ASSAM UNIVERSITY, SILCHAR

SYLLABUS UNDER

CHOICE BASED CREDIT SYSTEM

PHYSICS

(HONOURS & GENERAL)

Course Structure
Details of courses for B.Sc. (Honors) Physics

Course	*Credits	
	Theory+ Practical	Theory+ Tutorial
I. Core Course		
Core Course Theory **(14 Papers)**	14X4= 56	14X5=70
Core Course Practical / Tutorial* **(14 Papers)**	14X2=28	14X1=14
II. Elective Course		
A.1. Discipline Specific Elective **(4 Papers)**	4X4=16	4X5=20
A.2. Discipline Specific Elective Practical/Tutorial* **(4 Papers)**	4 X 2=8	4X1=4
B.1. Generic Elective **(4 Papers)** to be chosen from other discipline	4X4=16	4X5=20
B.2. Generic Elective Practical/ Tutorial* **(4Papers)**	4 X 2=8	4X1=4
III. Ability Enhancement Courses		
A.1. Ability Enhancement Compulsory **(2 Papers)**		
Environmental Science	1 X 4=4	1 X 4=4
English/MIL Communication	1 X 4=4	1 X 4=4
A.2. Ability Enhancement Elective (Skill Based) **(2 Papers)**	2 X 4=8	2 X 4=8
Total credit	148	148

- Each credit is equivalent to 1 hour of activity per week

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN
B. Sc. Honours (Physics)

	CORE COURSE (14)	Ability Enhancement Compulsory Course (AECC) (2)	Skill Enhancement Course (SEC) (2) (Skill Based)	Elective: Discipline Specific DSE (4)	Elective: Generic (GE) 4 To be taken from other discipline
I	PHYSICS-C-101	Environmental Science			GE-1
	PHYSICS-C-102				
II	PHYSICS-C-201	English/MIL Communication			GE-2
	PHYSICS-C-202				
III	PHYSCS-C-301		PHYSICS-SEC-301		GE-3
	PHYSICS-C-302				
	PHYSICS-C-303				
IV	PHYSICS-C-401		PHYSICS-SEC-401		GE-4
	PHYSICS-C-402				
	PHYSICS-C-403				
V	PHYSICS-C-501			PHYSICS-DSE-501	
	PHYSICS-C-502			PHYSICS-DSE -502	
VI	PHYSICS-C-601			PHYSICS-DSE -601	
	PHYSICS-C-602			PHYSICS-DSE -602	

PROPOSED SCHEME FOR CHOICE BASED CREDIT SYSTEM IN
B. Sc. (General)

Course	Credits	
	Theory+ Practical	Theory+ Tutorial
I. Core Course		
Core Course Theory **(12 Papers)** 04 papers from each of the 03 disciplines of choice	12X4= 48	12X5=60
Core Course Practical / Tutorial* **(12 Practical/ Tutorials*)** 04 papers from each of the 03 Disciplines of choice	12X2=24	12X1=12
II. Elective Course		
Elective Course Theory **(6 Papers)** 02 papers from each discipline of choice	6x4=24	6X5=30
Elective Course Practical / Tutorials* **(6 Practical / Tutorials*)** 02 Papers from each discipline of choice	6 X 2=12	6X1=6
III. Ability Enhancement Courses		
Ability Enhancement Compulsory **(2 Papers)** Environmental Science English/MIL Communication	2 X 4=8	2X4= 8
Skill Enhancement Course (Skill Based) **(4 Papers)**	4 X 4=16	4X4=16
	Total credit= 132	**Total credit= 132**

- Each credit is equivalent to 1 hour of activity per week

SCHEME FOR CHOICE BASED CREDIT SYSTEM IN

B. Sc. with Physics

	CORE COURSE (12)	**Ability Enhancement Compulsory Course (AECC) (2)**	**Skill EnhancementCourse (SEC)** (4)	**Discipline Specific Elective DSE (6)**
I	PHYSICS-DSC-101 DSC- 2 A DSC- 3 A	Environmental Science		
II	PHYSICS-DSC-201 DSC- 2 B	English/MIL Communication		
	DSC- 3 B			
III	PHYSICS-DSC-301 DSC- 2 C DSC- 3 C		PHYSICS-SEC-301	
IV	PHYSICS-DSC-401 DSC- 2 D DSC- 3 D		PHYSICS-SEC-401	
V			PHYSICS-SEC-501	PHYSICS-DSE-501 DSE-2 A DSE-3 A
VI			PHYSICS-SEC-601	PHYSICS-DSE-601 DSE-2 B DSE-3 B

Semester wise list of Physics papers to be studied by a Physics (H) student

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS
I	PHYSICS-C-101	Mathematical Physics-I	4
	PHYSICS-C-101-LAB	Mathematical Physics-I Lab	2
	PHYSICS-C-102	Mechanics	4
	PHYSICS-C-102-LAB	Mechanics Lab	2
II	PHYSICS-C-201	Electricity and Magnetism	4
	PHYSICS-C-201-LAB	Electricity and Magnetism Lab	2
	PHYSICS-C-202	Waves and Optics	4
	PHYSICS-C-202-LAB	Waves and Optics Lab	2
III	PHYSICS-C-301	Mathematical Physics-II	4
	PHYSICS-C-301-LAB	Mathematical Physics-II Lab	2
	PHYSICS-C-302	Thermal Physics	4
	PHYSICS-C-302-LAB	Thermal Physics Lab	2
	PHYSICS-C-303	Digital Systems and Applications	4
	PHYSICS-C-303-LAB	Digital Systems & Applications Lab	2
	PHYSICS-SEC-301	Workshop skill	4
IV	PHYSICS-C-401	Mathematical Physics III	4
	PHYSICS-C-401-LAB	Mathematical Physics-III Lab	2
	PHYSICS-C-402	Elements of Modern Physics	4
	PHYSICS-C-402-LAB	Elements of Modern Physics Lab	2
	PHYSICS-C-403	Analog Systems and Applications	4
	PHYSICS-C-403-LAB	Analog Systems & Applications Lab	2
	PHYSICS-SEC-401	Electrical Circuit and Network	4
V	PHYSICS-C-501	Quantum Mechanics & Applications	4
	PHYSICS-C-501-LAB	Quantum Mechanics Lab	2
	PHYSICS-C-502	Solid State Physics	4
	PHYSICS-C-502-LAB	Solid State Physics Lab	2
	PHYSICS-DSE-501	A. Classical Dynamics B. Biological Physics	6
	PHYSICS-DSE-502	A. Nuclear and Particle Physics B. Advanced Mathematical Physics	6
VI	PHYSICS-C-601	Electro-magnetic Theory	4
	PHYSICS-C-601-LAB	Electro-magnetic Theory Lab	2
	PHYSICS-C-602	Statistical Mechanics	4
	PHYSICS-C-602-LAB	Statistical Mechanics Lab	2
	PHYSICS-DSE-601	A. Astronomy and Astrophysics B. Nano-materials and applications	6
	PHYSICS-DSE-602	A. Dissertation B. Physics of Devices and Communication	6

Semester wise list of Physics Generic Elective papers for students taking honours in other disciplines

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS
I	PHYSICS-GE-101	Mechanics	4
	PHYSICS-GE-101-LAB	Mechanics Lab	2
II	PHYSICS-GE-201	Electricity, Magnetism and EMT	4
	PHYSICS-GE-201-LAB	Electricity, Magnetism and EMT Lab	2
III	PHYSICS-GE-301	Thermal Physics and Statistical Mechanics	4
	PHYSICS-GE-301-LAB	Thermal Physics and Statistical Mechanics Lab	2
IV	PHYSICS-GE-401	Waves and Optics	4
	PHYSICS- GE -401-LAB	Waves and Optics Lab	2

Semester wise list of Physics papers to be studied by a B.Sc. student with Physics.

