UNIVERSITY OF GOUR BANGA

(Established Under West Bengal Act XXVI Of 2007)

CBCS SYLLABUS

For

B.Sc. PHYSICS GENERAL

TOTAL MARKS: 1200

TOTAL CREDIT: 120

2019

		Discipline Core(DC)	Discipline Specific Elective(DSE)	Ability Enhancement Compulsory (AEC)	Skill Enhancement (SEC)	Credits	Marks
1st year	Sem-I	DC1(A1)Mechanics(6) DC2(B1) DC3(C1)		ENVS(2)		20	200
	Sem-II	DC4(A2)Electricity and Magnetism(6) DC5(B2) DC6(C2)		MIL(2)		20	200
2nd year	Sem-III	DC7(A3) Thermal Physics and Statistical Mechanics (6) DC8(B3) DC9(C3)			SEC1(2)	20	200
	Sem-IV	DC10 (A4) (6) DC11(B4) DC12(C4)			SEC2(2)	20	200
3rd year	Sem-V		DSE1(A1) DSE2(B1) DSE3(C1)		SEC3(2)	20	200
	Sem-VI		DSE4(A2) DSE5(B2) DSE6(C2)		SEC4(2)	20	200
	Total					120	1200

Syllabi for Discipline Core Courses (General)

DC1(A1): Mechanics

Mechanics (Theory): DC1(A1)-1T **Credits: 4**

Total Lectures:24

1. Mathematical Methods

(a) Vector Algebra: Vectors as directed line segments. Addition of vectors and multiplication by a scalar. Scalar and vector products. Basis and representation of vectors. (b) Vector Analysis: Derivatives of a vector with respect to a parameter. Gradient, divergence and Curl. Vector integration, line, surface and volume integrals of vector fields. Gauss'-divergence theorem and Stoke's theorem of vectors (Statement only).

2. Laws of Motion

(a) Laws of Motion: Frames of reference. Newton's Laws of motion. Dynamics of a system of particles. Conservation of momentum. Centre of Mass.

3. Work and Energy

(a) Work-energy theorem. Conservative forces. Concept of Potential Energy. Conservation of energy.

4. Gravitation

(a) Motion of a particle in a central force field. Conservation of angular momentum leading to restriction of the motion to a plane and constancy of areal velocity. Newton's Law of Gravitation. Kepler's Laws (statement only). Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS). Weightlessness.

5. Oscillations

(a) Simple harmonic motion. Differential equation of SHM and its solutions. Kinetic and Potential Energy, Total Energy and their time averages. Damped oscillations. Forced oscillations with harmonic forces. Compound pendulum.

6. Rotational Motion

(a) Rotation of a rigid body about a fixed axis. Angular velocity and angular momentum. Moment of Inertia. Torque. Conservation of angular momentum.

7. Elasticity

(a) 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. (b) Twisting couple on a cylinder - Determination of Rigidity modulus by static torsion. Torsional pendulum. (c) Bending of beams. (d) Work done in stretching and work done in twisting a wire.

8. Surface Tension

(a) Synclastic and anticlastic surface - Excess of pressure - Application to spherical drops and bubbles - variation of surface tension with temperature.

9. Viscosity

(a) Rate of liquid in a capillary tube - Poiseuille's formula.

Reference Books

- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison- Wesley
- 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, 2 nd edn., 2015, Oxford University Press.
- Physics for Degree Students (For B.Sc. 1st Year); C.L. Arora & P.S. Hemme; S.Chand Publishing.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.

Mechanics (Practical): DC1(A1)P **Credits: 2**

Total Lectures:32

1. To determine the Moment of Inertia of a metallic cylinder/rectangular bar about an axis passing through its centre of gravity.
2. To determine the Young's Modulus of the material of a beam by the method of Flexure.
3. To determine the Modulus of Rigidity of the material of a Wire by Statical method.
4. To determine the Young's modulus of the material of a Wire by Searle's method.
5. To determine g by Bar Pendulum.
6. To determine g by Kater's Pendulum.

7. To study the Motion of a Spring and calculate (a) Spring Constant, (b) g.

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.

DC4(A2): Electricity and Magnetism

Electricity and Magnetism (Theory): DC4(A2)T **Credits: 4**

Total Lectures:24

1. Electrostatics

(a) Coulombs law. Principle of superposition. Electrostatic Field. (b) Divergence of the Electrostatic field. Flux, Gauss's theorem of electrostatics. Applications of Gauss theorem to and Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor. (c) Curl of the Electrostatic Field. Electric potential as line integral of electric field. Potential for a uniformly charged spherical shell and solid sphere. Calculation of electric field from potential. Electric potential and field due to an electric dipole. Electric dipole moment. Force and Torque on a dipole. (d) Conductors: Electric field and charge density inside and on the surface of a conductor. Force per unit area on the surface. Capacitance of a conductor. Capacitance an isolated spherical conductor. Parallel plate, spherical and cylindrical condenser. Energy per unit volume in electrostatic field. (e) Electric Fields inside matter: Electric Polarisation. Bound charges. Displacement vector. Gauss's theorem in dielectrics. Linear Dielectric medium. Electric Succeptibility and Permittivity. Parallel plate capacitor completely lled with dielectric.

