Learning Outcome based Curriculum Framework (LOCF)

For

Choice Based Credit System (CBCS)

Syllabus

B.Sc.(Program) in Physics

w.e.f. Academic Session 2020-21

Kazi Nazrul University

Asansol, Paschim Bardhaman

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Preamble
B. Sc. (Program) with Physics

The learning outcomes-based curriculum framework (LOCF) for the undergraduate program like B.Sc.(Physics) is intended to create an academic base that responds to the need of the students to understand the basics of Physics and its steadily developing nature of applications in clarifying all the observed natural phenomenon just as foreseeing the future applications to the new wonder with a global perspective. The graduates should have the option to exhibit a basic comprehension of the scholastic field of Physics, its diverse learning regions like Classical Physics, Electricity and Magnetism, Thermal Physics, Optics, Computational Physics, Modern Physics, Astronomy and Astrophysics, Electronics and Nanotechnology and applications. The graduates ought to have the option to exhibit procedural knowledge that makes various kinds of experts identified with various spaces of study in Physics, including research and development, teaching and government and public service.

The curriculum framework is planned and detailed to obtain and keep up with norms of accomplishment as far as knowledge, understanding and skills in Physics and their applications to the natural phenomenon just as the improvement of logical mentalities and qualities suitable for objective thinking, basic reasoning and creating abilities for critical thinking and starting exploration which are competitive internationally.

Semester - I

Course Name: Mechanics

Course Code: BSCPPHSC101

Course Type: **Core (Theory & Practical)**	Course Details: **CC-1(1)**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	**20**	**40**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Understand vector calculus, classical mechanics of single as well as system of particles within the scope Newtonian formulation.*
2. *Describe general properties of bulk matter and different types of simple harmonic linear oscillations.*
3. *Discuss classical mechanics of rotating systems and particle under central force.*
4. *Introduce Einstein's special theory of relativity and the classical mechanics of fast moving particles.*

Course Content:

Theory:

1. Elementary Vector Calculus: Directional derivatives, gradient, divergence, curl of a vector, line integrals, Gauss's theorem. **(6L)**

2. Mechanics of a Single Particle

Velocity and acceleration of a particle in (i) plane polar coordinates - radial and cross-radial components ; Time and path integral of force; work and energy; Conservative force and concept of potential; Conservation of energy; Dissipative forces; Conservation of linear and angular momentum. **(6L)**

3. Mechanics of a System of Particles

Linear momentum, angular momentum and energy - centre of mass decomposition; Equations of motion, conservation of linear and angular momentum. **(6L)**

4. Rotational Motion

Moment of inertia, radius of gyration; Energy and angular momentum of rotating systems of

particles; Parallel and perpendicular axes theorems of moment of inertia; Calculation of moment of inertia for simple symmetric systems. **(6L)**

5. Central force Motion

Motion of a particle under a central force field. Kepler's Laws. Satellite in circular orbit and applications. Geosynchronous orbits. Basic idea of global positioning system (GPS).

(6L)

6. Elasticity: Elastic moduli and their relations (deduction not required), qualitative idea on bending of beam, torsional oscillation **(3L)**

7. Oscillations:

SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Kinetic energy, potential energy, total energy and their time-average values. Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor. **(8L)**

8. Special Theory of Relativity: Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.

(4 L)

Practical

1. Determination of Young's modulus by flexure method.
2. Measurement of the rigidity modulus of a wire by dynamic method.
3. Measurement of surface tension of a liquid by capillary tube method and verification of Jurin's law (capillary tubes of different bores to be supplied).
4. To draw the frequency – resonance length curve of a sonometer wire and to determine an unknown frequency of a tuning fork
5. Measurement of the velocity of sound by Kundt's tube
6. To determine coefficient of viscosity of water by capillary flow method.
7. To determine the elastic constants of a wire by Searle's method.
8. To determine the value of g using Bar Pendulum/ Kater's pendulum.
9. Determination of surface tension of a liquid by Jaeger's method.
10. To study the motion of spring and calculate (a) Spring constant, (b) **g** and (c) Modulus of rigidity.
11. To determine the moment of inertia of a Flywheel/regular shaped body.

