an Atom. Depolarization Field. Electric Susceptibility. Polarizability. Clausius Mosotti Equation. Classical Theory of Electric Polarizability. Normal and Anomalous Dispersion. Cauchy and Sellmeir relations. Langevin-Debye equation. Complex Dielectric Constant. Optical Phenomena. Application: Plasma Oscillations, Plasma Frequency, Plasmons, TO modes. **Ferroelectric Properties of Materials:** Structural phase transition, Classification of crystals, Piezoelectric effect, Pyroelectric effect, Ferroelectric effect, Electrostrictive effect, Curie-Weiss Law, Ferroelectric domains, PE hysteresis loop.

Unit: IV Review of Band Theory of Solids and Superconductivity
Elementary band theory: Kronig Penny model. Band Gap. Conductor, Semiconductor (P and N type) and insulator. Conductivity of Semiconductor, mobility, Hall Effect. Measurement of conductivity (04 probe method) & Hall coefficient. **Superconductivity:** Experimental Results. Critical Temperature. Critical magnetic field. Meissner effect. Type I and type II Superconductors, London's Equation and Penetration Depth. Isotope effect. Idea of BCS theory (No derivation)

Reference Books:

1. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
2. Elements of Solid State Physics, J.P. Srivastava, 4th Edition, 2015, Prentice-Hall of India
3. Introduction to Solids, Leonid V. Azaroff, 2004, Tata Mc-Graw Hill
4. Solid State Physics, N.W. Ashcroft and N.D. Mermin, 1976, Cengage Learning
5. Solid-state Physics, H. Ibach and H. Luth, 2009, Springer
6. Solid State Physics, Rita John, 2014, McGraw Hill
7. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India Solid State Physics, M.A. Wahab, 2011, Narosa Publications

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (5th Semester)
PHYSICS: CORE

Module: SSP Lab	**Sessional Marks: 15**
	Practical Marks:35
Module Code: PHYS3104	**Total Marks: 50**
Credits: 2.0	

Practical

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)
2. To measure the Magnetic susceptibility of Solids.
3. To determine the Coupling Coefficient of a Piezoelectric crystal.
4. To measure the Dielectric Constant of a dielectric Materials with frequency
5. To determine the complex dielectric constant and plasma frequency of metal using Surface Plasmon resonance (SPR)
6. To determine the refractive index of a dielectric layer using SPR
7. To study the PE Hysteresis loop of a Ferroelectric Crystal.
8. To draw the BH curve of Fe using Solenoid & determine energy loss from Hysteresis.
9. To measure the resistivity of a semiconductor (Ge) with temperature by four-probe method (room temperature to 150 ^{o}C) and to determine its band gap.
10. To determine the Hall coefficient of a semiconductor sample.

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 Ed., 2011, Kitab Mahal
4. Elements of Solid State Physics, J.P. Srivastava, 2nd Ed., 2006, Prentice-Hall of India.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (6th Semester)
PHYSICS: CORE

Module: Statistical Mechanics	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS3105	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

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

Unit: II- Classical And Quantum Theory of Radiation
Classical Theory of Radiation: Properties of Thermal Radiation. Blackbody Radiation. Pure temperature dependence. Kirchhoff's law. Stefan-Boltzmann law: Thermodynamic proof. Radiation Pressure. Wien's Displacement law. Wien's Distribution Law. Saha's Ionization Formula. Rayleigh-Jean's Law. Ultraviolet Catastrophe.
Quantum Theory of Radiation: Spectral Distribution of Black Body Radiation. Planck's Quantum Postulates. Planck's Law of Blackbody Radiation: Experimental Verification. Deduction of (1) Wien's Distribution Law, (2) Rayleigh-Jeans Law, (3) Stefan-Boltzmann Law, (4) Wien's Displacement law from Planck's law.