2. Magnetism

(a) Biot-Savart's law and the Lorentz force law. Application of Biot-Savart's law to determine the magnetic eld of a straight conductor, circular coil, solenoid carrying current. Force between two straight current carrying wires. (b) Divergence of the magnetic field. Magnetic vector potential. (c) Curl of the magnetic field. Ampere's circuital law. Determination of the magnetic field of a straight current carrying wire. Potential and field due to a magnetic dipole. Magnetic dipole moment. Force and torque on a magnetic dipole. (d) Magnetic fields inside matter: Magnetization. Bound currents. The magnetic intensity - H. Linear media. Magnetic susceptibility and Permeability. Brief introduction of dia-, para- and ferro-magnetic materials.

3. Electromagnetic Induction

4. Ohms law and definition of E.M.F. 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.

5. Linear Network

(a) Impedance of L, C, R and their combinations. Thevenin & Norton's Theorem. Maximum power transfer theorem and superposition theorem. Anderson's bridge.

6. Maxwell's Equations and Electromagnetic Wave Propagation

(a) Equation of continuity of current, Displacement current, Maxwell's equations, Poynting vector, energy density in electromagnetic field, electromagnetic wave propagation through vacuum and isotropic dielectric medium, transverse nature of EM waves, Polarization of E.M. waves.

General Topic

1. Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.

2. To study the random error in observations.

Reference Books

• Introduction to Electrodynamics, David J Griffiths 3rd Edn, 1998, Benjamin Cummings.

• 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.

• Electricity and Magnetism; R.Murugeshan; S. Chand Publishing.

Electricity and Magnetism (Practical): DC4(A2)P Credits: 2

Total Lectures:34

1. Ballistic Galvanometer:
    a. Measurement of charge and current sensitivity
    b. Measurement of Galvanometer Resistance by half deflection method
2. To compare capacitances using De'Sauty's bridge.
3. To study the I-V Characteristics of a Series RC Circuit.
4. To study a series LCR circuit LCR circuit and determineits
    a. Resonant frequency
    b. Quality factor
5. To study a parallel LCR circuit and determine its:
    a. Anti-resonant frequency and b. Quality factor Q
6. To determine a Low Resistance by Carey Foster's Bridge.

General Topic

1. To use a Multimeter for measuring a
    a. Resistances
    b. AC and DC Voltages

c. DC

Current

d. Checking electrical fuses.

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, I. Prakash & Ramakrishna, 11th Ed.2011, Kitab Mahal

DC7(A3):Thermal Physics and Statistical Mechanics

Thermal Physics and Statistical Mechanics (Theory): DC7(A3)T Credits: 4

Total Lectures:24

1. Laws of Thermodynamics

(a) Thermodynamic Description of system: Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamically Processes, Applications of First Law: General Relation between C_P and C_v, Work Done during Isothermal and Adiabatic Processes. Compressibility and Expansion Coefficients, Reversible and irreversible processes. Second law and Entropy, Carnot's cycle & Carnot's theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, un-attainability of absolute zero.

2.Thermo-dynamical Potentials

(a) Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Maxwell's relations and applications-Joule-Thompson Effect, Clausius-Clapeyron Equation, Expression for $(C_P - C_V)$, $\frac{C_P}{C_V}$, TdS equations.

3. Kinetic Theory of Gases (a) 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.

4. Theory of Radiation (a) 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.

5. Statistical Mechanics

(a) Phase space, Macrostate and Microstate. Ensemble - Ergodic hypothesis. Entropy and Thermodynamic probability - Boltzmann hypothesis. Maxwell-Boltzmann law - distribution of velocity - Quantum statistics (qualitative discussion only) - Fermi-Dirac distribution law (statement only) - electron gas as an example of Fermi gas - Bose-Einstein distribution law (statement only) - photon gas as an example of Bose gas- comparison of three statistics.

Reference Books

• Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGrawHill.

• 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 and G.L. Salinger. 1988, Narosa.

• Heat, Thermodynamics and Statistical Physics; B. Lal, N. Subramanyam and P.S.Hemme; S.Chand Publishing. • Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. chand Publications.

• University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole

Thermal Physics and Statistical Mechanics (Practical): DC3(B1)P Credits: 2

Total Lectures:32

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

2. To determine the coefficient of thermal conductivity of a bad conductor by Lee and

Charlton's disc method.

3. To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
4. To study the variation of thermo emf across two junctions of a thermocouple with temperature.
5. To determine the co efficient of linear expansion by optical lever method.