References/ Suggested Readings:

1. Classical Mechanics – J. Goldstein (Narosa Publ. House).
2. Principles Of Mechanics - John. L Synge and Byron. A Griffith,

3. Theoretical Mechanics - M. R. Spiegel, (Schaum's Outline Series) (McGraw-Hill).
4. Mechanics - K. R. Symon (Addison-Wesley).
5. Introduction to Classical Mechanics - R. G. Takwale and P. S. Puranik (Tata McGraw-Hill).
6. Classical Mechanics – N. C. Rana and P. S. Joag (Tata McGraw-Hill).
7. The Feynman Lectures on Physics – Vol I (Addison-Wesley).
8. Mechanics – H. S. Hans and S. P. Puri (Tata McGraw-Hill).
9. Berkeley Physics Course, Vol – I (Mechanics) (Mc Graw Hill).
10. Mechanics – D. S. Mathur (S. Chand and Company).
11. Waves and Oscillations by N K Bajaj
12. Waves and Oscillations by R N Chowdhury

Semester – II

Course Name: Electricity and Magnetism
Course Code: BSCPPHSC201

Course Type: **Core (Theory & Practical))**	Course Details: **CC-1(2)**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	20	**40**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. Explain the properties of (i) the electric field produced due to charges at rest; (ii) the magnetic field produced due to steady current, both in free-space and inside matter.
2. Describe the basic idea of electromagnetism, through Maxwell's equation, hence the generation of EM waves.
3. Describes on the electrical circuits and bridges in presence of AC current.

Course Content:

Theory:

1. Electric Field and Electric Potential:

Electric field: Electric field lines. Electric flux. Gauss' Law with applications to charge distributions with spherical, cylindrical and planar symmetry. Conservative nature of Electrostatic Field. Electrostatic Potential. Laplace's and Poisson equations. Potential and Electric Field of a dipole. Force and Torque on a dipole. **(12 L)**

Electrostatic energy of system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. Capacitance of a system of charged conductors. Parallel-plate capacitor. Capacitance of an isolated conductor.

(6 L)

2. Dielectric Properties of Matter: Electric Field in matter. Polarization, Polarization Charges. Electrical Susceptibility and Dielectric Constant. Capacitor (parallel plate) filled with dielectric. Displacement vector **D**. Relations between **E**, **P** and **D**. Gauss' Law in dielectrics. **(4 L)**

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field **B**. Biot- Savart's Law and its simple applications: straight wire and circular loop. Current Loop as a Magnetic Dipole. Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid.

Properties of **B**: curl and divergence. Vector Potential (qualitative idea). Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field.

(6 L)

3. Magnetic Properties of Matter: Magnetization vector (**M).** Magnetic Intensity(**H).** Magnetic Susceptibility and permeability. Relation between **B, H, M**. Ferromagnetism. B-H curve and hysteresis. **(2 L)**

4. Electromagnetic Induction: Faraday's Law. Lenz's Law. Self Inductance and Mutual Inductance. Reciprocity Theorem. Energy stored in a Magnetic Field. **(3 L)**

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, transverse nature of EM waves.

(8 L)

6. Electrical Circuits: AC Circuits: Kirchhoff's laws for AC circuits. Complex Reactance and Impedance. Series LCR Circuit: (1) Resonance, (2) Power Dissipation and (3) Quality Factor, and (4) Band Width. **(4L)**

Practical

1. Use a multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, (d) Capacitances, and (e) Checking electrical fuses.
2. To study the characteristics of a series RC Circuit.
3. To determine an unknown low resistance using Potentiometer.
4. To determine an unknown low resistance using Carey Foster's Bridge.
5. To verify the Thevenin and Norton theorems.
6. To verify the superposition, and maximum power transfer theorems.
7. To determine self inductance of a coil by Anderson's bridge.
8. To study response curve of a series LCR circuit and determine its (a) Resonant frequency, (b) Impedance at resonance, (c) Quality factor Q, and (d) Band width.
9. To study the response curve of a parallel LCR circuit and determine its (a) anti-resonant frequency and (b) Quality factor Q.
10. Measurement of charge and current sensitivity and CDR of Ballistic Galvanometer
11. Determine a high resistance by leakage method using Ballistic Galvanometer.