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

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

Reference 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 Statistical and Thermal Physics, S. Lokanathan and R.S. Gambhir. 1991, Prentice Hall Thermodynamics, Kinetic Theory and Statistical Thermodynamics, Francis W. Sears and Gerhard L. Salinger, 1986, Narosa.
3. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer
4. An Introduction to Statistical Mechanics & Thermodynamics, R.H. Swendsen, 2012, Oxford Univ. Press

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (6^{th} Semester)
PHYSICS: CORE

Module: Statistical Mechanics Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS3106	**Total Marks: 50**
Credits: 2.0	

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

1. Computational analysis of the behavior of a collection of particles in a box that satisfy Newtonian mechanics and interact via the Lennard-Jones potential, varying the total number of particles N and the initial conditions:
a) Study of local number density in the equilibrium state (i) average; (ii) fluctuations
b) Study of transient behavior of the system (approach to equilibrium)
c) Relationship of large N and the arrow of time
d) Computation of the velocity distribution of particles for the system and comparison with the Maxwell velocity distribution
e) Computation and study of mean molecular speed and its dependence on particle mass
f) Computation of fraction of molecules in an ideal gas having speed near the most probable speed
2. Computation of the partition function Z( ) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and BoseEinstein statistics:
a) Study of how Z( ), average energy <E>, energy fluctuation E, specific heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.
b) Ratios of occupation numbers of various states for the systems considered above
c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.
3. Plot Planck's law for Black Body radiation and compare it with Raleigh-Jeans Law at high temperature and low temperature.
4. Plot Specific Heat of Solids (a) Dulong-Petit law, (b) Einstein distribution function, (c) Debye distribution function for high temperature and low temperature and compare them for these two cases.
5. Plot the following functions with energy at different temperatures
a) Maxwell-Boltzmann distribution
b) Fermi-Dirac distribution
c) Bose-Einstein distribution

Reference Books:

1. Elementary Numerical Analysis, K.E.Atkinson, 3rd Edn. 2007, Wiley India Edition Statistical Mechanics, R.K. Pathria, Butterworth Heinemann: 2nd Ed., 1996, Oxford University Press.
2. Introduction to Modern Statistical Mechanics, D. Chandler, Oxford University Press, 1987
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. Statistical and Thermal Physics with computer applications, Harvey Gould and Jan Tobochnik, Princeton University Press, 2010.
6. 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
7. Scilab by example: M. Affouf, 2012. ISBN: 978-1479203444
8. Scilab Image Processing: L.M.Surhone. 2010, Betascript Pub., ISBN: 9786133459274

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (6th Semester)
PHYSICS: CORE

Module: Electromagnetic Theory	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS3107	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 03 hrs**

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

Unit: II- EM Waves in bounded and Unbounded Media
EM Wave Propagation in Unbounded Media: Plane EM waves through vacuum and isotropic dielectric medium, transverse nature of plane EM waves, refractive index and dielectric constant, wave impedance. Propagation through conducting media, relaxation time, skin depth. Wave propagation through dilute plasma, electrical conductivity of ionized gases, plasma frequency, refractive index, skin depth, application to propagation through ionosphere.
EM Wave in Bounded Media: Boundary conditions at a plane interface between two media. Reflection & Refraction of plane waves at plane interface between two dielectric media-Laws of Reflection & Refraction. Fresnel's Formulae for perpendicular & parallel polarization cases, Brewster's law. Reflection & Transmission coefficients. Total internal reflection, evanescent waves. Metallic reflection (normal Incidence)

Unit: III- Polarization of EM Waves and Rotatory Polarization
Polarization of Electromagnetic Waves: Description of Linear, Circular and Elliptical Polarization. Propagation of E.M. Waves in Anisotropic Media. Symmetric Nature of Dielectric Tensor. Fresnel's Formula. Uniaxial and Biaxial Crystals. Light Propagation in Uniaxial Crystal. Double Refraction. Polarization by Double Refraction. Nicol Prism. Ordinary & extraordinary refractive indices. Production & detection of Plane, Circularly and Elliptically Polarized Light. Phase Retardation Plates: Quarter-Wave and Half-Wave Plates. Babinet Compensator and its Uses. Analysis of Polarized Light
Rotatory Polarization: Optical Rotation. Biot's Laws for Rotatory Polarization. Fresnel's Theory of optical rotation. Calculation of angle of rotation. Experimental verification of Fresnel's theory. Specific rotation. Laurent's half-shade polarimeter.