Reference Book:

- 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.

DC10(A4): Waves and Optics

Waves and Optics (Theory):DC10(A4)T **Credits: 4**

Total Lectures:24

1. Superposition of Two Collinear Harmonic oscillations (a) Linearity & Superposition Principle. (1) Oscillations having equal frequencies and (2) Oscillations having different frequencies (Beats).

2. Superposition of Two Perpendicular Harmonic Oscillation (a) Graphical and Analytical Methods. Lissajous Figures with equal an unequal frequency and their uses.

Wave Motion - General

(a) 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.

4. Sound

(a) Review of SHM, damped & forced vibrations - resonance. Fourier's Theorem - Application to saw tooth wave and square wave. 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.

5. Wave Optics - General

(a) Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle.

6. Interference

(a) Interference: Division of amplitude and division of wave-front. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Bi-prism. Phase change on reaction: Stoke's treatment. Interference in Thin Films: parallel and wedge shapedfilm. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness. Newton's Rings: measurement of wavelength and refractive index.

7. Michelson's Interferometer

(a) Idea of form of fringes (no theory needed), Determination of wavelength, Wavelength difference, Refractive index, and Visibility of fringes.

8. Diffraction

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

9. Polarization

10. Transverse nature of light waves. Plane polarized light - production and analysis. Circular and elliptical polarization. Optical activity.

Reference Books

• Fundamentals of Optics, F.A Jenkins and H.E White, 1976, McGraw-Hill.

• Principles of Optics, B.K. Mathur, 1995, Gopal Printing.

• University Physics. F.W. Sears, M.W. Zemansky and H.D. Young. 13/e, 1986. Addison-Wesley.

• Fundamentals of Optics, H.R. Gulati and D.R. Khanna, 1991, R. Chand Publications.

• Mechanics; D.S.Mathur and P.S.Hemme; S.Chand Publishing.

Waves and Optics (Practical): DC10(A4)-P **Credits: 2**

Total Lectures:32

1. To determine the Frequency of an Electrically Maintained Tuning Fork by Melde's Experiment and to verify $\lambda 2 - T$ Law.

2. Familiarization with Schuster`s focussing; determination of angle of prism.

3 To determine the Refractive Index of the Material of a Prism using Sodium Light.

4. To determine wavelength of sodium light using Newton's Rings.

5. To determine the refractive index of a liquid by the travelling microscope.

6. To determine the focal length of a concave lens by auxiliary lens method.

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.

Syllabi for Discipline Specific Elective Courses (General)

DSE1(A1):Advanced Mathematical Methods - I

Advanced Mathematical Methods - I - (Theory):DSE1(A1)T Credits: 5 (+1 for Tutorial)

Total Lectures:56

1. Preliminaries

(a) Set, Logical Connectivities, Proof and Function: Notion of set and basic set algebra (Venn diagram should not be used to do set algebra). Definition of OR, AND, NOT and IF-THEN. Example of direct proof, proof by contradiction. Vacuous proof (as for example null set is a subset of every set).

(b) Definition of function (distinction should be made between function f and the value of the function f (x) of function f at x). For real or complex valued function definition of zeros of a function and Zero function. Equality of functions. Example of function. Constant function (Mention the fact that function is neither a dependence nor an expression), Dirichlet function (Mention the fact that it does not have any graph) and other examples of standard real and complex valued functions.

(c) Mathematical Induction (Mention that it requires proof) and its

applications.

2. Real Numbers and Complex Numbers

(a) Axiomatic description of real number, Few applications of axioms to show its power (as for example prove a. $0 = 0$, a $(-b) = -(ab)$ $1 > 0$,etc.). Distinction between real or finite number and infinity and also between undefined quantity (as for example $a/0$) and infinity. Complex numbers (Mention the fact that they are two dimensional vectors as Real numbers are one dimensional vectors and unlike real numbers complex numbers do not admit ordering and finally beyond complex number there is only one infinity not two).

(b) Sequence, Series and Power Series: Definition of sequence and series (Mention the fact that sums in the series are not real sum but limit of finite sums; they actually mimic some of the properties of actual sum). Limit superior and Limit inferior of a sequence. Convergence of a sequence (Stress should be given on $\varepsilon - N$ definition of convergence and show proof of few elementary sequences directly from $\varepsilon - N$ definition), Power series, Example of power series, Infinite G.P. series, Uniform convergence of power series, example and Weierstrass M-test (Also mention the fact for uniform convergence of a power series we can differentiate or integrate a power series term by term), Zero power series and equality of two power series. Radius of convergence of a power series mentioning its relation with the Limit Superior of its coefficients.

