ASSAM UNIVERSITY, SILCHAR

SYLLABUS UNDER

CHOICE BASED CREDIT SYSTEM

PHYSICS

(GENERAL)

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	English/MIL Communication		
II	PHYSICS-DSC-201 DSC- 2 B	Environmental Science		
	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 B.Sc. student with Physics

SEMESTER	COURSE OPTED	COURSE NAME	CREDITS
I	PHSDSC101T	Mechanics	4
	PHSDSC101P	Mechanics Lab	2
II	PHSDSC201T	Electricity, Magnetism and EMT	4
	PHSDSC201P	Electricity, Magnetism and EMT Lab	2
III	PHSDSC301T	Thermal Physics and Statistical Mechanics	4
	PHSDSC301P	Thermal Physics and Statistical Mechanics Lab	2
	PHSSEC301T	Physics workshop skill	4
IV	PHSDSC401T	Waves and Optics	4
	PHSDSC401P	Waves and Optics Lab	2
	PHSSEC401T	Electrical Circuits and Network Skills	4
V	PHSSEC501T	Basic Instrumentation Skills	4
	PHSDSE501T	A. Classical Dynamics	6
		B. Biological Physics	
VI	PHSSEC601T	Renewable Energy and Energy Harvesting	4
	PHSDSE601T	A. Astronomy and Astrophysics	6
		B. Nano-materials and Applications	

SEMESTER-I

PHSDSC101T: MECHANICS / PHSGEC101T: MECHANICS

Contact Hours: 60

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

Pass Marks = 28 [ESE (20) CCA (08)]

(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 triple products. Derivatives of a vector with respect to a parameter. **(4 Lectures)**

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

Unit 2:

Momentum and Energy: Conservation of momentum, Conservation of energy. Work energy theorem, Centre of Mass and centre of gravity. Motion of rockets. **(6 Lectures)**

Rotational Motion: Angular velocity and angular momentum. Torque. Conservation of angular momentum. Moment of inertia and radius of gyration. Calculation of moment of inertia of rectangular bar, cylinder and shell. **(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 -. Viscosity: Rate flow of liquid in a capillary tube - Poiseuille's formula and Variations of viscosity of a liquid with temperature. **(6 Lectures)**

Special Theory of Relativity: Frames of reference, Galilean transformation, Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities. **(6 Lectures)**

Reference Books:

i. University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. AddisonWesley.
ii. Mechanics Berkeley Physics course,v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
iii. Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley.
iv. Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press.
v. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

PHSDSC101P: MECHANICS / PHSGEC101P: MECHANICS

Contact Hours: 60

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

(One experiment to be performed at the time of ESE)

1. Measurements of diameter of a thick wire 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:

i. Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
ii. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
iii. Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
iv. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

SEMESTER-II

PHSDSC201T: ELECTRICITY AND MAGNETISM

/ PHSGEC201T: ELECTRICITY AND MAGNETISM

Contact Hours: 60

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

Pass Marks = 28 [ESE (20) CCA (08)]

(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. Electric potential as line integral of electric field, potential due to a point charge, electric dipole. Capacitance of an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. **(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. Transformer, Auto Transformer, different losses of transformer. **(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:

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

PHSDSC201P: ELECTRICITY AND MAGNETISM

/ PHSGEC201P: ELECTRICITY AND MAGNETISM

Contact Hours: 60

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

(One experiment to be performed at the time of ESE)

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 Thevenins theorem.
9. To verify the Norton's theorem.
10. To verify series and parallel laws of resistance by Post office Box.
11. To compare the emf of two cells by potentiometer.

Reference Books

i. Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
ii. A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
iii. Engineering Practical Physics, S.Panigrahi & B.Mallick, 2015, Cengage Learning India Pvt. Ltd.
iv. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers

SEMESTER-III

PHSDSC301T: THERMAL PHYSICS AND STATISTICAL MECHANICS

/ PHSGEC301T: THERMAL PHYSICS AND STATISTICAL MECHANICS

Contact Hours: 60

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

Pass Marks = 28 [ESE (20) CCA (08)]

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

Unit 1:

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, Reversible & irreversible processes, Second law & Entropy, Entropy changes in reversible & irreversible processes. Carnot's theorem (Statement only).

(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 a. Wien's distribution law b. Rayleigh-Jeans Law, c. Stefan Boltzmann Law and d. 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 and comparison of three statistics. **(11 Lectures)**

Reference Books:

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

PHSDSC301T: THERMAL PHYSICS AND STATISTICAL MECHANICS / PHSGEC301T: THERMAL PHYSICS AND STATISTICAL MECHANICS

Contact Hours: 60

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

(One experiment to be performed at the time of ESE)

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:

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

PHSSEC 301T: WORKSHOP SKILL

Contact Hours: 60

Marks = 50 [ESE (35) CCA(15)]

Pass Marks = 20 [ESE (14) CCA (06)]

(Two questions of 7 marks will be set from each unit, one needs to be answered from each unit during ESE. 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. **(8 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. **(8 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. Drilling of holes of different diameter in metal sheet and wooden block. Use of bench vice and tools for fitting. **(8 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 circuits, regulated power supply, IC555 Timer, Electronic switch using transistor and relay. **(8 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. **(8 Lectures)**

Hands on Training: 20 hours.

Reference Books:

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

SEMESTER-IV

PHSDSC401P: WAVES AND OPTICS
/ PHSGEC401P: WAVES AND OPTICS

Contact Hours: 60

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

Pass Marks = 28 [ESE (20) CCA (08)]

(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:

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

PHSDSC401P: WAVES AND OPTICS

/ PHSGEC401P: WAVES AND OPTICS

Contact Hours: 60

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

(One experiment to be performed at the time of ESE)

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:

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

PHSSEC 401T: ELECTRICAL CIRCUITS AND NETWORK

Contact Hours: 60

Marks = 50 [ESE (35) CCA(15)]

Pass Marks = 20 [ESE (14) CCA (06)]

(Two questions of 7 marks will be set from each unit, one needs to be answered from each unit during ESE. 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. **(8 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. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. **(8 Lectures)**

Unit 3:

Electrical Drawing and Symbols: Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Reading of circuit schematics.