Unit: IV -Wave guides and Fiber optics
Wave Guides: Planar optical wave guides. Planar dielectric wave guide. Condition of continuity at interface. Phase shift on total reflection. Eigenvalue equations. Phase and group velocity of guided waves. Field energy and Power transmission.
Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only). Single and Multiple Mode Fibres (Concept and Definition Only).

Reference Books:

1. Introduction to Electrodynamics, D.J. Griffiths, 3rd Ed., 1998, Benjamin Cummings.
2. Elements of Electromagnetics, M.N.O. Sadiku, 2001, Oxford University Press.
3. Classical Electrodynamics, J.D. Jackson

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (6th Semester)
PHYSICS: CORE

Module: EMT Lab	**Sessional Marks: 15**
	Practical Marks:35
Module Code: PHYS3108	**Total Marks: 50**
Credits: 2.0	

Practical

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

Reference Books

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

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: Major Project (Part-I)	**Sessional Marks: 40**
	Practical Marks: 60
Module Code: PHYS3109	**Total Marks: 100**
Credits: 4.0	

1. Topic (s) of the project would be decided by the Supervisor himself for a group of students. However, it would be among one of the thrust areas out lined by the Department of Science and Technology (DST) and related to the industry.

2. The students shall devote their time for solving the problem (which ultimately may be published as research work.) assigned by the supervisor

3. Project title and/or problem would be such that it can be extended to higher level
4. Finally, the project report would be submitted in the prescribed format.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics (3rd Semester)
PHYSICS: CORE

Module: Major Project (part II)	**Sessional Marks: 40**
	Practical Marks: 60
Module Code: PHYS3110	**Total Marks: 100**
Credits: 4.0	

1. Topic of the project would be decided by the Supervisor himself. However, it would be among one of the thrust areas out lined by the Department of Science and Technology (DST) and related to the industry.

2. The student shall devote his/her time for solving the problem (which ultimately may be published as research work.) assigned by the supervisor

3. Project title and/or problem would be such that it can be extended to higher level
4. Finally, the project report would be submitted in the prescribed format.

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics
PHYSICS-DSE I-IV (ELECTIVES)

Module: Classical Dynamics	**Sessional Marks: 50**
	Theory Paper Marks:100
Module Code: PHYS3201	**Total Marks: 150**
Credits: 6.0	**Duration of Examination : 3 hrs**

The emphasis of the course is on applications in solving problems of interest to physicists. Students are to be examined on the basis of problems, seen and unseen.

Classical Mechanics of Point Particles: Review of Newtonian Mechanics; Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities, Hamilton's principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta & Hamiltonian. Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton's equation for Simple Harmonic Oscillations; particle in a central force field- conservation of angular momentum and energy.

Small Amplitude Oscillations: Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, normal modes of oscillations example of N identical masses connected in a linear fashion to (N -1) - identical springs.

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 and twin paradox. Four-vectors: space-like, time-like and light-like. Four-velocity and acceleration. Metric and alternating tensors. Four-momentum and energy-momentum relation. Doppler effect from a four-vector perspective. Concept of four-force. Conservation of four-momentum. Relativistic kinematics. Application to two-body decay of an unstable particle.