3. Basics of Calculus

(a) Differential Calculus in one variable: Definition of limit (Stress should be given on epsilon-delta definition and show proof of some standard limits using epsilon-delta definition, also mention the fact that limiting value of a function when x approaches a does not depend at all on f (a)). Definition of Continuity (Mention the fact that if function is continuous at a and f (a) > 0, then there exists an open interval around a where function is entirely positive). Definition of derivative (Emphasis given on the first principle and mention the fact that for any arbitrary curve derivative actually defines tangent i.e. we de ne derivative via tangent). Rolle's Theorem and Mean value Theorem of Differential Calculus (with proof) and its application.

(b) Integral Calculus in one variable: Definition of Anti derivative and Riemann (or definite) integral. Fundamental Theorem of Integral Calculus (With proof, mention the fact that although they are different, but we use one of them to calculate another). Riemann integral defines area enclosed by arbitrary curve. Mention

sufficient conditions for integrability (as for example continuity or piece-wise continuity or even when set of points of discontinuity is countable, the function is integrable). Mean Value Theorem of Integral Calculus (with proof) and its applications.

4. Linear Algebra.

a. Abstract Systems. Binary Operations and Relations. Introduction to Groups and Fields. Vector Spaces over Real and Complex Fields. Subspaces. Homomorphism and Isomorphism of Vector Spaces. Lin- ear Independence and Dependence of Vectors. Completeness of a set of vectors. Basis of a vector space. Replacement theorem - unique- ness of cardinality of different bases - Dimensions of a Vector Space. Change of basis. Isomorphism of every n - dimensional vector space with C^n - basis dependence of this isomorphism.
b. Inner products Space. Norm (defined in terms of inner product). Orthogonality. Orthogonal and Orthonormal sets. Orthonormal basis. Change of orthonormal basis. Gram-Schmidt orthogonalization - proof that an orthonormal basis will always exist. Schwarz inequality. Linear functionals on a vector space. Addition and Multiplication by scalars on linear functionals. Dual Space. Bra and Ket vectors and the Bra-Ket notation. Dual Basis. Construction of bra from ket and vice-versa.
c. Linear Transformations and Linear Operators. Consequences of linearity: Specification of the action of an operator on a basis defines the action on the whole space - Representation of Linear Operators by Matrices. Transformation of representations under change of basis. Algebra of Linear Operators. Singular and Non-singular operators. The Adjoint or Hermitian conjugate of an operator. Hermitian, Orthogonal and Unitary operators. Projection operators.
d. Eigenvalues and Eigenvectors of an operator. Degeneracy and Eigen spaces. Algebraic and Geometric multiplicity of eigenvalues. Diagonalization and Diagonalizability. Normal operators. Eigen properties of Hermitian and Unitary operators. Commuting operators and its relation to simultaneous diagonalizability. Complete sets of commuting operators.
e. Tensor Products of Inner product spaces. Tensor products of vectors and operators. Extensions of operators to product spaces.

Reference Books

- Calculus Volume I and II, Tom Apostol, John Wiley and Sons Inc.
- Bartle and Sherbert, Introduction to Real Analysis, Third edition, Wiley-India
- Complex Analysis, V.L Ahlfors, McGraw-Hill Inc.

- Finite Dimensional Vector Spaces, P. R.Halmos, Springer.
- Introduction To Matrices And Linear Transformations, D.T. Finkbeiner, Courier Corporation.
- Linear Algebra, S. Lipschutz and M.L.Lipson, Schaums Outline Series, 2009 McGraw Hill.

DSE1(A1):Nuclear and Particle Physics

Nuclear and Particle Physics - (Theory): DSE1(A1)T Credits: 5 (+1 for Tutorial)

Total Lectures:56

a. Recapitulation of general properties of nuclei, nuclear models and radioactivity.
b. Nuclear Reactions (a) Types of Reactions, Conservation Laws, kinematics of reactions, Q- value, reaction rate, reaction cross section, Concept of compound and direct Reaction, resonance reaction, Coulomb scattering (Rutherford scattering).
c. Interaction of Nuclear Radiation with matter
   (a) Energy loss due to ionization (Bethe- Block formula), energy loss of electrons, Cerenkov radiation. Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, neutron's interaction with matter.
d. Detector for Nuclear Radiations
   (a) Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semi- conductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility), neutron detector.

5. Particle Accelerators

(a) Accelerator facility available in India: Van-de Graaf generator (Tan- dem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

6. Particle Physics

(a) Fundamental particles and their families. Fundamental particle-interactions and their basic features. Symmetries and Conservation Laws: energy and momentum, angular momentum, parity, baryon number, Lepton number, Isospin, Strangeness and charm, concept of quark model, color quantum number and gluons. Quark structure of hadrons.

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 High Energy Physics, D.H. Perkins, Cambridge Univ. Press.
- 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).
- Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).
- Theoretical Nuclear Physics, J.M. Blatt & V.F.Weisskopf (Dover Pub.Inc., 1991).