References/ Suggested Readings:

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

Semester - III

Course Name: Basics of Thermal and Statistical Physics

Course Code: BSCPPHSC301

Course Type: **Core(Theory & Practical)**	Course Details: **CC-1(3)**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	20	**40**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Realize the kinetic theory of ideal classical gas.*
2. *Explain radiative process of heat transfer*
3. *Understand the laws of thermodynamics and their applications in simple system.*
4. *Introduce (i) classical (MB) and quantum (BE, FD) distributions as most-probable micro-canonical distributions; (ii) different thermodynamic quantities (viz., entropy, pressure, chemical potential etc.) (iii) black-body radiation and BE condensation.*

Course Content:

Theory:

1.Laws of Thermodynamics: Thermodynamic Description of system, Zeroth Law of thermodynamics and temperature. First law and internal energy, conversion of heat into work, Various Thermodynamical Processes, Applications of First Law: General Relation between C_P & C_V, Work Done during Isothermal and Adiabatic Processes, Compressibility &Expansion Coefficient, Reversible & irreversible processes, Second law & Entropy, Carnot's cycle & theorem, Entropy changes in reversible & irreversible processes, Entropy-temperature diagrams, Third law of thermodynamics, Un attainability of absolute zero. **(16 L)**

2.Kinetic Theory of Gases: Brownian motion; Pressure expression (elementary calculation); Derivation of Maxwell's law of distribution of velocities and its experimental verification, Mean free path (Elementary calculation), Transport Phenomena: Viscosity, Conduction and Diffusion (for vertical flow), Law of equipartition of energy (no derivation) and its applications to specific heat of gases; mono-atomic and diatomic gases. **(11L)**

3.Theory of Radiation: Blackbody radiation, Spectral distribution, Concept of Energy Density, Derivation of Planck's law, Deduction of Wien's distribution law, Rayleigh-Jeans Law, Stefan

Boltzmann Law and Wien's displacement law from Planck's law. **(8 L)**

4. Statistical Mechanics: Phase space, Macrostate and Microstate, Entropy and Thermodynamic probability, Maxwell-Boltzmann law - distribution of velocity -Quantum statistics - Fermi-Dirac distribution law - electron gas - Bose-Einstein distribution law - photon gas - comparison of three statistics (Derivation not required) Qualitative discussion on Fermi Level, B-E Condensation.

(**10 L**)

Practical

1. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2. To determine the Coefficient of Thermal Conductivity of Cu by Searle's Apparatus.
3. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
4. To determine the Temperature Coefficient of Resistance/boiling point by Platinum Resistance Thermometer
5. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
6. To determine temperature co-efficient of resistance by meter-bridge.
7. Determination of coefficient of linear expansion by optical lever/travelling microscope.

References/ Suggested Readings:

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

SKILL ENHANCEMENT COURSE
(Evaluation is to be done internally)

Course Name: Electrical Circuit Network Skills
Course Code: BSCPPHSSEC301

Course Type: **SEC (Practical)**	Course Details: **SEC-1**			L-T-P: **0-0-8**	
Credit: **4**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	…….	20	……

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Design and trouble shoots the electrical circuits, networks and appliances through hands-on mode.*
2. *Analyze any given* electrical network.
3. *Synthesize an electrical network from a given impedance/admittance function.*

Course Content:

Practical

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.

2.Understanding Electrical Circuits: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage dropacross 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: 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: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

5. Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DCor AC sources to control heaters & motors. Speed & power of ac motor.

6. 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.

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

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

References/ Suggested Readings:

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

Semester - IV

Course Name: Basics of Waves and Optics
Course Code: BSCPPHSC401

Course Type: **Core (Theory & Practical)**	Course Details: **CC-1(4)**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	20	**40**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Find the resultant of two collinear and mutually perpendicular SHMs and, explain progressive elastic wave.*
2. *Understand the manifestations of optical wave (viz., interference, diffraction and polarisation).*

Course Content:

Theory

1. Superposition of Collinear Harmonic oscillations: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). **(5 L)**

2. Superposition of two perpendicular Harmonic Oscillations: Analytical Methods. Lissajous Figures (1:1) and their uses. **(2 L)**

3. Wave Motion: Plane and Spherical Waves. Longitudinal and Transverse Waves. Plane Progressive (Travelling) Waves. Wave Equation. Particle and Wave Velocities. Differential Equation. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. **(4 L)**

4. Interference of light waves

Young's experiment; spatial and temporal coherence; intensity distribution; Fresnel's biprism, interference in thin film; fringes of equal inclination and equal thickness; Newton's ring.