Fluid Dynamics: Density �and pressure P in a fluid, an element of fluid and its velocity, continuity equation and mass conservation, stream-lined motion, laminar flow, Poiseuille's equation for flow of a liquid through a pipe, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

Reference Books:

1. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
2. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
3. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
4. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
5. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
6. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
7. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
8. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
9. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics
PHYSICS-DSE I-IV (ELECTIVES)

Module: Astronomy & Astro- Physics	**Sessional Marks: 50**
	Theory Paper Marks:100
Module Code: PHYS3202	**Total Marks: 150**
Credits: 6.0	**Duration of Examination : 3 hrs**

Course Objectives: A study of the subject matter presented in this course will enable the students to become familiarwith

- Χ: Astronomical coordinates and observational data
- Δ: Telescopes and instrumentation
- Ε: Sun and solar atmosphere
- Φ: Variable stars

Course Contents:

Unit 1: Observational Data

Astronomical. coordinates- Celestial Sphere, Horizon, Equatorial, Ecliptic and Galactic Systems of Coordinates, Conversion from one system of co-ordinates to another, Magnitude Scale- Apparent and absolute magnitude, distance modulus. Determination of mass, luminosity, radius, temperature and distance of a star, Color Index, Stellar classification Henry-Draper and modern M-K Classification schemes, H-R Diagram, H-R Diagram of Clusters, Empirical mass luminosity relation

Unit 2: Telescopes and Instrumentation

Different optical configurations for Astronomical telescopes, Mountings, plate scale and diffraction limits, telescopes for gamma ray, X-ray, UV, IR, mm and radio astronomy, Stellar Photometry - solid state, Photo-multiplier tube and CCD based photometers, Spectroscopy and Polarimetery using CCD detectors

Unit 3: Sun and solar atmosphere

Physical Characteristics of sun- basic data, solar rotation, solar magnetic fields, Photosphere - granulation, stin spots, Babcock model of sunspot formation, solar atmosphere — chromo sphere and Corona1 Solar activity- flares, prominences, solar wind, activity cycle, Helio-seismology

Unit 4: Variable Stars and Astero-seismology

Photometry of variable stars, differential photometry, extinction coefficients, Classes of variable stars, Period-Mean density relationship, Classical Cepheid's as distance indicators, pulsation Mechanisms.

Text Books:

1. Introduction to Astronomy and Cosmology: I Morrison Wiley Publications, New Delhi
2. An Introduction to Astronomical Photometry: E Budding Cambridge Univ. Press, UK
3. Fundamentals of Solar Astronomy: A Bhatnagar and W C Livingston World Scientific, Singapore

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics
PHYSICS-DSE I-IV (ELECTIVES)

Module: Plasma Physics	**Sessional Marks: 50**
	Theory Paper Marks:100
Module Code: PHYS3203	**Total Marks: 150**
Credits: 6.0	**Duration of Examination : 3 hrs**

Course Objectives: A study of the subject matter presented in this course will enable the students to become familier with

Unit 1: Plasma properties and parameters
Definition and properties of plasma; Range of plasma parameters; Degree of ionization; Thermal versus non-thermal plasmas; potentials; magnetization; Comparison of plasma and gas phase

Unit 2: Microscopic description of plasmas
Dynamics of a charged particle in crossed electric and magnetic fields; Particle drifts-curvature, gradient drifts; Controlled thermonuclear devices; Magnetically confined open and closed systems -linear pinch, mirror machine and Tokamak; Laser plasmas; Initially confined system

Unit 3: Kinetic theory and statistical description of plasmas
BBGKY. hierarchy of equations; BoltZinann-Vlasov equation; Equivalence of particle orbit theory and the Vlasov equation; Boltzmann and Landau collision integral; H—theorem; BGK model- Fokker-Planck term; Solution of Boltzmann equation (brief outline); Transport coefficients-electrical conductivity, diffusion

Unit 4: Magneto hydrodynamics (MHD) and fluid description of plasmas
Brief review of magneto-hydrodynamics; Moment equations. MHD and C, G.L. equations; Generalized Ohm’s law; Flux conservation; Decay of fields. Pressure balanced and force free fields