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS
I	PHYSICS-DSC-101	Mechanics	4
	PHYSICS-DSC-101-LAB	Mechanics Lab	2
II	PHYSISC-DSC-201	Electricity, Magnetism and EMT	4
	PHYSISC-DSC-201-LAB	Electricity, Magnetism and EMT Lab	2
III	PHYSIS-DSC-301	Thermal Physics and Statistical Mechanics	4
	PHYSIS-DSC-301-LAB	Thermal Physics and Statistical Mechanics Lab	2
	PHYSICS-SEC-301	physics workshop skill	4
IV	PHYSIS-DSC-401	Waves and Optics	4
	PHYSIS- DSC -401-LAB	Waves and Optics Lab	2
	PHYSICS-SEC-401	Electrical Circuits and Network Skills	4
V	PHYSICS-SEC-501	Basic Instrumentation Skills	4
	PHYSICS-DSE-501	*A.* Classical Dynamics *B.* Biological Physics	6
VI	PHYSICS-SEC-601	Renewable Energy and Energy Harvesting	4
	PHYSICS-DSE-601	A. Astronomy and Astrophysics B. Nano-materials and Applications	6

SYLLABI FOR CORE COURSE PAPERS

PHYSICS-C-101: MATHEMATICAL PHYSICS-I

Contact Hours: 60
Full Marks = 70 [ESE (50) CCA(20)]
Pass Marks = 28 [ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

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 1: Calculus:

Matrices : Addition law of matrices, matrix multiplication, properties of matrices, special square matrices, inverse of matrices, Elementary transformation of matrices – similarity, orthogonal and unitary transformation. Eigen value, Eigen vector. Solution of simultaneous linear equations. Diagonalisation of matrix. **(8 Lectures)**

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. **(7 Lectures)**

Unit 2: Vector Calculus I:

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. **(5 Lectures)**

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. **(7 Lectures)**

Unit 3: Vector Calculus II:

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). **(14 Lectures)**

Unit 4: Orthogonal Curvilinear Coordinates:

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

(**8 Lectures)**

Unit 5: Introduction to probability and Dirac Delta function:
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. **(7 Lectures)**

Theory of Errors: 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. **(4 Lectures)**

Reference Books:

- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, F.E. Harris, 2013, 7^{th} Edn., Elsevier.
- An introduction to ordinary differential equations, E.A. Coddington, 2009, PHI learning
- Differential Equations, George F. Simmons, 2007, McGraw Hill.
- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications.
- Mathematical methods for Scientists and Engineers, D.A. McQuarrie, 2003, Viva Book
- Advanced Engineering Mathematics, D.G. Zill and W.S. Wright, 5 Ed., 2012, Jones and Bartlett Learning
- Mathematical Physics, Goswami, 1^{st} edition, Cengage Learning
- Engineering Mathematics, S.Pal and S.C. Bhunia, 2015, Oxford University Press
- Advanced Engineering Mathematics, Erwin Kreyszig, 2008, Wiley India.
- Essential Mathematical Methods, K.F.Riley & M.P.Hobson, 2011, Cambridge Univ. Press
- Vector Analysis, Tensor Analysis and Linear Vector Space, S P Kuila, New Central Book Agency

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PHYSICS -C 101 LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 20 ESE Time = 3 hours

(A minimum of 8 practical should be done taking at least one from each group of no.5)

The aim of this Lab is 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
1. Introduction and Overview	Computer architecture and organization, memory and Input/output devices

2. Basics of scientific computing	Binary and decimal arithmetic, Floating point numbers, algorithms, Sequence, Selection and Repetition, single and double precision arithmetic, underflow &overflow-emphasize the importance of making equations in terms of dimensionless variables, Iterative methods
3. Errors and error Analysis	Truncation and round off errors, Absolute and relative errors, Floating point computations.
4. Review of C & C++ /FORTRAN Programming	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. 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
5. (a) Programs:	i. Sum & average of a list of numbers. ii. largest of a given list of numbers and its location in the list iii. sorting of numbers in ascending descending order iv. Maximum minimum and range of numbers, v. addition, multiplication and inverse of matrix, vi. solution of quadratic equation, vii. solution of simultaneous equation, viii. values of sine, cosine and exponential function using their series expansion
(b) Random number generation	i. Area of circle, ii. area of square, iii. volume of sphere, iv. value of pi (**π**)
(c) Solution of Algebraic and Transcendental equations by Bisection, Newton Raphson,Simpson Rule and Secant methods	i. Solution of linear and quadratic equation, ii. solving $\alpha = \tan\alpha \; ; I = I_0 \left(\frac{\sin \alpha}{\alpha} \right)^2$ in optics
(d) 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.*
(e) Numerical differentiation (Forward and Backward difference formula) and Integration (Trapezoidal and Simpson rules), Monte Carlo method	i. Given Position with equidistant time data to calculate velocity and acceleration and vice versa. ii. Find the area of B-H Hysteresis loop

(f) Solution of Ordinary Differential Equations (ODE) First order Differential equation Euler, modified Euler and Runge-Kutta (RK) second and fourth order methods	Attempt following problems using RK 4 order method: i. Radioactive decay ii. Current in RC, LC circuits with DC source iii. Newton's law of cooling iv. Classical equations of motion

Referred Books:

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

PHYSICS –C-102: MECHANICS

Contact Hours: 60

Full Marks = 70 **[**ESE (50) CCA(20)]

Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1: Fundamentals of Dynamics: Reference frames. Inertial frames; Review of Newton's Laws of Motion. Galilean transformations; Galilean invariance. Momentum of variable-mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.

(6 Lectures)

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.

(4 Lectures)

Collisions: Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit 2: 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.

(17 Lectures)

Unit 3: 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). **(9 Lectures)**

Unit 4:

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. **(11 Lectures)**

Unit 5: 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.

(10 Lectures)

Reference Books:

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

PHYSICS-C-102-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 20 ESE Time = 3 hours

1. To measure the diameter of a wire using vernier caliper, screw gauge and travelling microscope and hence find its cross-section.
2. To determine the Moment of Inertia of unknown body by suitable method
3. To determine Coefficient of Viscosity of water by suitable method
4. To determine the Young's Modulus of a Wire by suitable method.
5. To determine the Modulus of Rigidity of a Wire by suitable method
6. To determine the value of g using Bar Pendulum.
7. To determine the value of g using Kater's Pendulum.
8. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.

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 Edn, 2011, Kitab Mahal
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- Practical Physics, G.L. Squires, 2015, 4th Edition, Cambridge University Press.

Semester II

PHYSICS-C-201: ELECTRICITY AND MAGNETISM

Contact Hours: 60
Full Marks = 70 **[**ESE (50) CCA(20)]
Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:
Electric Field and Electric Potential

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry.

Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. The Uniqueness Theorem. Potential and Electric Field of a dipole. Force and Torque on a dipole. **(12 Lectures)**

Unit 2:

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. **(10 Lectures)**

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. **(6 Lectures)**

Unit 3:

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field**B**. Biot-Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (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. **(11 Lectures)**

Unit 4:

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. **(4 Lectures)**

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. **(6 Lectures)**

Unit 5:

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. **(4 Lectures)**

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. **(4 Lectures)**

Ballistic Galvanometer: Torque on a current Loop. Ballistic Galvanometer: Current and Charge Sensitivity. Electromagnetic damping. Logarithmic damping. CDR. **(3 Lectures)**

Reference Books:

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

PHYSICS –C-201-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 20 ESE Time = 3 hours

1. To study the characteristics of a series RC Circuit connected to an ac/dc source.
2. To determine an unknown Low Resistance using Potentiometer.
3. To determine an unknown Low Resistance using Carey Foster's Bridge.
4. To compare two capacitances using De'Sauty's bridge.
5. To determine the strength of the magnetic field produced at the centre of the tangent galvanometer coil due to a current flowing in it and hence to determine horizontal component of earth's magnetic field.
6. To verify the Thevenin, Norton and Maximum power transfer theorems.
7. To determine self inductance of a coil by Anderson's bridge/Maxwell's bridge.
8. To study response curve of a Series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
9. To determine the resistance of a given galvanometer by half deflection method.
10. To determine the mutual inductance between two coils by suitable method.

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

PHYSICS-C-202: WAVES AND OPTICS

Contact Hours: 60
Full Marks = 70 **[**ESE (50) CCA(20)]
Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

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. **(5 Lectures)**

Superposition of two perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses. **(2 Lectures)**

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. **(4 Lectures)**

Unit 2:

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. **(6 Lectures)**

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. **(7 Lectures)**

Unit 3:

Wave Optics: Electromagnetic nature of light. Definition and properties of wave front. Huygens Principle. Temporal and Spatial Coherence. **(3 Lectures)**

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. **(9 Lectures)**

Unit 4:

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. **(4 Lectures)**

Diffraction: Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) **(2 Lectures)**

Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope. Double slit. Multiple slits. Diffraction grating. Resolving power of grating. **(8 Lectures)**

Unit 5:

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.