DSE1(A1):Applied Dynamics

Applied Dynamics - (Theory): DSE1(A1)T **Credits: 4**
Total Lectures:24

1. Small Amplitude Oscillations

(a)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.

2. Dynamical Systems

(a) Definition of a continuous first order dynamical system. The idea of phase space, flows and trajectories. Simple mechanical systems as dynamical systems: the free particle, particle under uniform gravity, simple and damped harmonic oscillator, pendulum. Sketching flows and trajectories in phase space; sketching variables as functions of time, relating the equations and pictures to the underlying physical

intuition. Other examples of dynamical systems - Population models e.g. exponential growth and decay, logistic growth, species competition, predator-prey dynamics, simple genetic circuits In Chemistry: Rate equations for chemical reactions e.g. autocatalysis, bi-stability In Economics: Examples from game theory. Illustrative examples from other disciplines. Fixed points, attractors, stability of fixed points, basin of attraction, notion of qualitative analysis of dynamical systems, with applications to the above examples. Computing and visualizing trajectories on the computer using software packages. Discrete dynamical systems. The logistic map as an example.

3. Introduction to Chaos and Fractals

(a) Examples of 2-dimensional billiard, Projection of the trajectory on momentum space. Sinai Billiard and its variants. Computational visualization of trajectories in the Sinai Billiard. Randomization and ergodicity in the divergence of nearby phase space trajectories, and dependence of time scale of divergence on the size of obstacle. Electron motion in mesoscopic conductors as a chaotic billiard problem. Other examples of chaotic systems; visualization of their trajectories on the computer. Self-similarity and fractal geometry: Fractals in nature -trees, coastlines, earthquakes, etc. Need for fractal dimension to describe self-similar structure. Deterministic fractal vs. self-similar fractal structure. Chaos in nonlinear finite difference equations- Logistic map: Dynamics from time series. Parameter dependence- steady, periodic and chaos states. Cobweb iteration. Fixed points. Defining chaos- aperiodic, bounded, deterministic and sensitive dependence on initial conditions. Period- Doubling route to chaos. Nonlinear time series analysis and chaos characterization: Detecting chaos from return map. Power spectrum, autocorrelation, Lyapunov exponent, correlation dimension.

Reference Books

- Classical Mechanics: A Course of Lectures. A.K. Raychaudhuri, 1983, Oxford University Press.
- Mechanics, L. D. Landau and E. M. Lifshitz, 1976, Pergamon.
- Classical Mechanics, P.S. Joag, N.C. Rana, 1st Edn., McGraw Hall.
- Nonlinear Dynamics and Chaos, S.H. Strogatz, Levant Books, Kolkata, 2007
- Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.

Advanced Dynamics - (Practical): DSE1(A1)P **Credits: 2**

Total Lectures:32

List of Practicals

1. To draw the phase portrait of damped harmonic oscillator using numerical techniques.
2. To draw the phase portrait of a pendulum with different values of energy using numerical techniques.
3. To study logistic growth population model for different parameter values drawing cobweb diagrams (few steps).
4. To study the phenomenon of chaos in logistic growth model using simple computer programs and to estimate the corresponding Lyapunov exponent.
5. Computational visualization of trajectories in the Sinai Billiard.
6. Visualization of fractal nature of the chaotic attractors in logistic map by numerically generating the orbit diagram fractal.
7. Computational visualization of formations of a self-similar fractal structure such as middle third cantor set.

Reference Books

- Nonlinear Dynamics and Chaos, Steven H. Strogatz, Levant Books, Kolkata, 2007.
- Chaos An Introduction to Dynamical Systems, K. T. Alligood, T. D. Sauer and J. A. Yorke, Springer.
- Understanding Nonlinear Dynamics, Daniel Kaplan and Leon Glass, Springer.
- Simulation of ODE/PDE Models with MATLAB, OCTAVE and SCILAB: Scienti c and Engineering Applications: A. Vande Wouwer, P. Saucez, C. V. Fernández. 2014 Springer ISBN: 978-3319067896

DSE1(A1):Communication Electronics

Communication Electronics - (Theory): DSE1(A1)T Credits: 4

Total Lectures:24

1. Electronic communication

(a) Introduction to communication means and modes. Need for modulation. Block diagram of an electronic communication system. Brief idea of frequency allocation for radio communication system in India (TRAI). Electromagnetic communication spectrum, band designations and usage. Channels and base-band signals. Concept of Noise, signal-to-noise (S/N) ratio.

2. Analog Modulation

(a) Amplitude Modulation, modulation index and frequency spectrum. Generation of AM (Emitter Modulation), Amplitude Demodulation (diode detector), Concept of Single side band generation and detection. Frequency Modulation (FM) and Phase Modulation (PM), modulation index and frequency spectrum, equivalence between FM and PM, Generation of FM using VCO, FM detector (slope detector), Qualitative idea of Super heterodyne receiver.