References

1. Principles of Plasma Mechanics: BishwanathChakraborty Wiley Eastern Ltd, New Delhi
2. Introduction to Plasma physics: F F Chen Plenum Press, New York
3. Introduction to Plasma Physics: R J Goldston and PH Rutherford IOP, New York
4. Principles of Plasma Physics: N A Krall and Trivelpiece San Fransisco Press
5. Physics of High temperature Plasmas (2nd edition): G Schimdt Academic Press, New York

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics
PHYSICS-DSE I-IV (ELECTIVES)

Module: Fundamentals of Photonics	**Sessional Marks: 50**
	Theory Paper Marks:100
Module Code: PHYS3204	**Total Marks: 150**
Credits: 6.0	**Duration of Examination : 3 hrs**

Course objectives: a study of the subject matter presented in this course will enable the students to familiar with;

Unit 1: Introduction of Photonics and Beam Optics

Introduction of Ray Optics, Gaussian Beams, Helmholtz equation and other solution of Helmholtz equation, Short duration beams, Alternate method for describing a beam: covariance matrix

Unit 2: Electromagnetic description of light & propagation in matter

Light in vacuum, Theory of electromagnetic beams, Light guiding, Absorption of light & Dispersion, Optical phenomena in non-isotropic media, Dichroism and birefringence, Acousto-optics effects, E-field effects, B-field effects.

Unit 3: Nonlinear Optics

Origin of Nonlinearity, Nonlinear optical media, 2nd order optics, 3rd order optics, wave mixing, high harmonic generation, self-focusing and phase modulation. Introduction to Quantum Optics

Unit 4: Photonics Devices

Photo detectors and display devices, photodiodes, PIN photodiodes, liquid crystal display, Photo voltaic cells. Optical modulators- acoustic-optics, electro-optics and magneto-optics. Holography, Lasers.

References

1. John M senior, Optical fiber communications PHI, 1992.
2. A.Ghatak & K. Thyagarajan, Lasers: Theory & Applications, Macmillan India LTD. 2003
3. A.Ghatak & K. Thyagarajan, Optical Electronics, Cambridge University Press, 2004
4. Francis T.S Yu, Shizhuo Yin (Eds), Fiber Optic Sensors, Marcel Dekker Inc., New York,2002
5. Bahaae A. Saleh and Malvin Carl Teich Fundamentals of Photonics, John Wiley & Sons, 1991
6. Govind PAgrawal, Non Linear Optics, Academic Press, 1989
7. Emmanuel Rosencher and Borge Vinter, Optoelectronics, Cambridge University Press, 2002

Faculty of Physical Sciences
Department of Physics
B.Sc. (Hons): Physics
PHYSICS-DSE I-IV (ELECTIVES)

Module: Communication System	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS3205	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 3 hrs**

Introduction to communication systems: The essentials of a Communication system, modes and media's of Communication, Classification of signals and systems, Analog Communication & Digital Communication, effect of limited bandwidth on digital signal

Transmission Media: Twisted pair, co-axial, fiber optic cables, wireless media Transmission impairments: attenuation, limited bandwidth of the channels, delay distortion, noise

Communication modes: simplex, half duplex, full duplex, Transmission modes: serialtransmission, parallel transmission, Type of services: connection oriented, connectionless services, Flow control: unrestricted simplex protocol, simplex stop and wait protocol, sliding window protocol, Switching systems: circuit switching, packet switching: datagram, virtual circuits, permanent virtual circuits

Multiplexing: frequency divisionmultiplexing, time divisionmultiplexing, wavedivision multiplexing

Analog modulation & demodulation: Amplitude modulation(AM), Generation of AM waves, Demodulation of AM waves, Phase modulation (PM), Generation of PM waves, Demodulation of PM waves , frequency modulation(FM), Generation of FM waves, Demodulation of FM waves