(7 Lectures)

Holography: Principle of Holography. Recording and Reconstruction Method. Theory of Holography as Interference between two Plane Waves. Point source holograms.

(3 Lectures)

Reference Books

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

PHYSICS – C-202-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.
2.. To determine refractive index of the material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine the wavelength of sodium source using Michelson's interferometer.
5. To determine wavelength of sodium light using Fresnel Biprism.
6. To determine wavelength of sodium light using Newton's Rings.
7. To draw the D- λ calibration curve and hence find the wavelength of unknown source.
8. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
9. To determine dispersive power and resolving power of a plane diffraction grating.

Reference Books

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

Semester III

PHYSICS-C-301: MATHEMATICAL PHYSICS-II

Contact Hours: 60
Full Marks = 70 [ESE (50) CCA(20)]
Pass Marks = 28 [ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

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 1:

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. **(10 Lectures)**

Unit 2:

Frobenius Method and Special Functions: Singular Points of Second Order Linear Differential Equations and their importance. Frobenius method and its applications to find the solution of Legendre, Bessel, Hermite and Laguerre Differential Equations.

(12 Lectures)

Unit 3:

Properties of Legendre Polynomials: Rodrigues Formula, Generating Function, Orthogonality. Simple recurrence relations. Expansion of function in a series of Legendre Polynomials. Bessel Functions of the First Kind: Generating Function, simple recurrence relations. Zeros of Bessel Functions ($J_o(x)$ and $J_1(x)$)and Orthogonality.

(12 Lectures)

Unit 4:

Some Special Integrals: Beta and Gamma Functions and Relation between them. Expression of Integrals in terms of Gamma Functions. **(4 Lectures)**

Dirac Delta function and its properties:

Definition of Dirac delta function. Representation as limit of a Gaussian function and rectangular function. Properties of Dirac delta function. **(6 Lectures)**

Unit 5:

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.

(14 Lectures)

Reference Books:

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

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PHYSICS –C-301-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

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 will be done on the basis of formulating the problem

Topics	**Description with Applications**
Introduction to Numerical computation software Scilab/FORTRAN/C/C^{++}/Matlab/Mathematica.	Introduction to Scilab/FORTRAN/C/C^{++}/Matlab/Mathematica, Advantages and disadvantages.
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	Generating and plotting Legendre Polynomials
User defined functions in Scilab	Generating and plotting Bessel function
Solution of ODE First order Differential equation Euler, modified Euler and Runge-Kutta second order methods Second order differential equation Fixed difference method	First order differential equation • Radioactive decay • Current in RC, LC circuits with DC source • Newton's law of cooling • Classical equations of motion Second order Differential Equation • Harmonic oscillator (no friction) • Damped Harmonic oscillator • Over damped • Critical damped • Oscillatory • Forced Harmonic oscillator • Transient and • Steady state solution • Apply above to LCR circuits also
Partial differential equations	Partial Differential Equation: • Wave equation • Heat equation • Poisson equation • Laplace equation

Reference Books:

- Mathematical Methods for Physics and Engineers, K.F Riley, M.P. Hobson and S. J. Bence, 3rd ed., 2006, Cambridge University Press
- Complex Variables, A.S. Fokas & M.J. Ablowitz, 8th Ed., 2011, Cambridge Univ. Press
- First course in complex analysis with applications, D.G. Zill and P.D. Shanahan, 1940, Jones & Bartlett
- Computational Physics, D.Walker, 1st Edn., 2015, Scientific International Pvt. Ltd.
- A Guide to MATLAB, B.R. Hunt, R.L. Lipsman, J.M. Rosenberg, 2014, 3rd Edn., Cambridge University Press
- Simulation of ODE/PDE Models with MATLAB®, OCTAVE and SCILAB: Scientific and Engineering Applications: A.V. Wouwer, P. Saucez, C.V. Fernández. 2014 Springer
- 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
- www.**scilab**.in/textbook_companion/generate_book/291

PHYSICS-C-302: THERMAL PHYSICS

Contact Hours: 60

Full Marks = 70 **[**ESE (50) CCA(20)]

Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

Introduction to Thermodynamics

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, 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. **(7 Lectures)**

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. **(8 Lectures)**

Unit 2:

Entropy: Concept of Entropy, Clausius Theorem. Clausius Inequality, Second Law of Thermodynamics in terms of Entropy. Entropy of a perfect gas. Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe. 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. **(9 Lectures)**

Thermodynamic Potentials: Thermodynamic Potentials: Internal Energy, Enthalpy,

Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications. **(3 Lectures)**

Unit 3: Maxwell's Thermodynamic Relations & Phase Transition

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

Phase Transition: First and second order Phase Transitions with examples, Clausius Clapeyron Equation and Ehrenfest equations **(12 Lectures)**

Unit 4:

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. **(7 Lectures)**

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. **(4 Lectures)**

Unit 5:

Real Gases: Behavior of Real Gases: Deviations from the Ideal Gas Equation.

The Virial Equation. Andrew's Experiments on CO_2 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. **(10 Lectures)**

Reference Books:

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

PHYSICS –C-302-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. To determine Mechanical Equivalent of Heat, J, by Joule's / Callender and Barne's constant flow method

2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus or any suitable method.

3. To determine the coefficient of linear expansion by optical lever method or any other suitable method.

4. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method or any suitable method

5. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT)

6. To study the variation of resistance with temperature by Carry-Foster bridge and hence determine the temperature coefficient of the material using hotplate.

7. To study the variation of Thermo-emf of a Thermocouple with Difference of Temperature of its Two Junctions

8. To calibrate a thermocouple to measure temperature in a specified Range using

i) Null Method, ii) Direct measurement using Op-Amp difference amplifier and to determine Neutral Temperature.

Reference Books

- Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House
- A Text Book of Practical Physics, I.Prakash & Ramakrishna, 11th Ed., 2011, Kitab Mahal
- A Text Book of Advanced Practical Physics, Samir Kumar Ghosh, New Central Book Agency
- A Laboratory Manual of Physics for undergraduate classes,D.P.Khandelwal,1985, Vani Pub.

PHYSICS-C-303: DIGITAL SYSTEMS AND APPLICATIONS

Contact Hours: 60

Full Marks = 70 [ESE (50) CCA(20)]

Pass Marks = 28 [ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

Introduction to CRO: Block Diagram of CRO. Electron Gun, Deflection System and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference. **(3 Lectures)**

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. **(3 Lectures)**

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. **(6 Lectures)**

Unit 2:

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. **(6 Lectures)**

Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **(4 Lectures)**

Unit 3:

Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors, 4-bit binary Adder/Subtractor. **(5 Lectures)**

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. **(6 Lectures)**

Timers: IC 555: block diagram and applications: Astable multivibrator and Monostable multivibrator. **(3 Lectures)**

Unit 4:

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). **(2 Lectures)**

Counters(4 bits): Ring Counter. Asynchronous counters, Decade Counter. Synchronous Counter. **(4 Lectures)**

Computer Organization: Input/Output Devices. Data storage (idea of RAM and ROM). Computer memory. Memory organization & addressing. Memory Interfacing. Memory Map. **(6 Lectures)**

Unit 5:

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. **(8 Lectures)**

Introduction to Assembly Language: 1 byte, 2 byte & 3 byte instructions. **(4 Lectures)**

Reference Books:

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

- Logic circuit design, Shimon P. Vingron, 2012, Springer.
- Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
- Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
- Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.

PHYSICS-C-303-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. To verify the truth tables of AND, OR, NOT, NOR and NAND gates.

2. To design a combinational logic system for a specified Truth Table.

3. To convert a Boolean expression into logic circuit and design it using logic gate ICs

4. To design and verify the De Morgan's theorem using breadboard.

5. To design and verify Half Adder and Full Adder.

6. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.

7. To build JK Master-slave flip-flop using Flip-Flop ICs

8. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.

9. To design an astable multivibrator of given specifications using 555 Timer.

10. To design a monostable multivibrator of given specifications using 555 Timer.

11.To measure (a) Voltage, (b) rise and fall times and (c) Time period of a periodic waveform using CRO.