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers. **(8 Lectures)**

Unit 4:

Electric Motors: Single-phase and three-phase & AC motors. Basic design. Speed & power of ac motor.

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.

Electrical protection: Relays, Fuses and switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. **(8 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. **(8 Lectures)**

Hands on Training: 20 hours.

Reference Books:

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

PHSDSE 501T (A): CLASSICAL DYNAMICS

Contact Hours: 90

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: Classical Mechanics

Dynamics of a system of particles-Centre of mass of two particle system, Velocity, acceleration and linear momentum of centre of mass of two particle system, constraints, Constrained motion and degrees of freedom.

Characteristics of motion under central force, Reduction of two-body central force problem to the equivalent one body problem, Central force and motion in a plane, Equations of motion under central force. Keplers laws of motion and their deductions. **(15 Lectures)**

Unit 2: Lagrangian formalism

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

Equilibrium and its types, Stability, Stability of simple pendulum. Minima of potential energy and points of stable equilibrium, expansion of the potential energy around a minimum, small amplitude oscillations about the minimum, Examples of system performing small oscillations. Calculation of frequency of vibration of diatomic molecule. Normal modes of oscillations- example of N identical masses connected in a linear fashion to (N -1) - identical springs. Normal coordinate and frequency. **(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:

i. Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002,Pearson Education.
ii. Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
iii. Classical Electrodynamics, J.D. Jackson, 3rd Edn., 1998, Wiley.
iv. The Classical Theory of Fields, L.D Landau, E.M Lifshitz, 4th Edn., 2003, Elsevier.
v. Introduction to Electrodynamics, D.J. Griffiths, 2012, Pearson Education.
vi. Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
vii. Classical Mechanics, R. Douglas Gregory, 2015, Cambridge University Press.
viii. Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer.
ix. Solved Problems in classical Mechanics, O.L. Delange and J. Pierrus, 2010, Oxford Press.
x. Classical Mechanics and properties of Matter, A. B. Gupta, Books and Allied publisher.

PHSDSE 501T (B): BIOLOGICAL PHYSICS

Contact Hours: 90

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 signalling 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 lecures)

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. Self-sustaining ecosystems.

(14 Lectures)

Tutorials: 15 hours

References:

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

PHSSEC 501T: BASIC INSTRUMENTATION

Contact Hours: 60

Marks = 50 [ESE (35) CCA(15)]

Pass Marks = 20 [ESE (14) CCA (06)]

(Two questions of 7 marks will be set from each unit, one needs to be answered from each unit during ESE. 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 good multimeters and their significance. **(8 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 of ac millivoltmeter**,** specifications of good ac millivoltmeter and their significance. **(8 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, Digital storage Oscilloscope: Block diagram and principle of working. **(8 Lectures)**

Unit 4:

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

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. **(8 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.

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. **(8 Lectures)**

Hands on Training on the following: 20 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. Winding a coil / transformer.
6. Study the layout of receiver circuit.
7. Balancing of LCR 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 R, L and C using a LCR bridge/ universal bridge.

Reference Books:

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

PHSDSE601T (A): 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: 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: Sun

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.)

(18 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 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), Virial theorem and Introduction to Dark Matter, Big-bang theory. **(12 Lectures)**

Tutorials: 15 hours

Reference Books:

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

PHSDSE601T (B): 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:

Nanoscale systems: Length scales in physics, Nanostructures: 1D, 2D and 3D nanostructures (nanodots, thin films, nanowires, nanorods)**,** Band structure and density of states of materials at nanoscale, Size Effects in nano systems, Quantum confinement: Applications of Schrodinger equation- Infinite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences. **(15 Lectures)**

Unit 2:

Synthesis of nanostructure materials: Top down and Bottom up approach, Photolithography. Ball milling. Gas phase condensation. Vacuum deposition. Physical vapor deposition (PVD): Thermal evaporation, E-beam evaporation, Pulsed Laser deposition. Chemical vapor deposition (CVD). Sol-Gel. Electro deposition. Spray pyrolysis. Hydrothermal synthesis. Preparation through colloidal methods. MBE growth of quantum dots. (**15 Lectures**)

Unit 3:

Characterization: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. **Electron transport**: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects. **(15 Lectures)**

Unit 4:

Optical properties: Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative Processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures. **(15 Lectures)**

Unit 5:

Applications: Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructure lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage. Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS). **(15 Lectures)**

Tutorials: 15 hours

Reference Books:

i. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
ii. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
iii. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
iv. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
v. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
vi. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
vii. K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
viii. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
ix. M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).
x. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
xi. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

PHSSEC 601T: RENEWABLE ENERGY AND ENERGY HARVESTING

Contact Hours: 60

Marks = 50 [ESE (35) CCA(15)]

Pass Marks = 20 [ESE (14) CCA (06)]

(Two questions of 7 marks will be set from each unit, one needs to be answered from each unit during ESE. 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. **(8 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 and sun tracking systems. **(8 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. **(8 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, Piezoelectric energy harvesting applications. **(8 Lectures)**

Unit 5:

Electromagnetic Energy Harvesting: Linear generators, physical mathematical models, recent applications. Carbon captured technologies, cell, batteries, power consumption. Environmental issues and Renewable sources of energy, sustainability. **(8 Lecture)**

Hands on Training: 20 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:

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