Digital modulation techniques: ASK, FSK, BPSK, QPSK

Telephone Systems: PSTN, ISDN, asynchronous digital subscriber line

Reference Books:

1. Communication systems (4th edition): Simon Haykins; John wiley & sons
2. Communication systems: Singh & Sapre; TMH
3. Communication systems: Analog and Digital ; Sanjay Sharma
4. Data Communication and Networking (2nd edition): Behrouz A. Forouzan

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PHYSICS-DSE I-IV (ELECTIVES)

Module: Communication System Lab	**Sessional Marks: 15**
	Theory Paper Marks: 35
Module Code: PHYS3206	**Total Marks 50**
Credits: 2.0	

LIST OF EXPERIMENTS:

1. Generation of DSB/DSB-SC AM signal using balanced modulator& determine modulation Index.
2. Generation of SSB AM signal & detection of SSB signal using product detector
3. To study envelop detector for demodulation of AM signal and observe diagonal peak clipping effect.
4. Frequency modulation using voltage controlled oscillator.
5. To generate a FM Signal using Varactor & reactance modulation,
6. Detection of FM Signal using PLL & foster seelay method
7. To study the circuit of PAM/PWM/PPM modulator & Demodulator
8. Study of Frequency Division Multiplexing/De multiplexing with sinusoidal &audio inputs.
9. Generation & study of Analog TDM at least 4 channels.
10. Study pulse data coding & Decoding techniques for various formats

Experiments based on advanced topics:

11. Study of ASK, FSK modulator and demodulator.
12. Study of PSK & QPSK modulator and demodulator.

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PHYSICS-DSE I-IV (ELECTIVES)

Module: Embedded System: Introduction to Microcontrollers	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS3207	**Total Marks: 100**
Credits:4.0	**Duration of Examination : 3 hrs**

Unit: I
Embedded system introduction: Introduction to embedded systems and general purpose computer systems, architecture of embedded system, classifications, applications and purpose of embedded systems,

Unit: II
Review of microprocessors: Organization of Microprocessor based system, 8085µp pin diagram and architecture, concept of data bus and address bus, 8085 programming model, instruction classification, subroutines, stacks and its implementation, delay subroutines, hardware and software interrupts.
8051 microcontroller: Introduction and block diagram of 8051 microcontroller, architecture of 8051, overview of 8051 family, 8051 assembly language programming, Program Counter and ROM memory map, Flag bits and Program Status Word (PSW) register, Jump, loop and call instructions.

Unit: III
8051 I/O port programming: Introduction of I/O port programming, pin out diagram of 8051 microcontroller, I/O programming: Bit manipulation.
Programming: 8051 addressing modes and accessing memory using various addressing modes, assembly language instructions using each addressing mode, arithmetic and logic instructions
Timer and counter programming: Programming 8051 timers.
Interfacing 8051 microcontroller to peripherals: ADC, DAC interfacing, LCD interfacing.

Unit: IV
Embedded system design and development: Embedded system development environment, disassembler/ de compiler, simulator, emulator and debugging, embedded product development life-cycle, trends in embedded industry.

References:

1. Embedded Systems: Architecture, Programming & Design, R.Kamal, 2008,Tata McGraw Hill The 8051 Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India. Embedded microcomputor system: Real time interfacing, J.W.Valvano, 2000, Brooks/Cole Microcontrollers in practice, I. Susnea and M. Mitescu, 2005, Springer.
2. Embedded Systems: Design & applications, S.F. Barrett, 2008, Pearson Education India
3. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning

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PHYSICS-DSE I-IV (ELECTIVES)

Module: Embedded Systems: Introduction to Microcontrollers Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS3208	**Total Marks: 50**
Credits: 2.0	