12. 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.

    f) Use of CALL and RETURN Instruction.

Reference Books:

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

Semester IV

PHYSICS-C-401: MATHEMATICAL PHYSICS-III Full Marks = 100

Contact Hours: 60

Full Marks = 70 [ESE (50) CCA(20)]

Pass Marks = 28 [ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

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 1:

Complex Analysis: Brief Revision of Complex Numbers and their Graphical Representation. Euler's formula, De Moivre's theorem, Roots of Complex Numbers. Functions of Complex Variables. Analyticity and Cauchy-Riemann Conditions. Examples of analytic functions.

(12 Lectures)

Unit 2:

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. **(12 Lectures)**

Unit 3:

Residues at simple pole, Residue at a pole of order greater than unity, Residue at infinity, Cauchy's Residue Theorem, Application in solving Definite Integrals. **(12 Lectures)**

Unit 4:

Laplace Transforms: Laplace Transform (LT) of Elementary functions. Properties of LTs: Change of Scale Theorem, Shifting Theorem. LTs of 1^{st} and 2^{nd} order Derivatives and Integrals of Functions, Derivatives and Integrals of LTs. LT of Unit Step function, Periodic Functions. **(12 Lectures)**

Unit 5:

Convolution Theorem. Inverse LT. Application of Laplace Transforms to 2^{nd} order Differential Equations: Damped Harmonic Oscillator, Simple Electrical Circuits, Coupled differential equations of 1^{st} order. Solution of heat flow along infinite bar using Laplace transform. **(12 Lectures)**

Reference Books:

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

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PHYSICS –C-401-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

Scilab/FORTRAN/C/C^{++} /others based simulations experiments 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 $\frac{1}{\sqrt{2\pi\sigma^2}}\int e^{\frac{-(x-3)^2}{2\sigma^2}}(x+3)dx$, for $\sigma = 1,\ 0.1,\ 0.01$ and show it tends to 5.

3. Fourier Series:

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

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

4. Frobenius method and Special functions:

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

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

   Show recursion relation

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

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

   ii. 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.

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

   iv. Find the two square roots of $-5+12j$.

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

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

   vii. 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

PHYSICS-C-402: ELEMENTS OF MODERN PHYSICS

Contact Hours: 60

Full Marks = 70 **[**ESE (50) CCA(20)]

Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

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.

(11 Lectures)

Unit 2:

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 Size and structure of atomic nucleus, Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. **(13 Lectures)**

Unit 3:

Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; 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. **(11 Lectures)**

Unit 4:

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. **(8 Lectures)**

Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers. **(4 Lectures)**

Unit 5:

Radioactivity: stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus. **(6 Lectures)**

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). **(3 Lectures)**

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. **(4 Lectures)**

Reference Books:

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

Additional Books for Reference

- Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
- Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
- Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.
- Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.
- Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

PHYSICS-C-402-LAB

Contact Hours: 60

Full Marks = 30 **Pass Mark = 12** **ESE Time = 3 hours**

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 value of e/m by Magnetic focusing/ Bar magnet or by any suitable method.

7. To setup the Millikan oil drop apparatus and determine the charge of an electron.

8. To show the tunnelling effect in tunnel diode using I-V characteristics.

9. To determine the wavelength of laser source using diffraction of single slit.

10. To determine the wavelength of laser source using diffraction of double slits.

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 Edn, 2011,Kitab Mahal

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PHYSICS-C-403: ANALOG SYSTEMS AND APPLICATIONS

Contact Hours: 60

Full Marks = 70 **[**ESE (50) CCA(20)]

Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

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

Unit 2:

Two-terminal Devices and their Applications: (1) Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification Efficiency, C-filter (2) Zener Diode and Voltage Regulation. Principle and structure of (1) LEDs, (2) Photodiode and (3) Solar Cell. **(6 Lectures)**

Bipolar Junction transistors: n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point. Physical Mechanism of Current Flow. Active, Cutoff and Saturation Regions. **(6 Lectures)**

Unit 3:

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. **(10 Lectures)**

Coupled Amplifier: Two stage RC-coupled amplifier and its frequency response. **(4 Lectures)**

Unit 4:

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. **(4 Lectures)**

Sinusoidal Oscillators: Barkhausen's Criterion for self-sustained oscillations. RC Phase shift oscillator, determination of Frequency. Hartley & Colpitts oscillators. **(4 Lectures)**

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and concept of Virtual ground. **(4 Lectures)**

Unit 5:

Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator, (6) Log amplifier, (7) Zero crossing detector (8) Wein bridge oscillator. **(9 Lectures)**

Conversion: Resistive network (Weighted and R-2R Ladder). Accuracy and Resolution. A/D Conversion (successive approximation) **(3 Lectures)**

Reference Books:

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

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PHYSICS-C-403-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. To study V-I characteristics of PN junction diode, and Light emitting diode.

2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.

3. Study of V-I & power curves of solar cells, and find maximum power point & efficiency.

4. To study the characteristics of a Bipolar Junction Transistor in CE configuration.

5. To design a CE transistor amplifier of a given gain (mid-gain) using voltage

divider bias.

6. To study the frequency response of voltage gain of a single stage RC-coupled transistor amplifier.

7. To design a phase shift oscillator of given specifications using BJT.

8. To design a Wien bridge oscillator for given frequency using an op-amp.

9. To study the analog to digital convertor (ADC) IC.

10. To design an inverting amplifier using Op-amp (741,351) for dc input voltage and study its closed loop gain.

11. To design inverting amplifier using Op-amp (741,351) and study its frequency response

12. To design non-inverting amplifier using Op-amp (741,351) & study its frequency response

13. To investigate the use of an op-amp (741,351) as an Integrator and Differentiator.

14. To add two dc voltages using Op-amp (741,351) in inverting and non-inverting mode

15. To investigate the use of an op-amp (741,351) as adder and subtractor.

Reference Books:

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

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Semester V

PHYSICS-C-501:QUANTUM MECHANICS AND APPLICATIONS

Contact Hours: 60
Full Marks = 70 [ESE (50) CCA(20)]
Pass Marks = 28 [ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

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. **(10 Lectures)**

Unit 2:

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. **(10 Lectures)**

Unit 3:

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. **(10 Lectures)**

Unit 4:

Quantum theory of hydrogen-like atoms: time independent Schrodinger equation in spherical polar coordinates; separation of variables for second order partial differential equation; angular momentum operator & quantum numbers; Radial wavefunctions from Frobenius method; shapes of the probability densities for ground & first excited states; Orbital angular momentum quantum numbers l and m; s, p, d,.. shells. **(10 Lectures)**

Atoms in Electric & Magnetic Fields: Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Electron Magnetic Moment, Gyromagnetic Ratio and Bohr Magneton ,Spin Magnetic Moment. Stern-Gerlach Experiment.. **(6 Lectures)**

Unit 5:

Atoms in External Magnetic Fields:- Zeeman Effect: ,Normal and Anomalous Zeeman Effect. Paschen Back and Stark Effect (Qualitative Discussion only). **(4 Lectures)**

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.) **(10 Lectures)**

Reference Books:

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

Additional Books for Reference

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

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PHYSICS –C-501-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

A. Laboratory based experiments:

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

B. *Use C/C^{++}/Scilab/FORTRAN/Others for solving the following problems based on Quantum Mechanics like*

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

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

Here, m is the reduced mass of the electron. Obtain the energy eigenvalues and plot the corresponding wavefunctions. Remember that the ground state energy of 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:

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

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

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

Find the energy (in eV) of the ground state of the atom to an accuracy of three significant digits. Also, plot the corresponding wavefunction. Take e = 3.795 $(eVÅ)^{1/2}$, m = 0.511×10^6 eV/c^2, and a = 3 Å, 5 Å, 7 Å. In these units hc = 1973 (eVÅ). The ground state energy is expected to be above -12 eV in all three cases.

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

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

For the anharmonic oscillator potential

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

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

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

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

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

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

Find the lowest vibrational energy (in MeV) of the molecule to an accuracy of three significant digits. Also plot the corresponding wave function.