Michelson's interferometer, Multiple beam interference – reflected and transmitted pattern. Fabry-Perot interferometer. **(9 L)**

5. Diffraction of light waves

Fresnel and Fraunhofer class, Fresnel's half period zones; explanation of rectilinear propagation of light; zone plate. Fraunhofer diffraction due to a single slit, double slit and circular aperture (qualitative). Plane diffraction grating (transmission). Rayleigh criterion of resolution; resolving power of transmission grating. **(10 L)**

6. Polarisation

Different states of polarisation; double refraction, Huygen's construction for uniaxial crystals; polaroids and their uses. Production of plane, circularly and elliptically polarised light; Analysis of plane and unpolarised light; retardation plates; rotatory polarisation and optical activity; Fresnel's explanation of optical activity; Biquartz and half shade polarimeter. **(6 L)**

Practical

1. To verify the law of Malus for plane polarized light.
2. To determine the specific rotation of sugar solution using Polarimeter.
3. To analyze elliptically polarized light by using a Babinet's compensator.
4. Determination of angle of prism and to determine refractive index of the Material of a prism using sodium source.
5. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
6. To determine wavelength of sodium light using Fresnel Biprism.
7. To determine wavelength of sodium light using Newton's Rings.
8. To determine wavelength of (1) sodium source and (2) spectral lines of mercury source using plane diffraction grating.
9. Determine the refractive index of the material of a convex lens with the help of a 'plane mirror and lens arrangement' for the same.
10. Determine refractive index of a liquid [water (say)] with the help of a plane mirror and a convex lens / travelling microscope.
11. Determine focal length of a concave lens with the help of an auxiliary lens (convex) by displacement method.
12. Determine focal length and power of a concave lens with the help of an auxiliary lens (convex) by displacement method. Also compare the powers of the two lenses (concave & convex). [Focal length of the convex lens may be supplied].

References/ Suggested Readings:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Optics (Classical & Quantum) -R.K. Kar (Books and Allied)
8. Waves and Oscillations by N K Bajaj
9. Waves and Oscillations by R N Chowdhury
10. Advanced Practical Physics for students, B.L. Flint and H.T. Worsnop, 1971, Asia Publishing House
11. A Text Book of Practical Physics, I. Prakash & Ramakrishna, 11th Ed., 2011, KitabMahal
12. Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
13. A Laboratory Manual of Physics for undergraduate classes, D. P. Khandelwal, 1985, Vani Pub.

SKILL ENHANCEMENT COURSE
(Evaluation is to be done internally)

Course Name: Basic Instrumentation Skills
Course Code: BSCPPHSSEC401

Course Type: **SEC (Practical)**	Course Details: **SEC-II**			L-T-P: **0-0-8**	
Credit: **4**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	…….	20	……

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Get exposure with various aspects of instruments and their usage through hands-on mode.*
2. *Do experiments listed below in continuation of the topics.*

Course Content:

Theory

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

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

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 &chemical composition. Time base operation, synchronization. Front panel controls. Specifications of a CRO and their significance.
Use of CRO for the measurement of voltage (dc and ac frequency, time period. Special features of dual trace, introduction to digital oscilloscope, probes. Digital storage Oscilloscope: Block diagram and principle of working.

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

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

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

7. 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.

The test of lab skills will be of the following test items:

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

Laboratory Exercises:

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

Open Ended Experiments:

1. Using a Dual Trace Oscilloscope.
2. Converting the range of a given measuring instrument (voltmeter, ammeter).

References/ Suggested Readings:

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

Semester- V

DISCIPLINE SPECIFIC ELECTIVES (DSE)

Course Name: Modern Physics

Course Code: BSCPPHSDSE501

Course Type: D**SE-I (Theory)**	Course Details: **DSEC-1(1)**			L-T-P: **5-1-0**	
Credit: **6**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		…..	**10**	…..	**40**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Understand the root in the development of modern physics*
2. *Understand the relationship between the real and reciprocal space and learn the Bragg's X-ray diffraction in crystals*
3. *Gain a hands-on learning experience by performing experiments on these properties of materials.*
4. *Describe the behaviour of matter and energy at atomic and subatomic level*

Course Content:

Theory

1. Quantum Theory:

(a) Failures of Classical Physics: Photoelectric effect; Compton effect; black body radiation and Planck's law (qualitative discussions). **(3L)**

(b) Line spectra and Bohr's theory of Hydrogen atom; Franck and Hertz experiment (principles only); concept of quantum numbers. **(2L)**

(c) Vector Atom Model; Stern-Gerlach experiment (principles only); electron spin; alkali spectra – qualitative discussions; Pauli exclusion principle and the periodic table; Zeeman effect. **(5L)**