Practical

8051 microcontroller based Programs and experiments

1. To find that the given numbers is prime or not.
2. To find the factorial of a number.
3. Write a program to make the two numbers equal by increasing the smallest number and decreasing the largest number.
4. Use one of the four ports of 8051 for O/P interfaced to eight LED's. Simulate binary counter (8 bit) on LED's .
5. Program to glow the first four LEDs then next four using TIMER application.
6. Program to rotate the contents of the accumulator first right and then left.
7. Program to run a countdown from 9-0 in the seven segment LED display.
8. To interface seven segment LED display with 8051 microcontroller and display 'HELP' in the seven segment LED display.
9. To toggle '1234' as '1324' in the seven segment LED display.
10. Interface stepper motor with 8051 and write a program to move the motor through a given angle in clock wise or counter clockwise direction.
11. Application of embedded systems: Temperature measurement, some information on LCD display, interfacing a keyboard. ***Arduino based programs and experiments:***
12. Make a LED flash at different time intervals.
13. To vary the intensity of LED connected to Arduino
14. To control speed of a stepper motor using a potential meter connected to Arduino
15. To display "PHYSICS" on LCD/CRO.

Reference Books:

1. Embedded Systems: Architecture, Programming& Design, R.Kamal,]2008,Tata McGraw Hill The 8051
2. Microcontroller and Embedded Systems Using Assembly and C, M.A. Mazidi, J.G. Mazidi, and R.D. McKinlay, 2nd Ed., 2007, Pearson Education India.
3. Embedded Microcomputer systems: Real time interfacing, J.W. Valvano 2011, Cengage Learning.

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PHYSICS-DSE I-IV (ELECTIVES)

Module: Digital System Design	**Sessional Marks: 40**
	Theory Paper Marks: 60
Module Code: PHYS3209	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 3 hrs**

Unit: I – Introduction to computer aided design tools

Introduction to Computer-aided design tools for digital systems. Hardware description languages;introduction to VHDL data objects, classes and data types, Operators, Overloading, logical operators. Types of delaysEntity and Architecture declaration. Introduction to behavioral dataflow and structural models.

Unit: II-VHDL Statements

Assignment statements, sequential statements and process, conditional statements, casestatement Array and loops, resolution functions, Packages and Libraries, concurrent statements. Subprograms: Applicationof Functions and Procedures, Structural Modelling, component declaration, structural layout and generics.

Unit: III-Combinational & Sequential Circuit Design

VHDL Models and Simulation of combinational circuitssuch as Multiplexers, Demultiplexers, encoders, decoders , implementation of Booleanfunctions etc. VHDL Models and Simulation of Sequential Circuits Shift Registers, Counters etc.

Unit: IV-Design Of Micro-computer & Programmable Device

Basic components of a computer,specifications, architecture of a simple microcomputer system, implementation of a simple microcomputer system usingVHDL Programmable logic devices : ROM, PLAs, PALs,CPLDs and FPGA. Design implementation usingCPLDs and FPGAs

References

1.Ashenden - Digital design,Elsevier
2. IEEE Standard VHDL Language Reference Manual (1993).
3. Digital Design and Modelling with VHDL and Synthesis : KC Chang; IEEE Computer Society Press.
4. "A VHDL Primmer": Bhasker; Prentice Hall 1995.
5. Modern Digital Electronics- III Edition: R.P Jain; TMH (2003).

6. Grout - Digital system Design using FPGA & CPLD 'S,Elsevier

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Course Code:
PHYSICS-DSE (ELECTIVES)

Module: DSD- LAB	**Sessional Marks: 15** **Practical Marks:35**
Module Code: PHYS3210	**Total Marks: 50**
Credits: 2.0	

List Of Experiments:VHDL

1. Design all gates using VHDL.
2. Write VHDL programs for the following circuits, check the wave forms and the hardware generated a. half adder .
3. Write VHDL programs for the following circuits, check the wave forms and the hardware generated full adder.
4. Write VHDL programs for the following circuits, check the wave forms and the hardware generated a. multiplexer b. demultiplexer.
5. Write VHDL programs for the following circuits, check the wave forms and the hardware generated a. decoder b. encoder.
6. Write a VHDL program for a comparator and check the wave forms and the hardware generated.
7. Write a VHDL program for a code converter and check the wave forms and the hardware generated.
8. Write a VHDL program for a FLIP-FLOP and check the wave forms and the hardware generated.
9. Write a VHDL program for a counter and check the wave forms and the hardware generated.
10. Write VHDL programs for the following circuits, check the wave forms and the hardware generated a. register b. shift register.
11. Implement ADC & DAC interface with FPGA.
12. Implement a serial communication interface with FPGA.