3. Analog Pulse Modulation

(a) Channel capacity, Sampling theorem, Basic Principles- PAM, PWM, PPM, modulation and detection technique for PAM only, Multiplexing.

4. Digital Pulse Modulation

(a) Need for digital transmission, Pulse Code Modulation, Digital Carrier Modulation Techniques, Sampling, Quantization and Encoding. Concept of Amplitude Shift Keying (ASK), Frequency Shift Keying (FSK).

5. Introduction to Communication and Navigation systems:

(a) Satellite Communication Introduction, need, Geosynchronous satellite orbits geostationary satellite advantages of geostationary satellites. Satellite visibility, transponders (C - Band), path loss, ground station, simplified block diagram of earth station. Uplink and down- link.
(b) Mobile Telephony System Basic concept of mobile communication, frequency bands used in mobile communication, concept of cell sectoring and cell splitting, SIM number, IMEI number, need for data encryption, architecture (block diagram) of mobile communication network, idea of GSM, CDMA, TDMA and FDMA technologies, simplified block diagram of mobile phone handset, 2G, 3G and 4G concepts (qualitative only). GPS navigation system (qualitative idea only).

Reference Books

- Electronic Communications, D. Roddy and J. Coolen, Pearson Education India.
- Advanced Electronics Communication Systems- Tomasi, 6th edition, Prentice Hall.
- Electronic Communication systems, G. Kennedy, 3rd Edn, 1999, Tata McGraw Hill.
- Principles of Electronic communication systems Frenzel, 3rd edition, McGraw Hill
- Communication Systems, S. Haykin, 2006, Wiley India
- Electronic Communication system, Blake, Cengage, 5th edition.
- Wireless communications, Andrea Goldsmith, 2015, Cambridge University Press

Communication Electronics - (Practical) :DSE1(A1)P **Credits: 2**

Total Lectures:32

List of Practicals

1. To design an Amplitude Modulator using Transistor

2. To study envelope detector for demodulation of AM signal

3. To study FM - Generator and Detector circuit

4. To study AM Transmitter and Receiver

5. To study FM Transmitter and Receiver

6. To study Time Division Multiplexing (TDM)

7. To study Pulse Amplitude Modulation (PAM)

Reference Books

- Electronic Communication systems, G. Kennedy, 1999, Tata McGraw Hill.
- Electronic Communication system, Blake, Cengage, 5th edition.
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DSE4(A2):Advanced Mathematical Methods - II

Advanced Mathematical Methods - II - (Theory): DSE4(A2)T Credits: 5 (+1 for Tutorial)

Total Lectures:56

1. Tensors
   (c) Cartesian 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.

Isotropic Tensors. Tensorial Character of Physical Quantities. Moment of Inertia Tensor. Stress and Strain Tensors: Symmetric Nature. Elasticity Tensor. Generalized Hooke's Law. Electric Sus- ceptibility tensor.

(d) 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.

2. Group Theory
   (a) Groups: Elementary properties of groups, uniqueness of Identity, Inverse, Rearrangement theorem. Conjugate relations, Classes, Subgroup, Invariant Subgroups, Co-sets, Co-set multiplication, Factor Groups. Centre of a group. Cyclic group, Permutation groups and Transformation Groups. Homomorphism and Isomorphism of groups, Kernel.
   (b) Matrix Representations of Groups Reducible and Irreducible representations. Schur's lemma. Orthogonality theorems. Character tables and their uses.
   (c) Lie Groups: Definition using metric associated with faithful finite dimensional matrix representation. Connected component and Connected Lie group. Compact Lie group.
   (d) Lie Algebra: Definition, Lie Product and Structure constants. Lie Subalgebra, Invariant Lie Subalgebra. Homomorphism and Isomorphism of Lie Algebras. Representations of Lie Algebras.
   (e) Connection of Lie Groups with Lie Algebra. The matrix exponential and its properties. Fundamental theorem of Lie Algebra. Analytic curves and Tangent vectors in Lie Groups. One parameter Subgroups and the exponential map connection. Special cases of connected and compact Lie groups. Constructing representations of Lie Algebras using corresponding analytic representations of Lie Groups.
   (f) SO(3), SU(2) and SU(3) groups as examples.

Reference Books

- Mathematical Methods for Physicists: Weber and Arfken, 2005, Academic Press.
- Mathematical Methods for Physicists: A Concise Introduction: Tai L. Chow, 2000, Cambridge Univ. Press.
- Elements of Group Theory for Physicists by A. W. Joshi, 1997, John Wiley.
- GroupTheory and its ApplicationstoPhysicalProblemsbyMortonHamermesh, 1989, Dover.
- Group Theory in Physics, Volume I & II, J.F.Cornwell, Academic Press, 1984.