(d) Wave particle duality and de Broglie waves; wave and group velocity; Davisson Germer experiment (principles only). **(3L)**

(e) Schrödinger wave equation (time dependent and time independent); interpretation of the wave function; stationary states; Heisenberg's Uncertainty principle (qualitative discussion with examples); particle crossing a potential barrier – tunneling (no detailed algebra, but basic features and difference with classical physics to be emphasized); particle in one dimensional infinite well. **(10L)**

2. **Structure of Solids:** Amorphous and Crystalline solids; elementary ideas about crystal structure – unit cell, basis, lattice; fundamental types of lattices; diffraction of X-Rays by a crystal lattice; Bragg's law. **(8L)**

3. **Semiconductor Physics:** Qualitative ideas about energy bands; intrinsic semiconductors; doped and extrinsic semi-conductors; electrons and holes; majority and minority carriers; p-n junction and its properties – depletion region, barrier voltage, junction capacitance. **(8L)**

4. **Nuclear and Elementary Particle Physics:**

(a) Constituents of the nucleus: Description and conclusions from Rutherford's experiment (no derivation of formula); constituents of the nucleus. **(2L)**

(b) Nuclear Gross properties: Mass and binding energy; binding energy curve. **(2L)**

(c) Unstable Nuclei: radioactive decay laws; successive decays and radioactive equilibrium (transient and secular); alpha, beta and gamma rays. **(3L)**

(d) Nuclear reactions: examples; systematic and characteristics; artificial radioactivity. **(3 L)**

(e) Fission and Fusion: Systematics and energy release; chain reaction (qualitative) energy cycles in stars (qualitative). **(3L)**

(f) Accelerators: basic principles of a cyclotron and a linear accelerator. **(2L)**

(g) Discovery of elementary particles like pion, positron etc.; concept of anti-particles; quantum numbers of particles; types of interaction in nature; classification of particles – hadrons and leptons, baryons and mesons. **(6 L)**

References/ Suggested Readings:

1. Introduction to Quantum Mechanics (2nd Edition) by David J. Griffiths
2. Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, 2ed by Robert Eisberg, Robert Resnick
3. A Textbook of Quantum Mechanics 2/E by P M Mathews and K Venkatesan
4. Quantum Mechanics: Theory and Applications by Ajoy Ghatak and S. Lokanathan
5. Introductory Quantum Mechanics by S. N. Ghoshal
6. Nuclear Physics by S. N. Ghosal
7. Atomic Physics (Modern Physics) by S. N. Ghoshal
8. Modern Atomic Physics by Vasant Natarajan
9. Introduction to Solid State Physics, Charles Kittel, 8th Edition, 2004, Wiley India Pvt. Ltd.
10. Solid State Physics by Singhal.

Course Name: Astronomy & Astrophysics

Course Code: BSCPPHSDSE502

Course Type: D**SE-I(Theory)**	Course Details: **DSEC-1(1)**			L-T-P: **5-1-0**	
Credit: **6**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		…..	**10**	…..	**40**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Learn how to unravel the secrets of the Universe applying basic physical principles from a broad range of topics in physics to astronomical circumstances.*
2. *Understand the astrophysical processes and systems, ranging from our own sun to stars, galaxies and the whole universe.*
3. *Use proficiency in physics, mathematics, computer science, and statistics to get a broader understanding of the universe*

Course Content:

Theory

1. Astronomical Scales: Astronomical Distance, Mass and Time, Scales, Brightness, Radiant Flux and Luminosity, Measurement of Astronomical Quantities Astronomical Distances, Stellar Radii, Masses of Stars, Stellar Temperature. Basic concepts of positional astronomy: Celestial Sphere, Geometry of a Sphere, Spherical Triangle, Astronomical Coordinate Systems, Geographical Coordinate Systems, 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. **(14L)**

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). Physical principles: Gravitation in Astrophysics (Virial Theorem, Newton versus Einstein), Systems in Thermodynamic Equilibrium. **(8L)**

3. 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) **(10L)**

4. The milky way: 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. **(10L)**

5. Galaxies: 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. **(10L)**

6. Large scale structure & expanding universe: Cosmic Distance Ladder (An Example from Terrestrial Physics, Distance Measurement using Cepheid Variables), Hubble's Law (Distance-Velocity Relation), Clusters of Galaxies (Virial theorem and Dark Matter). **(8L)**

