DEPARTMENT OF PHYSICS
CHANDIDAS MAHAVIDYALAYA

A Govt. Aided Degree College Affiliated to the University of Burdwan
UGC Accrediated under section 2(f) & 12(B) [1979] * NAAC Accrediated in 2016
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Ref. No. *Date:*

Three-Year Zoology General Degree Course (CBCS)
Course Module

SEMESTER-I CORE COURSE I-A: MECHANICS (Theory)		Class
Module 1	• Vector algebra, Scalar and vector products. • Derivatives of a vector with respect to a parameter.	4
Module 2	• 1st order homogeneous differential equations. • 2nd order homogeneous differential equations with constant coefficients.	4
Module 3	• Frames of reference. Newton's Laws of motion. • Dynamics of a system of particles. Centre of Mass.	4
Module 4	• Conservation of momentum. Work and energy. • Conservation of energy. Motion of rockets.	4
Module 5	• Angular velocity and angular momentum. Torque. • Conservation of angular momentum.	4
Module 6	• Newton's Law of Gravitation. • Motion of a particle in a central force field (motion is in a plane. • Angular momentum is conserved, areal velocity is constant).	4
Module 7	• Kepler's Laws (statement only). Satellite in circular orbit and applications. • Geosynchronous orbits. Weightlessness. • Basic idea of global positioning system (GPS).	4
Module 8	• Simple harmonic motion. • Differential equation of SHM and its solutions. • Kinetic and Potential Energy, Total Energy and their time averages. • Damped oscillations.	4
Module 8	• 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.	4
Module 9	• Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder. • Determination of Rigidity modulus by static torsion. • Torsional pendulum- Determination of Rigidity modulus and moment of inertia - q, η and σ by Searle's method.	4
Module 10	• Constancy of speed of light. • Postulates of Special Theory of Relativity. • Length contraction. • Time dilation. • Relativistic addition of velocities.	4

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CORE COURSE I-A: MECHANICS (Practical)		
Module 1	• Measurements of length (or diameter) using Vernier Caliper, Screw Gauge and Travelling Microscope.	4
Module 2	• To determine the Moment of Inertia of a Flywheel/ regular shaped object.	4
Module 3	• To determine Young's Modulus by flexure method.	4
Module 4	• To determine the Modulus of Rigidity of a wire by dynamical method. • To determine the Elastic Constants of a Wire by Searle's method.	6
Module 5	• To determine g by Bar/Kater's Pendulum. • To determine the coefficient of viscosity by Poiseuille's method.	6

SEMESTER-II CC-1B: ELECTRICITY AND MAGNETISM (Theory)		Class
Module 1	• Review of vector algebra (Scalar and Vector product). • Gradient • Divergence • Curl and their significance.	3
Module 2	• Vector Integration. • Line, surface and volume integrals of Vector fields. • Gauss-divergence theorem and Stoke's theorem of vectors (statement only).	3
Module 3	• Electrostatic Field, electric flux, Gauss's theorem of electrostatics. • Applications of Gauss Theorem-Electric field due to point charge. • Infinite line of charge, Uniformly charged spherical shell	3
Module 4	• Applications of Gauss Theorem-Electric field due to Solid Sphere, • Plane charged sheet and Charged Conductor. • Electric potential as line integral of electric field.	3
Module 5	• Potential due to a Point Charge and Electric Dipole • Uniformly charged Spherical Shell and Solid Sphere. • Calculation of electric field from potential.	3
Module 6	• Capacitance of an isolated spherical conductor. • Parallel plate, spherical and cylindrical condenser. • Energy per unit volume in electrostatic field.	3
Module 7	• Dielectric medium, Polarization, Displacement vector. • Gauss's theorem in dielectrics. • Parallel plate capacitor completely filled with dielectric.	3

Module 8	• Magnetostatics
	• Biot-Savart's law & its applications-
	  ◦ Straight Conductor
	  ◦ Circular Coil
	  ◦ Solenoid Carrying Current
		3