Take: m = $940 \times 10^6 eV/C^2$, D = 0.755501 eV, α = 1.44, r_0 = 0.131349 Å

Reference Books:

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

PHYSICS-C-502: SOLID STATE PHYSICS

Contact Hours: 60
Full Marks = 70 [ESE (50) CCA(20)]
Pass Marks = 28 [ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

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. **(12 Lectures)**

Unit 2:

Elementary Lattice Dynamics: Lattice Vibrations and Phonons: Linear Monoatomic and Diatomic Chains. Acoustical and Optical Phonons. Qualitative Description of the Phonon Spectrum in Solids. Dulong and Petit's Law, Einstein and Debye theories of specific heat of solids. T^3 law **(10 Lectures)**

Unit 3:

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.

(10 Lectures)

Unit 4:

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.

(8 Lectures)

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. **(6 lectures)**

Unit 5:

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. **(8 Lectures)**

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) **(6 Lectures)**

Reference Books:

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

PHYSICS –C-502-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. Measurement of susceptibility of paramagnetic solution by (Quinck`s Tube Method)/suitable method.

2. To measure the Magnetic susceptibility of Solids.

3. To measure the Dielectric Constant of a dielectric Material by suitable method.

4. To study the PE Hysteresis loop of a Ferroelectric Crystal.

5. To draw the BH curve of Fe using Solenoid/transformer & determine energy loss from Hysteresis.

6. 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.

7. To determine the Hall coefficient of a semiconductor sample.

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

Semester VI

PHYSICS-C-601: ELECTROMAGNETIC THEORY

Contact Hours: 60
Full Marks = 70 [ESE (50) CCA(20)]
Pass Marks = 28 [ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:
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. **(12 Lectures)**

Unit 2:
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. **(10 Lectures)**

Unit 3:
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)

(10 Lectures)

Unit 4:
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 **(17 Lectures)**

Unit 5:
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. **(8 Lectures)**

Optical Fibres:- Numerical Aperture. Step and Graded Indices (Definitions Only).

Single and Multiple Mode Fibres (Concept and Definition Only). **(3 Lectures)**

Reference Books:

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

Additional Books for Reference

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

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PHYSICS –C-601-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

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 suitable method (using a Babinet's compensator).
4. To study the polarization of light by reflection and determine the polarizing angle and hence determine the refractive index of the material.
5. To verify the Stefan's law of radiation and to determine Stefan's constant.
6. 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

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PHYSICS-C-602: STATISTICAL MECHANICS

Contact Hours: 60

Full Marks = 70 [ESE (50) CCA(20)]

Pass Marks = 28 [ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

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. **(16 Lectures)**

Unit 2:

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. **(11 Lectures)**

Unit 3:

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. **(13 Lectures)**

Unit 4:

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. **(10 Lectures)**

Unit 5:

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 (Qualitative Idea), White Dwarf Stars, Chandrasekhar Mass Limit. **(10 Lectures)**

Reference Books:

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

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PHYSICS –C-602-LAB

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

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

1. Computation of the partition function Z(β) for examples of systems with a finite number of single particle levels (e.g., 2 level, 3 level, etc.) and a finite number of non-interacting particles N under Maxwell-Boltzmann, Fermi-Dirac and Bose-Einstein statistics:

a) Study of how $Z(\beta)$, average energy $\langle E \rangle$, energy fluctuation ΔE, specific heat at constant volume C_v, depend upon the temperature, total number of particles N and the spectrum of single particle states.
b) Ratios of occupation numbers of various states for the systems considered above
c) Computation of physical quantities at large and small temperature T and comparison of various statistics at large and small temperature T.

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

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

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

Reference Books:

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

SYLLABI FOR DSC/GE PAPERS

PHYSICS-DSC-101: MECHANICS / PHYSICS-GE-101: MECHANICS

Contact Hours: 60
Full Marks = 70 **[**ESE (50) CCA(20)]
Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:
Vectors: Vector algebra. Scalar and vector products. Derivatives of a vector with respect to a parameter. **(4 Lectures)**

Ordinary Differential Equations: 1^{st} order homogeneous differential equations. 2^{nd} order homogeneous differential equations with constant coefficients. **(6 Lectures)**

Unit 2:
Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Centre of Mass. **(6 Lectures)**
Momentum and Energy: Conservation of momentum. Work and energy. Conservation of energy. Motion of rockets. **(6 Lectures)**
Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. **(5 Lectures)**

Unit 3:
Gravitation: Newton's Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness. Basic idea of global positioning system (GPS).

(10 Lectures)

Unit 4:
Elasticity: Hooke's law - Stress-strain diagram - Elastic moduli-Relation between elastic constants - Poisson's Ratio-Expression for Poisson's ratio in terms of elastic constants - Work done in stretching and work done in twisting a wire - Twisting couple on a cylinder, Torsional pendulum. **(10 Lectures)**

Unit 5:
Fluids: Surface Tension: Synclastic and anticlastic surface - Excess of pressure - Application to spherical and cylindrical drops and bubbles - variation of surface tension with temperature - Jaegar's method. Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula and Determination of coefficient of viscosity of a liquid - Variations of viscosity of a liquid with temperature. **(8 Lectures)**

Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. **(5 Lectures)**

Note: Students are not familiar with vector calculus. Hence all examples should involve differentiation either in one dimension or with respect to the radial coordinate.

Reference Books:

- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. AddisonWesley
- Undergraduate Physics, A B Bhattacahrjee and R Bhattacharjee, New Central Book Agency
- Mechanics Berkeley Physics course,v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
- Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
- Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

PHYSICS-DSC-101-LAB: MECHANICS / PHYSICS-GE-101-LAB: MECHANICS

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. Measurements of length (or diameter) using Vernier Calliper, screw gauge and travelling microscope.
2. To determine the Moment of Inertia of a regular body by torsional pendulum.
3. To determine the Young's Modulus of a Wire by Searle's Method.
4. To determine the Modulus of Rigidity of a Wire by Statistical method.
5. To determine g by Bar Pendulum.
6. To determine g by Kater's Pendulum.
7. To determine **g** and velocity for a freely falling body using Digital Timing Technique
8. To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g
9. To determine the Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).

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

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

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Semester II

PHYSICS-DSC-201: ELECTRICITY AND MAGNETISM

/ PHYSICS-GE-201: ELECTRICITY AND MAGNETISM

Contact Hours: 60
Full Marks = 70 **[**ESE (50) CCA(20)]
Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem and Stoke's theorem of vectors (statement only).

(12 Lectures)

Unit 2:

Electrostatics: Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. Electric potential as line integral of electric field, potential due to a point charge, electric dipole, uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. Dielectric medium, Polarisation, Displacement vector. Gauss's theorem in dielectrics. Parallel plate capacitor completely filled with dielectric. **(15 Lectures)**

Unit 3:

Magnetism: Magnetostatics: Biot-Savart's law & its applications- straight conductor, circular coil, solenoid carrying current. Divergence and curl of magnetic field. Magnetic vector potential. Ampere's circuital law.

Magnetic properties of materials: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility. Brief introduction of dia-, para- and ferro-magnetic materials. **(13 Lectures)**

Unit 4:

Electromagnetic Induction: Faraday's laws of electromagnetic induction, Lenz's law, self and mutual inductance, L of single coil, M of two coils. Energy stored in magnetic Field. Trasformer, Auto Trasformer, different losses of trasformer

(10 Lectures)

Unit 5:

Maxwell`s equations and Electromagnetic wave propagation: Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum. **(10 Lectures)**

Reference Books:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education..
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- D.J. Griffiths, Introduction to Electrodynamics, 3rd Edn, 1998, Benjamin Cummings.

PHYSICS-DSC-201-LAB: ELECTRICITY AND MAGNETISM / PHYSICS-GE-201-LAB: ELECTRICITY AND MAGNETISM

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.
2. To determine the specific resistance by metre bridge.
3. To determine the strength of the magnetic field produced at the centre of the tangent galvanometer coil due to a current flowing in it and hence to determine horizontal component of earth's magnetic field.
4. To determine the self induction of a coil and its internal resistance in an L-R circuit
5. To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor
6. To determine the resistance of a galvanometer by half deflection method.
7. To determine a resistance per unit length of metre bridge wire by Carey Foster's method.
8. To verify the Thevenin and Norton theorem.
9. To verify series and parallel laws of resistance by Post office Box.
10. To compare the emf of two cells by potentiometer.