DSE4(A2):Classical Dynamics

Classical Dynamics(Theory): DSE4(A2)T Credits: 5 (+1 for Tutorial)

Total Lectures:56

1. Classical Mechanics of Point Particles:

   (a) Review of Newtonian Mechanics;
   (b) Application to the motion of a charge particle in external electric and magnetic fields- motion in uniform electric field, magnetic field- gyroradius and gyrofrequency, motion in crossed electric and magnetic fields. Generalized coordinates and velocities,
   (c) Hamilton‟s principle, Lagrangian and the Euler-Lagrange equations, one-dimensional examples of the Euler-Lagrange equations- one-dimensional
   (d) Simple Harmonic Oscillations and falling body in uniform gravity; applications to simple systems such as coupled oscillators Canonical momenta

2. Hamiltonian.

   (a) Hamilton's equations of motion. Applications: Hamiltonian for a harmonic oscillator, solution of Hamilton‟s equation for Simple Harmonic Oscillations;
   (b) particle in a central force field- conservation of angular momentum and energy.

3. Small Amplitude Oscillations:

   (a) 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
   (b) Example of N identical masses connected in a linear fashion to (N -1) - identical springs.

4. Special Theory of Relativity:

   (a) Postulates of Special Theory of Relativity. Lorentz Transformations.Minkowski space. The invariant interval, light cone and world lines. Space-time diagrams. Time-dilation, length contraction and twin paradox.

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

5. Fluid Dynamics:

(a) 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, Navier-Stokes equation, qualitative description of turbulence, Reynolds number.

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

DSE4(A2):Astronomy and Astrophysics

Astronomy and Astrophysics - (Theory): DSE4(A2)-T Credits: 5 (+1 for Tutorial)

Total Lectures:56

1. Astronomical Scales Astronomical Distance.

(a) 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, Horizon System, Equatorial System, Diurnal Motion of the Stars, Conversion of Coordinates. 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; Determination of Masses from Binary orbits; Stellar Spectral Classification, Hertzsprung-Russell Diagram.

2. Astronomical techniques

(b) Basic Optical Definitions for Astronomy (Magnification Light Gathering Power, Resolving Power and Diffraction Limit, Atmospheric Windows), Optical Telescopes (Types of Reflecting Telescopes, Tele- scope Mountings, Space Telescopes, Detectors and Their Use with Telescopes (Types of Detectors, detection Limits with Telescopes).

3. Physical principles

(c) Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium.

4. The sun and solar family

(d) The sun (Solar Parameters, Solar Photosphere, Solar Atmosphere, Chromosphere. Corona, Solar Activity, Basics of Solar Magneto-hydrodynamics. Helioseismology). The solar family (Solar System: Facts and Figures, Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets. Stellar spectra and classification Structure (Atomic Spectra Revisited, Stellar Spectra, Spectral Types and Their Temperature Dependence, Black Body Approximation, H R Diagram, Luminosity Classification). Main sequence, red giants and white dwarfs, Chandrashekhar mass limit, possibility of Neutron star.

5. The milkyway

(e) 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.

6. Galaxies

(f) Galaxy Morphology, Hubble's Classification of Galaxies, Elliptical Galaxies (The Intrinsic Shapes of Elliptical, de Vaucouleurs Law, Stars and Gas). Spiral and Lenticular Galaxies (Bulges, Disks, Galactic Halo) The Milky Way Galaxy, Gas and Dust in the Galaxy,

Spiral Arms.

7. Large scale structure & expanding universe

(g) 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).

Reference Books

- Modern Astrophysics, B.W. Carroll & D.A. Ostlie, Addison-Wesley Publishing Co.
- Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4 th Edition, Saunders College Publishing.
- The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
- Fundamentals of Astronomy (Fourth Edition), H. Karttunen et al. Springer
- K.S. Krishnasamy, `Astro Physics a modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
- 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

DSE4(A2):Nano Materials and Applications

Nano Materials and Applications - (Theory): DSE4(A2)T **Credits: 5 (+1 for Tutorial)**

Total Lectures:56

1. Nanoscale Systems

(h) 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- In finite potential well, potential step, potential box, quantum confinement of carriers in 3D, 2D, 1D nanostructures and its consequences.

2. Synthesis of Nanostructure Materials

(a) 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.

3. Characterization

(d) X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy.

4. Optical Properties

(c) Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure. Quasiparticles 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 heterostructures and nanostructures.

5. Electron Transport

(a) Carrier transport in nanostrucutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

6. Applications

(a) 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 De- vices: 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).

Reference Books

- C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).
- S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publish- ing Company).
- K.K. Chattopadhyay and A. N. Banerjee, Introduction to Nanoscience and Technology (PHI Learning Private Limited).
- Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).
- M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, Nanoparticle Technology Handbook (Elsevier, 2007).

- Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio, 2011, Cambridge University Press.
- Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).