References/ Suggested Readings:

1. Modern Astrophysics, B.W. Carroll & D. A. Ostlie, Addison-Wesley Publishing Co.
2. Introductory Astronomy and Astrophysics, M. Zeilik and S.A. Gregory, 4th Edition, Saunders College Publishing.
3. The physical universe: An introduction to astronomy, F.Shu, Mill Valley: University Science Books.
4. Fundamental of Astronomy (Fourth Edition), H. Karttunen et al. Springer.
5. K.S. Krishnasamy, 'Astrophysics: A modern perspective,' Reprint, New Age International (p) Ltd, New Delhi,2002.
6. Baidyanath Basu, 'An introduction to Astrophysics', Second printing, Prentice - 58 Hall of India Private limited, New Delhi, 2001.
7. Textbook of Astronomy and Astrophysics with elements of cosmology, V.B. Bhatia, Narosa Publication.

Course Name: Technical Drawing Skills
Course Code: BSCPPHSSEC501
(Evaluation is to be done internally)

Course Type: **SEC (Practical)**	Course Details: **SEC-III**		L-T-P: **0-0-8**	
Credit: **4**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	…….	20	……

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Know and understand the conventions and the method of engineering drawing.*
2. *Interpret engineering drawings using fundamental technical mathematics.*
3. *Construct basic and intermediate geometry.*
4. *Improve their visualization skills so that they can apply the skill in developing new products.*
5. *Improve their technical communication skill in the form of communicative drawings.*
6. *Comprehend the theory of projection.*

Course Content:

Practical

1. Introduction: Drafting Instruments and their uses. lettering: construction and uses of various scales: dimensioning as per I.S.I. 696-1972. Engineering Curves: Parabola: hyperbola: ellipse: cycloids, involute: spiral: helix and loci of points of simple movingmechanism.2D geometrical construction. Representation of 3D objects. Principles of projections.

2. Projections: Straight lines, planes and solids. Development of surfaces of right and oblique solids. Section of solids.

3.Object Projections: Orthographic projection. Interpenetration and intersection of solids. Isometric and oblique parallel projection of solids

4. CAD Drawing: Introduction to CAD and Auto CAD, precision drawing and drawing aids, Geometric shapes, Demonstrating CAD- specific skills (graphical user interface. Create, retrieve, edit, and use symbol libraries. Use inquiry commands to extract drawing data). Control entity properties. Demonstrating basic skills to produce 2-D and 3-Ddrawings. 3D modeling with Auto CAD (surfaces and solids), 3D modeling with sketch up, annotating in Auto CAD with text and hatching, layers, templates & design centre, advanced plotting (layouts, viewports), office standards, dimensioning, internet and collaboration, Blocks, Drafting symbols, attributes, extracting data. basic printing, editing tools, Plot/Print drawing to appropriate scale.

References/ Suggested Readings:

1. K. Venugopal, and V. Raja Prabhu. Engineering Graphic, New Age International
2. AutoCAD 2014 & AutoCAD 2014/Donnie Gladfelter/Sybex/ISBN:978-1-118-57510-9
3. Architectural Design with Sketchup/Alexander Schreyer/John Wiley & Sons/ISBN:978-1-118-12309-6

Semester -VI

Course Name: Basic Electronics

Course Code: BSCPPHSDSE601

Course Type: DSE-II(Theory & Practical)	Course Details: **DSEC-1(2)**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	20	**40**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Understand both in analog and digital electronics.*
2. *Design several electronic devices thorough the knowledge on electronic circuit, semiconductor and its properties*

Course Content:

Theory

1. Semiconductor Diodes

Classification of semiconductors. Energy Level Diagram. Conductivity and Mobility, Concept of Drift velocity. PN Junction Fabrication (Simple Idea). Barrier Formation in PN Junction Diode. Static and Dynamic Resistance. Current Flow Mechanism in Forward and Reverse Biased Diode. Drift Velocity. **(5L)**

2. Two-terminal Devices and their Applications

Rectifier Diode: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers, Calculation of Ripple Factor and Rectification. Zener Diode and Voltage Regulation. **(5L)**

3. Bipolar Junction transistors

n-p-n and p-n-p Transistors. Characteristics of CB, CE and CC Configurations. Current gains α and β Relations between α and β. Active, Cutoff and Saturation Regions. **(5L)**

4. Field Effect transistors

Basic principle of operations of JFET and MOSFET only. **(3L)**

5. Amplifiers

Amplifiers: Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as 2-port Network. h-parameter Equivalent Circuit. Analysis of a single-stage CE

amplifier using Hybrid Model. Input and Output Impedance. Current, Voltage and Power Gains. Classification of Class A, B & C Amplifiers. **(5L)**

Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise; Barkhausen's Criterion for self-sustained oscillations **(4L)**

Operational Amplifiers (Black Box approach): Characteristics of an Ideal and Practical Op-Amp. (IC 741).