Reference Books

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th

Edition, reprinted 1985, Heinemann Educational Publishers

Semester III

PHYSICS-DSC-301: THERMAL PHYSICS AND STATISTICAL MECHANICS / PHYSICS-GE-301: THERMAL PHYSICS AND STATISTICAL MECHANICS

Contact Hours: 60
Full Marks = 70 **[**ESE (50) CCA(20)]
Pass Marks = 28 **[**ESE (20) CCA (8)]
(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

Laws of Thermodynamics:

Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermo dynamical Processes, Applications of First Law: General Relation between C_P & C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility & Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Unattainability of absolute zero. **(15 Lectures)**

Unit 2:

Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations & applications - Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for $(C_P - C_V)$, C_P/C_V, TdS equations. **(12 Lectures)**

Unit 3:

Kinetic Theory of Gases: Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Zeroth Order), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical case), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases.

(12 Lectures)

Unit 4:

Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan Boltzmann Law and Wien's displacement law from Planck's law. **(10 Lectures)**

Unit 5:

Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity - Quantum statistics - Fermi-Dirac distribution law, Bose-Einstein distribution law, comparison of three statistics.

(11 Lectures)

Reference Books:

- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- A Treatise on Heat, Meghnad Saha, and B.N. Srivastava, 1969, Indian Press.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Heat and Thermodynamics, M.W.Zemasky and R. Dittman, 1981, McGraw Hill
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears &

G.L.Salinger. 1988, Narosa

- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

PHYSICS-DSC- 301-LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS / PHYSICS-GE-301-LAB: THERMAL PHYSICS AND STATISTICAL MECHANICS

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. To determine Mechanical Equivalent of Heat, J, by Joule's method.
2. To determine the specific heat of a liquid by the method of cooling.
3. To verify Stefan's law by electrical method.
4. To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5. To determine the coefficient of linear expansion by suitable method.
6. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
7. To study the variation of thermo emf across two junctions of a thermocouple with temperature.

Reference Books:

- Advanced Practical Physics for students, B.L.Flint & 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, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.

Semester IV

PHYSICS-DSC-401: WAVES AND OPTICS / PHYSICS-GE-401: WAVES AND OPTICS

Contact Hours: 60
Full Marks = 70 **[**ESE (50) CCA(20)]
Pass Marks = 28 **[**ESE (20) CCA (8)]

(Two questions of 10 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

Superposition of Two Collinear Harmonic oscillations: Linearity and Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats). **(5 Lectures)**

Superposition of Two Perpendicular Harmonic Oscillations: Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

(5 Lectures)

Unit 2:

Waves Motion- General: Transverse waves on a string. Travelling and standing waves on a string. Normal Modes of a string. Group velocity, Phase velocity. Plane waves.
Spherical waves, Wave intensity. **(5 Lectures)**

Sound: Simple harmonic motion - forced vibrations and resonance. Intensity and loudness of sound - Decibels - Intensity levels - musical notes - musical scale. Acoustics of buildings: Reverberation and time of reverberation - Absorption coefficient - Sabine's formula - measurement of reverberation time - Acoustic aspects of halls and auditoria. **(7 Lectures)**

Unit 3:

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front.
Huygens Principle. **(4 Lectures)**

Interference: Interference: Division of amplitude and division of wavefront. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. **(10 Lectures)**

Unit 4:

Interferometers: Michelson's Interferometer: Idea of form of fringes , Determination of wavelength, Wavelength difference, Refractive index and Visibility of fringes.

(6 Lectures)

Diffraction: Fraunhoffer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating. Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis. **(8 Lectures)**

Unit 5:

Polarization: Transverse nature of light waves. Polarised and unpolarised light, Nicol Prism, Production and analysis of Plane Polarised light by Nicol Prism. Zone Plate, Half wave and quater wave plate, Babinet Compensator

(10 Lectures)

Reference Books:

- Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing
- Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publication
- University Physics. FW Sears, MW Zemansky and HD Young 13/e, 1986. Addison-Wesley

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PHYSICS-DSC-401-LAB: WAVES AND OPTICS

/ PHYSICS-GE- 401-LAB: WAVES AND OPTICS

Contact Hours: 60

Full Marks = 30 Pass Mark = 12 ESE Time = 3 hours

1. To determine the frequency of tuning fork by sonometer.
2. To determine the refractive index of a given liquid by travelling microscope.
3. To determine the R. I. of the material of a given lens by suitable method.
4. To determine the focal length of convex mirror with the help of a convex lens by optical bench.
5. Familiarization with Schuster`s focussing; determination of angle of prism.
6. To determine the Refractive Index of the Material of a given Prism using Sodium Light.
7. To determine Dispersive Power of the Material of a given Prism using Mercury Light
8. To determine wavelength of sodium light using Newton's Rings.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint & 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, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

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SYLLABI FOR DSE PAPERS

PHYSICS- DSE-501A: CLASSICAL DYNAMICS

Contact Hours: 90
Full Marks = 100 [ESE (70) CCA(30)]
Pass Marks = 40 [ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit)
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: 1: Classical Mechanics Lagrangian formalism:
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. Coriolis force. **(15 Lectures)**

Unit 2 : Generalized coordinates and velocities, D'Alembert's Principle.Constraints and their classification. 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. **(15 Lectures)**

Unit: 3 :Hamiltonian Formalism:
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.
(15 Lectures)

Unit: 4: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. **(15 Lectures)**

Unit 5: Fluid Dynamics
Density ρ 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, qualitative description of turbulence, Reynolds number. **(15 Lectures)**

Tutorials: 15 hours
Reference Books:
- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.

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

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PHYSICS- DSE-501B: BIOLOGICAL PHYSICS

Contact Hours: 90
Full Marks = 100 [ESE (70) CCA(30)]
Pass Marks = 40 [ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:
The boundary, interior and exterior environment of living cells. Processes: exchange of matter and energy with environment, metabolism, maintenance, reproduction, evolution. Self-replication as a distinct property of biological systems. Time scales and spatial scales. Universality of microscopic processes and diversity of macroscopic form. Types of cells. Multicellularity. Allometric scaling laws. **(9 lectures)**

Unit 2:
Metabolites, proteins and nucleic acids. Their sizes, types and roles in structures and processes. Transport, energy storage, membrane formation, catalysis, replication, transcription, translation, signaling.
Typical populations of molecules of various types present in cells, their rates of production and turnover. Energy required to make a bacterial cell.
Simplified mathematical models of transcription and translation, small genetic circuits and signaling pathways. Random walks and applications to biology. Mathematical models to be studied analytically and computationally. **(22 lectures)**

Unit 3:
The numbers of distinct metabolites, genes and proteins in a cell. Complex networks of molecular interactions: metabolic, regulatory and signaling networks. Dynamics of metabolic networks; the stoichiometric matrix. Living systems as complex organizations; systems biology. Models of cellular dynamics. The implausibility of life based on a simplified probability estimate, and the origin of life problem. **(15 lectures)**

Unit 4:
Numbers and types of cells in multicellular organisms. Cell types as distinct attractors of a dynamical system. Stem cells and cellular differentiation. Pattern formation and development.
Brain structure: neurons and neural networks. Brain as an information processing system. Associative memory models. Memories as attractors of the neural network dynamics.
(15 lectures)

Unit 5:
The mechanism of evolution: variation at the molecular level, selection at the level of the organism. Models of evolution. The concept of genotype-phenotype map. Examples. **(14 Lectures)**
Self sustaining ecosystems.

Tutorials: 15 hours

References:

- Physics in Molecular Biology; Kim Sneppen & Giovanni Zocchi (CUP 2005)
- Biological Physics: Energy, Information, Life; Philip Nelson (W H Freeman & Co, NY, 2004)
- Physical Biology of the Cell (2nd Edition), Rob Phillips et al (Garland Science, Taylor & Francis Group, London & NY, 2013)
- An Introduction to Systems Biology; Uri Alon (Chapman and Hall/CRC, Special Indian Edition, 2013)
- Evolution; M. Ridley (Blackwell Publishers, 2009, 3rd edition)

PHYSICS-DSE- 502A: NUCLEAR & PARTICLE PHYSICS

Contact Hours: 90

Full Marks = 100 [ESE (70) CCA(30)]

Pass Marks = 40 [ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states. **(15 Lectures)**

Unit 2:

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies (qualitative idea), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of nuclear force. **(15 Lectures)**

Unit 3:

Radioactivity decay:(a) Alpha decay: basics of α-decay processes, qualitative idea of alpha emission theory, Geiger Nuttall law, α-decay spectroscopy. (b) Beta-decay: energy kinematics for beta-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **(10 Lectures)**

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate. **(7 Lectures)**

Unit 4:

Interaction of Nuclear Radiation with matter: Cerenkov radiation, Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production. **(5 Lectures)**

Detector for Nuclear Radiations: Ionization chamber, proportional counter and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). **(5 Lectures)**

Particle Accelerators: Van-de Graaff generator, Linear accelerator, Cyclotron, Betatrons. Accelerator facility available in India: **(4 Lectures)**

Unit 5:

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity,

baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model.