Syllabi for Skill Enhancement Courses (General)

SEC-1: Basics of Programming and Scientific Word Processing

Basics of Programming and Scientific Word Processing - (Theory) SEC-1T **Credits: 2**

Total Lectures:16

1. Elements of Programming

(a) An overview computers: History of computers, overview of architecture of computer, compiler, assembler, machine language, high level language, object oriented language, programming language.
(b) Algorithms and Flowcharts:
   i. Algorithm - definition, properties and development.
   ii. Flowchart - Concept of flowchart, symbols, guidelines, types.

2. Basic programming in C/FORTRAN

(a) Constants, Variables and Data types.

(b) Operation and Expressions - Arithmetic operators, relational opera- tors, logical operators.

(c) Managing input/output.

(d) Decision Making and Branching.

(e) Decision making and Looping.

(f) Arrays : One-dimension, two-dimension and multidimensional arrays, declaration of arrays, initialization of one and multi-dimensional arrays.

(g) User-defined Functions.

3. Visualization

(a) Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a le, saving and exporting, multiple data sets per le, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot.

4. Scientific word processing:

(a) Introduction to LaTeX TeX/LaTeX word processor, preparing a basic LaTeX

le, Document classes, Preparing an input le for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages.

(b) Equation representation: Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents Bibliography and citation, Making an index and glossary, List making environments,

(c) Fonts, Picture environment and colors, errors.

Reference Books

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77 . V. Rajaraman (Publisher: PHI).
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R.C. Verma, et al. New Age International Publishers, New Delhi(1999)
- E. Balagurnsamy, Programming in ANSI C, Tata McGraw Hill, 2004.
- C. Xavier, C-Language and Numerical Methods, New Age International.
- V. Rajaraman, Computer Oriented Numerical Methods, Prentice Hall of India, 1980.
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010).
- LaTeX A Document Preparation System , Leslie Lamport (Second Edition, Addison- Wesley, 1994).

SEC-2: Electrical Circuits and Network Skills

Electrical Circuits and Network Skills - (Theory): SEC-2A Credits: 2

Total Lectures:16

1. Basic Electricity Principles

(a) 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.

2. Understanding Electrical Circuits

(a) 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.

3. Electrical Drawing and Symbols

(a) 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.

4. Generators and Transformers

(a) DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

5. Electric Motors

(a) Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

6. Solid-State Devices

(a) Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources.

7. Electrical Protection

(a) 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)

8. Electrical Wiring

(a) 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.

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

SEC-3:Computer Algebra System & Figure Drawing Skill

Computer Algebra System & Figure Drawing Skill - (Theory): SEC-3T **Credits: 2**

Total Lectures:16

Elementary symbolic computation using some computer algebra system (CAS) like Yacas or Maxima.

(a) Arithmetic and other operations on numbers,
(b) Calculus and elementary functions, Simplification of expressions, Solvers, Differential Equations.
(c) Linear Algebra
(d) Operations on polynomials
(e) List operations
(f) Predicates
(g) Input/output and plotting
(h) Probability and Statistics
(i) Numerical methods using CAS
(j) Physics specific applications

Figure generation using drawing tools like latexdraw/ inkscape etc.

(a) Drawing lines with/without arrows with different line styles.
(b) Drawing curves with different line styles including brazier curves.
(c) Drawing different types of shapes including circle, ellipse, polygons etc.
(d) Changing figure properties like position, colour, orientation, size, shape, line properties, filling properties etc.
(e) Grouping and ungrouping of figures.
(f) Exporting the figure into different file formats.

Reference Books

- https://yacas.readthedocs.io/en/latest/reference_manual/
- The Maxima Book; Paulo Ney de Souza Richard J. Fateman Joel Moses Cli Yapp; http://maxima.sourceforge.net/docs/maximabook/maximabook-19-Sept-2004.pdf.
- Get Started With Maxima: https://www.whoishostingthis.com/resources/maxima/

Sec-4: Renewable Energy and Energy Harvesting

Renewable Energy and Energy Harvesting - (Theory): SEC-4T **Credits: 2**

Total Lectures:16

1. Fossil fuels and Alternate Sources of energy

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

2. Solar energy

(j) Solar energy, its importance, storage of solar energy, solar pond, non- convective solar pond, applications of solar pond and solar energy, solar water heater, at 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.

3. Wind Energy harvesting

(k) Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

4. Ocean Energy

(l) 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.

5. Geothermal Energy

(a) Geothermal Resources, Geothermal Technologies.

6. Hydro Energy

(b) Hydropower resources, hydropower technologies, environmental impact of hydropower sources.

7. Piezoelectric Energy harvesting

(a) 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

8. Electromagnetic Energy Harvesting

(m) Linear generators, physics mathematical models, recent applications (b) Carbon captured technologies, cell, batteries, power consumption.

(n) Environmental issues and Renewable sources of energy, sustainability.

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).