Applications of Op-Amps: Linear - (1) Inverting and non-inverting amplifiers, (2) Adder, (3) Subtractor, (4) Differentiator, (5) Integrator. **(3L)**

Unit-II: Digital

1. Digital Circuits: Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary and Binary to Decimal Conversion. BCD, Octal and Hexadecimal numbers. AND, OR and NOT Gates (realization using Diodes and Transistor). NAND and NOR Gates as Universal Gates. XOR and XNOR Gates. **(4L)**

2.Boolean algebra : De Morgan's Theorems. Boolean Laws. Simplification of Logic Circuit using Boolean Algebra. Fundamental Products. Idea of Minterms and Maxterms. Conversion of a Truth table into Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. **(5L)**

3.Data processing circuits: Basic idea of Multiplexers, De-multiplexers, Decoders, Encoders. **(3L)**

4. Circuits: Arithmetic Circuits: Binary Addition. Binary Subtraction using 2's Complement. Half and Full Adders. Half & Full Subtractors. **(3L)**

Practical

1. To study V-I characteristics of PN junction diode, and Light emitting diode.
2. To study the V-I characteristics of a Zener diode and its use as voltage regulator.
3. To study the characteristics of a Bipolar Junction Transistor in CE configuration..
4. To design a CE transistor amplifier of a given gain (mid-gain) using voltage divider bias.
5. To design a digital to analog converter (DAC) of given specifications.
6. To add two dc voltages using Op-amp in inverting and non-inverting mode
7. To investigate the use of an op-amp as an Integrator and as a Differentiator.
8. To verify and design AND, OR, NOT and XOR gates using NAND gates.
9. To design a combinational logic system for a specified Truth Table.
10. Half Adder, Full Adder and 4-bit binary Adder.
11. Half Subtractor, Full Subtractor, Adder-Subtractor using Full Adder I.C.

12. To build Flip-Flop (RS, Clocked RS, D-type and JK) circuits using NAND gates.
13. To build JK Master-slave flip-flop using Flip-Flop
14. To build a 4-bit Counter using D-type/JK Flip-Flop ICs and study timing diagram.
15. To make a 4-bit Shift Register (serial and parallel) using D-type/JK Flip-Flop ICs.

References/ Suggested Readings:

1. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill.
2. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.
3. Solid State Electronic Devices, B.G.Streetman & S.K.Banerjee, 6th Edn.,2009, PHI Learning
4. Electronic Devices & circuits, S.Salivahanan & N.S.Kumar, 3rd Ed., 2012, Tata Mc-Graw Hill
5. OP-Amps and Linear Integrated Circuit, R. A. Gayakwad, 4th edition, 2000, Prentice Hall
6. Microelectronic circuits, A.S. Sedra, K.C. Smith, A.N. Chandorkar, 2014, 6th Edn., Oxford University Press.
7. Electronic circuits: Handbook of design & applications, U.Tietze, C.Schenk,2008, Springer
8. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India
9. Microelectronic Circuits, M.H. Rashid, 2nd Edition, Cengage Learning
10. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson India
11. Digital Principles and Applications, A.P. Malvino, D. P. Leach and Saha, 7th Ed., 2011, Tata McGraw
12. Fundamentals of Digital Circuits, Anand Kumar, 2nd Edn, 2009, PHI Learning Pvt. Ltd.
13. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
14. Digital Electronics G K Kharate ,2010, Oxford University Press
15. Digital Systems: Principles & Applications, R.J.Tocci, N.S.Widmer, 2001, PHI Learning
16. Logic circuit design, Shimon P. Vingron, 2012, Springer.
17. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
18. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill
19. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.
20. Modern Digital Electronics, R.P. Jain, 4th Edition, 2010, Tata McGraw Hill.
21. Basic Electronics: A text lab manual, P.B. Zbar, A.P. Malvino, M.A. Miller, 1994, Mc- Graw Hill.