(14 Lectures)

Tutorials: 15 hours

Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).

Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

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PHYSICS-DSE- 502B: ADVANCED MATHEMATICAL PHYSICS

Contact Hours: 90

Full Marks = 100 [ESE (70) CCA(30)]

Pass Marks = 40 [ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces and Subspaces. Linear Independence and Dependence of Vectors. Basis and Dimensions of a Vector Space. Change of basis. Homomorphism and Isomorphism of Vector Spaces. Linear Transformations. Algebra of
Linear Transformations. Non-singular Transformations. Representation of Linear Transformations by Matrices. **(15 Lectures)**

Unit 2:

Orthogonal and Unitary Matrices, Trace of a Matrix. Inner Product.
Eigen-values and Eigenvectors of Matrices, Cayley- Hamiliton Theorem, Diagonalization of Matrices, Solutions of Coupled Linear Ordinary Differential Equations, Functions of a Matrix. **(15 Lectures)**

Unit 3:

Definition, Group multiplication table, Subgroup, Coset, Direct product, Homomorphism, Isomorphism,
Matrix representation, Reducible and irreducible representation, **(15 Lectures)**

Unit 4:

Certesian Tensors: Transformation of Co-ordinates. Einstein's Summation Convention. Relation between Direction Cosines. Tensors. Algebra of Tensors. Sum, Difference and Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Invariant Tensors : Kronecker and Alternating Tensors. Association of Antisymmetric Tensor of Order Two and Vectors. Vector Algebra and Calculus using Cartesian Tensors : Scalar and Vector Products, Scalar and Vector Triple Products. Differentiation. Gradient, Divergence and Curl of Tensor Fields. Vector Identities.

(15 Lectures)

Unit 5:

General Tensors: Transformation of Co-ordinates. Minkowski Space. Contravariant & Covariant Vectors. Contravariant, Covariant and Mixed Tensors. Kronecker Delta and Permutation Tensors. Algebra of Tensors. Sum, Difference & Product of Two Tensors. Contraction. Quotient Law of Tensors. Symmetric and Anti-symmetric Tensors. Metric Tensor. **(15 Lectures)**

Tutorials: 15 hours

Reference Books:

- Mathematical Tools for Physics, James Nearing, 2010, Dover Publications
- Mathematical Methods for Physicists, G.B. Arfken, H.J. Weber, and F.E. Harris, 1970, Elsevier.
- Modern Mathematical Methods for Physicists and Engineers, C.D. Cantrell, 2011, Cambridge University Press
- Introduction to Matrices and Linear Transformations, D.T. Finkbeiner, 1978, Dover Pub.
- Linear Algebra, W. Cheney, E.W.Cheney & D.R.Kincaid, 2012, Jones & Bartlett Learning
- Mathematics for Physicists, Susan M. Lea, 2004, Thomson Brooks/Cole
- Mathematical Methods for Physicis & Engineers, K.F.Riley, M.P.Hobson, S.J.Bence, 3rd Ed., 2006, Cambridge University Press

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PHYSICS-DSE-601A: ASTRONOMY & ASTROPHYSICS

Contact Hours: 90
Full Marks = 100 [ESE (70) CCA(30)]
Pass Marks = 40 [ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature.

Basic concepts of positional astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle,Astronomical Coordinate Systems, Geographical Coordinate Systems, Measurement of Time, Sidereal Time, Apparent Solar Time, Mean Solar Time, Equation of Time, Calendar. Basic Parameters of Stars: Determination of Distance by Parallax Method; Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus; Determination of Temperature and Radius of a star. **(20 Lectures)**

Unit 2:

Astronomical techniques: Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Telescope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes). **(15 Lectures)**

Unit 3:

The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity). **The solar family** (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings.

Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R

Diagram.) **(13 Lectures)**

Unit 4:

The milky way : Galaxy Morphology, Hubble's Classification of Galaxies Basic Structure and Properties of the Milky Way, Nature of Rotation of the Milky Way (Differential Rotation of the Galaxy and Oort Constant, Rotation Curve of the Galaxy and the Dark Matter, Nature of the Spiral Arms), Stars and Star Clusters of the Milky Way, Properties of and around the Galactic Nucleus. **(15 Lectures)**

Unit 5:

Large scale structure & expanding universe: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance- Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter). **(12 Lectures)**

Tutorials: 15 hours

Reference Books:

- Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
- Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
- The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
- Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer
- Baidyanath Basu, 'An introduction to Astro physics', Second printing, Prentice - Hall of India Private limited, New Delhi,2001.
- Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

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PHYSICS-DSE-601B: NANO-MATERIALS AND APPLICATIONS

Contact Hours: 90

Full Marks = 100 [ESE (70) CCA(30)]

Pass Marks = 40 [ESE (28) CCA(12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

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

Unit 2:

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies (qualitative idea), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of nuclear force. **(12 Lectures)**

Unit 3:

Radioactivity decay:(a) Alpha decay: basics of α-decay processes, qualitative idea of alpha emission theory, Geiger Nuttall law, α-decay spectroscopy. (b) Beta-decay: energy kinematics for beta-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion. **(10 Lectures)**

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate. **(8 Lectures)**

Unit 4:

Interaction of Nuclear Radiation with matter: Cerenkov radiation, Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production. **(8 Lectures)**
Detector for Nuclear Radiations: Ionization chamber, proportional counter and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT).
(8 Lectures)

Particle Accelerators: Van-de Graaff generator, Linear accelerator, Cyclotron, Betatrons. Accelerator facility available in India: **(5 Lectures)**

Unit 5:

Particle physics: Particle interactions; basic features, types of particles and its families. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model.
(14 Lectures)

Tutorials: 15 hours
Reference Books:

- Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of nuclear physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000). Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991)

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PHYSICS-DSE-602A: DISSERTATION

Contact Hours: 90

Full Marks = 100 [ESE (70) CCA(30)]
Pass Marks = 40 [ESE (28) CCA (12)]

A project of 100 marks to be done on topics in/related to any advanced theoretical/ experimental/ computational Topics under the supervision of one of the course teachers.
End semester exam will comprise of presentation (40 marks) as well as evaluation of the Report (30 marks) by an external examiner.

PHYSICS-DSE-602B: PHYSICS OF DEVICES AND COMMUNICATION

Contact Hours: 90
Full Marks = 100 [ESE (70) CCA(30)]

Pass Marks = 40 **[**ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit)

Unit 1:

Devices: Characteristic and small signal equivalent circuits of UJT and JFET. Metal-semiconductor Junction. Metal oxide semiconductor (MOS) device. Ideal MOS and Flat Band voltage. SiO_2-Si based MOS. MOSFET– their frequency limits. Enhancement and Depletion Mode MOSFETS, CMOS. Charge coupled devices. Tunnel diode. **(15 Lectures)**

Unit 2:

Power supply and Filters: Block Diagram of a Power Supply, Qualitative idea of C and L Filters. IC Regulators, Line and load regulation, Short circuit protection

Active and Passive Filters, Low Pass, High Pass, Band Pass and band Reject Filters.

Multivibrators: Astable and Monostable Multivibrators using transistors.

Phase Locked Loop(PLL): Basic Principles, Phase detector(XOR & edge triggered), Voltage Controlled Oscillator (Basics, varactor). Loop Filter– Function, Loop Filter Circuits, transient response, lock and capture. Basic idea of PLL IC (565 or 4046). **(15 Lectures)**

Unit 3:

Processing of Devices: Basic process flow for IC fabrication, Electronic grade silicon. Crystal plane and orientation. Defects in the lattice. Oxide layer. Oxidation Technique for Si. Metallization technique. Positive and Negative Masks. Optical lithography. Electron lithography. Feature size control and wet anisotropic etching. Lift off Technique. Diffusion and implantation. **(15 Lectures)**

Unit 4:

Digital Data Communication Standards:

Universal Serial Bus (USB): USB standards, Types and elements of USB transfers. Devices (Basic idea of UART).