References:

1.Ashenden - Digital design, Elsevier

2. IEEE Standard VHDL Language Reference Manual (1993).

3. Digital Design and Modelling with VHDL and Synthesis : KC Chang; IEEE Computer Society Press.

4. "A VHDL Primmer": Bhasker; Prentice Hall 1995.

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PHYSICS-DSE I-IV (ELECTIVES)

Module: Physics of Devices	**Sessional Marks: 40**
	Theory Paper Marks:60
Module Code: PHYS3211	**Total Marks: 100**
Credits: 4.0	**Duration of Examination : 3 hrs**

Basics of Devices: Introduction, Evolution of IC technology,IC Classification, Metal oxide semiconductor (MOS) device. Ideal MOS, SiO_2-Si based MOS. MOSFET– their frequency limits, Enhancement and Depletion Mode MOSFETS, Characteristics of MOSFET, CMOS.

Processing of Devices: Introduction, Moore Law, Basic process flow for IC fabrication, NMOS fabrication, PMOS fabrication, CMOS Fabrication, Electronic grade silicon, Crystal plane andorientation, Defects in the lattice, Oxide layer, Oxidation Technique,Positive and Negative Masks, Lithography: Optical lithography, Electron lithography, Feature size control, etching, Diffusion and implantation, Metallization.

Effects:, MOS Switches: NMOS Switches, PMOS switches, First order effects, Second Order Effects: Body Effects, Channel Length Modulation, Drain-Punch Through, Impact Ionization, General I-V Equation of MOS Transistor (NMOS Transistor Current Equation). NMOS Inverter,

Subsystem Design and Layout: Rules of Stick Diagram, Stick Diagram: Logic gates, NMOS, PMOS, CMOS Inverter and Combinational Circuits, Lambda Based Rules, Tally Circuits (NAND-NAND, NOR-NOR and AOI Logic) EXOR Structure, Multiplexer Structure, Barrel Shifter.

References:

1. Basic VLSI Design, D.A. Pucknell, 3rd Edition, PHI Publication, New Delhi, India
2. Physics of Semiconductor Devices, S.M. Sze & K.K. Ng, 3rd Ed.2008, John Wiley & Sons Electronic devices and integrated circuits, A.K. Singh, 2011, PHI Learning Pvt. Ltd. Op-Amps & Linear
3. Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd, Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
4. Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill

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PHYSICS-DSE I-IV (ELECTIVES)

Module: Physics of Devices Lab	**Sessional Marks: 15**
	Practical Marks: 35
Module Code: PHYS3212	**Total Marks: 50**
Credits: 2.0	

Practical

1. To study the different apparatus used like CRO, Function generator, Power Supply.
2. To study V-I characteristics of PN junction diode.
3. To study V-I characteristics of common emitter Bipolar Junction Transistor.
4. To study the output and transfer characteristics of a JFET.
5. To design a common source JFET Amplifier and study its frequency response.
6. To study the output characteristics of a MOSFET.
7. To study the characteristics of a UJT and design a simple Relaxation Oscillator.
8. To study the characteristics of CMOS Inverter.
9. Study and design the Multiplexer.
10. Study and design the EXOR combinational circuit:
11. Glow an LED via USB port of PC.
12. Sense the input voltage at a pin of USB port and subsequently glow the LED connected with another pin of USB port.

References :

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