Course Name: Nanomaterials and Applications

Course Code: BSCPPHSDSE602

Course Type: **DSEII (Theory & Practical)**	Course Details: **DSEC-1(2)**			L-T-P: **4-0-4**	
Credit: **6**	Full Marks: **100**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	**10**	20	**40**

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Gain experience in applying unique properties of nanomaterials to solve problems and challenges in our life.*
2. *Develop case studies of nanomaterials with a focus on fundamentals, fabrication, characterization, and applications.*
3. *Gather knowledge about synthesis, characterization and applications of nanomaterials.*
4. *Collect knowledge about optical, electrical and mechanical properties of the nanomaterials.*

Course Content:

Theory

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. **(8L)**

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. **(8L)**

3. Characterization: X-Ray Diffraction. Optical Microscopy. Scanning Electron Microscopy. Transmission Electron Microscopy. Atomic Force Microscopy. Scanning Tunneling Microscopy. **(8L)**

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. **(7L)**

5. Electron Transport: Carrier transport in nanostrcutures. Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects. **(7L)**

6. 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). **(7L)**

Practical

1. Synthesis of metal nanoparticles by chemical route.
2. Synthesis of semiconductor nanoparticles.
3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.
4. XRD pattern of nanomaterials and estimation of particle size.
5. To study the effect of size on color of nanomaterials.
6. To prepare composite of CNTs with other materials.
7. Growth of quantum dots by thermal evaporation.
8. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.
9. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.
10. Prepare a thin film capacitor and measure capacitance as a function of temperature or frequency.
11. Fabricate a p-n diode by diffusing Al over the surface of N-type Si and study its V-I characteristic.

References/ Suggested Readings:

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

(Elsevier, 2007).

6. Introduction to Nanoelectronics, V.V. Mitin, V.A. Kochelap and M.A. Stroscio,2011, Cambridge University Press.
7. Bharat Bhushan, Springer Handbook of Nanotechnology (Springer-Verlag, Berlin, 2004).
8. C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt.Ltd.).
9. S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).
10. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).
11. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

SKILL ENHANCEMENT COURSE
(Evaluation is to be done internally)

Course Name: Computational Physics

Course Code: BSCPPHSSEC601

(Evaluation is to be done internally)

Course Type: **SEC(Practical)**	Course Details: **SEC-IV**			L-T-P: **0-0-8**	
Credit: **4**	Full Marks: **50**	CA Marks		ESE Marks	
		Practical	Theoretical	Practical	Theoretical
		30	…….	20	……

Course Learning Outcomes:

After the completion of course, the students will have ability to:

1. *Use computer programming language FORTRAN for solving the problems in physics through programming.*
2. *Prepare manuscript for scientific publication using Latex .*
3. *Visualize numerical data using Gnuplot software.*

Course Content:

Practical

1. Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution**.** Usage of linux as an Editor.

2. Algorithms and Flowcharts: Algorithm: Definition, properties and development. Flowchart: Concept of flow chart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin(x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal.

3. Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted),Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic.

Examples from physics problems.

4. Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DOWHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines(Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN,CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

5. Programming:

1. Exercises on syntax on usage of FORTRAN.
2. Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.
3. To print out all natural even/ odd numbers between given limits.
4. To find maximum, minimum and range of a given set of numbers.
5. Calculating Euler number using exp(x) series evaluated at x=1

6. Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, Preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **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, Fonts, Picture environment and colors, errors.

7. Visualization: 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 file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot

Hands on exercises:

1. To compile a frequency distribution and evaluate mean, standard deviation etc.
2. To evaluate sum of finite series and the area under a curve.
3. To find the product of two matrices
4. To find a set of prime numbers and Fibonacci series.
5. To write program to open a file and generate data for plotting using Gnuplot.
6. Plotting trajectory of a projectile projected horizontally.
7. Plotting trajectory of a projectile projected making an angle with the horizontally.

8. Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.
9. To find the roots of a quadratic equation.
10. Motion of a projectile using simulation and plot the output for visualization.
11. Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12. Motion of particle in a central force field and plot the output for visualization.

References/ Suggested Readings:

1. Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
2. Computer Programming in Fortran 77, V. Rajaraman (Publisher: PHI).
3. LaTeX–A Document Preparation System, Leslie Lamport (Second Edition, Addison-Wesley, 1994).
4. Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
5. Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
6. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
7. A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning Elementary Numerical Analysis, K.E. Atkinson, 3rd Ed.