Parallel Communications: General Purpose Interface Bus (GPIB), GPIB signals and lines, Handshaking and interface management, Implementation of a GPIB on a PC. Basic idea of sending data through a COM port. **(15 Lectures)**

Unit 5:

Introduction to communication systems: Block diagram of electronic communication system, Need for modulation. Amplitude modulation. Modulation Index. Analysis of Amplitude Modulated wave. Sideband frequencies in AM wave. CE Amplitude Modulator. Demodulation of AM wave using Diode Detector. basic idea of Frequency, Phase, Pulse and Digital Modulation including ASK, PSK, FSK. **(15 Lectures)**

Tutorial: 15 hours

Reference Books:

- 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 Integrated Circuits, R.A.Gayakwad,4 Ed. 2000,PHI Learning Pvt. Ltd
- Electronic Devices and Circuits, A. Mottershead, 1998, PHI Learning Pvt. Ltd.
- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.

- Introduction to Measurements & Instrumentation, A.K. Ghosh, 3rd Ed., 2009, PHI Learning Pvt. Ltd.
- Semiconductor Physics and Devices, D.A. Neamen, 2011, 4th Edition, McGraw Hill
- PC based instrumentation; Concepts & Practice, N.Mathivanan, 2007, Prentice-Hall of India

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SYLLABI FOR SEC PAPERS

PHYSICS-SEC-301: WORKSHOP SKILL
Contact Hours: 90
Full Marks = 100 **[**ESE (70) CCA (30)]
Pass Marks = 40 **[**ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit during end semester exam. CCA will be on the basis of Hands on skill test.)

The aim of this course is to enable the students to familiar and experience with various mechanical and electrical tools through hands-on mode

Unit 1:
Introduction: Measuring units. conversion to SI and CGS. Familiarization with meter scale, Vernier calliper, Screw gauge and their utility. Measure the dimension of a solid block, volume of cylindrical beaker/glass, diameter of a thin wire, thickness of metal sheet, etc. Use of Sextant to measure height of buildings, mountains, etc.

(12 Lectures)

Unit 2:
Mechanical Skill: Concept of workshop practice. Overview of manufacturing methods: casting, foundry, machining, forming and welding. Types of welding joints and welding defects. Common materials used for manufacturing like steel, copper, iron, metal sheets, composites and alloy, wood.

(12 Lectures)

Unit 3:
Concept of machine processing, introduction to common machine tools like lathe, shaper, drilling, milling and surface machines. Cutting tools, lubricating oils. Cutting of a metal sheet using blade. Smoothening of cutting edge of sheet using file. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. Make funnel using metal sheet.

(14 Lectures)

Unit 4:
Electrical and Electronic Skill: Use of Multimeter. Soldering of electrical circuits having discrete components (R, L, C, diode) and ICs on PCB. Operation of oscilloscope. Making regulated power supply. Timer circuit, Electronic switch using transistor and relay.

(11 Lectures)

Unit 5:
Introduction to prime movers: Mechanism, gear system, wheel, Fixing of gears with motor axel. Lever mechanism, Lifting of heavy weight using lever. braking systems, pulleys, working principle of power generation systems. Demonstration of pulley experiment.

(11 Lectures)

Hands on Training: 30 hours.

Reference Books:

- A text book in Electrical Technology - B L Theraja – S. Chand and Company.
- Performance and design of AC machines – M.G. Say, ELBS Edn.
- Mechanical workshop practice, K.C. John, 2010, PHI Learning Pvt. Ltd.
- Workshop Processes, Practices and Materials, Bruce J Black 2005, 3rd Edn., Editor Newnes [ISBN: 0750660732]
- New Engineering Technology, Lawrence Smyth/Liam Hennessy, The Educational Company of Ireland [ISBN: 0861674480]

PHYSICS-SEC-401: ELECTRICAL CIRCUITS AND NETWORK

Contact Hours: 90
Full Marks = 100 **[**ESE (70) CCA (30)]
Pass Marks = 40 **[**ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit during end semester exam. CCA will be on the basis of Hands on skill test.)

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

Unit 1:

Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter.

(12 Lectures)

Unit 2:

Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money.

(14 Lectures)

Unit 3:

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.

(8 Lectures)

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

(5 Lectures)

Unit 4:

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing

DC or AC sources to control heaters & motors. Speed & power of ac motor.
(4 Lectures)

Solid State Devices: resistors, inductors and capacitors. Diode and rectifiers Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources. **(3 Lectures)**

Electrical protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) **(4 Lectures)**

Unit 5:

Electrical Wiring: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board.
(10 Lectures)

Hands on Training: 30 hours.

Reference Books:

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

PHYSICS-SEC-501: BASIC INSTRUMENTATION

Contact Hours: 90
Full Marks = 100 **[**ESE (70) CCA (30)]
Pass Marks = 40 **[**ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit during end semester exam. CCA will be on the basis of Hands on skill test.)

This course is to get exposure with various aspects of instruments and their usage through hands-on mode. Experiments listed below are to be done in continuation of the topics.

Unit 1:

Basic of Measurement: Instruments accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. **Multimeter:** Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance.
(10 Lectures)

Unit 2:

Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage, measurement (block diagram only). Specifications of an electronic Voltmeter/ Multimeter and their significance. **AC millivoltmeter:** Type of AC millivoltmeters: Amplifier- rectifier, and rectifier- amplifier. Block diagram ac millivoltmeter**,** specifications and their significance. **(14 Lectures)**

Unit 3:

Cathode Ray **Oscilloscope:** Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only– no mathematical treatment), brief discussion on screen phosphor, visual persistence &

Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

(13 Lectures)

Unit 4:

Signal Generators and Analysis Instruments: Block diagram, explanation and specifications of low frequency signal generators. pulse generator, and function generator. Brief idea for testing, specifications. Distortion factor meter, wave analysis.

(6 Lectures)

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

(5 Lectures)

Unit 5:

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

(6 Lectures)

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

(6 Lectures)

Hands on Training on the following: 30 hours.

1. Use of an oscilloscope.
2. CRO as a versatile measuring device.
3. Circuit tracing of Laboratory electronic equipment,
4. Use of Digital multimeter/VTVM for measuring voltages
5. Circuit tracing of Laboratory electronic equipment,
6. Winding a coil / transformer.
7. Study the layout of receiver circuit.
8. Trouble shooting a circuit
9. Balancing of bridges

Exercises:

1. To observe the loading effect of a multimeter while measuring voltage across a low resistance and high resistance.
2. To observe the limitations of a multimeter for measuring high frequency voltage and currents.
3. To measure Q of a coil and its dependence on frequency, using a Q- meter.
4. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of time period, frequency, average period using universal counter/ frequency counter.
6. Measurement of rise, fall and delay times using a CRO.
7. Measurement of distortion of a RF signal generator using distortion factor meter.
8. Measurement of R, L and C using a LCR bridge/ universal bridge.

Reference Books:

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

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PHYSICS-SEC-601: RENEWABLE ENERGY AND ENERGY HARVESTING

Contact Hours: 90

Full Marks = 100 **[**ESE (70) CCA (30)]

Pass Marks = 40 **[**ESE (28) CCA (12)]

(Two questions of 14 marks will be set from each unit, one needs to be answered from each unit during end semester exam. CCA will be on the basis of Hands on skill test.)

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

Unit 1:

Fossil fuels and Alternate Sources of energy: Fossil fuels and nuclear energy, their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **(13 Lectures)**

Unit 2:

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. **(13 Lectures)**

Unit 3:

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

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices.

Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy,Osmotic Power, Ocean Bio-mass. **(11 Lectures)**

Unit 4:

Geothermal Energy: Geothermal Resources, Geothermal Technologies.

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power **(12 Lectures)**

Unit 5:

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications. Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy, sustainability. **(11 Lecture)**

Hands on Training: 30 hours

1. Demonstration of Training modules on Solar energy, wind energy, etc.
2. Conversion of vibration to voltage using piezoelectric materials
3. Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

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