Module 9	• Divergence and curl of magnetic field. • Magnetic vector potential. • Ampere's circuital law.	2

Module 10	• Magnetic properties of materials:
	  ◦ Magnetic Intensity
	  ◦ Magnetic Induction
	  ◦ Permeability
	  ◦ Magnetic Susceptibility
	• Brief introduction of dia, para and ferro-magnetic materials.
		4

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Module 11	• Faraday's and Lenz's laws of electromagnetic induction • Self and Mutual Inductance, L of single coil, M of two coils. • Energy stored in magnetic field.	3
Module 12	• Equation of continuity of current • Displacement current. • Maxwell's equations • Poynting vector	4
Module 13	• Energy density in electromagnetic field. • Electromagnetic wave propagation through vacuum and isotropic dielectric medium. • Transverse nature of EM waves, Polarization.	3
CC-1B: ELECTRICITY AND MAGNETISM (Practical)		
Module 1	• To use a Multimeter for measuring (a)Resistances, (b)AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.	2
Module 2	• To study the Characteristics of a Series RC Circuit. • To determine a Low Resistance by Carey Foster's Bridge	6
Module 3	• To verify the Thevenin and Norton Theorem. • To verify the Superposition, and Maximum Power Transfer Theorem. • To determine the horizontal component of earth's magnetic field.	6
Module 4	• To study a Series and Parallel LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor.	6
SEMESTER-III **CC-1C: THERMAL PHYSICS AND STATISTICAL MECHANICS (Theory)**		**Class**
Module 1	• Zeroth Law of thermodynamics and temperature. • First law and internal energy, conversion of heat into work. • Various Thermo dynamical Processes.	4
Module 2	• Applications of First Law. • General Relation between C_P & C_V • Work Done during Isothermal and Adiabatic Processes.	3
Module 3	• Compressibility & Expansion Coefficient, Reversible & Irreversible Processes • Second law & Entropy, Carnot's cycle & theorem. • Entropy changes in Reversible & Irreversible processes.	4
Module 4	• Entropy-temperature diagrams. • Third law of thermodynamics. • Unattainability of absolute zero.	3
Module 5	• Enthalpy, Gibbs, Helmholtz and • Internal Energy functions. • Maxwell's relations & applications.	4
Module 6	• Joule-Thompson Effect • Clausius-Clapeyron Equation. • Expression for ($C_P - C_V$), C_P/C_V, TdS equations.	4
Module 7	• Derivation of Maxwell's law of distribution of velocities and its experimental verification. • Mean free path (Zeroth Order) and Transport Phenomena • Viscosity	3

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Module 8	• 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.	3
Module 9	• Blackbody radiation, Spectral distribution and 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.	4
Module 10	• Phase space, Macro state and Micro state. • Entropy and Thermodynamic probability. • Maxwell-Boltzmann law - distribution of velocity.	4
Module 11	• Quantum statistics - Fermi-Dirac distribution law - electron gas. • Bose-Einstein Distribution law - photon gas. • Comparison of three statistics.	3
CC-1C: THERMAL PHYSICS AND STATISTICAL MECHANICS (Practical)		
Module 1	• To determine Stefan's Constant.	4
Module 2	• To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.	4
Module 3	• To study the variation of thermo emf across two junctions of a thermocouple with temperature.	4
Module 4	• To determine the temperature co-efficient of resistance by Platinum resistance thermometer.	4
Module 5	• To determine the coefficient of thermal conductivity of a good conductor by Searle's method.	4

SEMESTER-III ***Skill Enhancement Course:*** **SEC-1: RENEWABLE ENERGY AND ENERGY HARVESTING (Theory)**		**Class**
Module 1	• Fossil fuels and Nuclear Energy, their imitation. • Need of renewable energy, Non-conventional energy sources. • An overview of developments in Offshore Wind Energy, Tidal Energy.	2
Module 2	• Wave energy systems, Ocean Thermal Energy Conversion, Solar energy. • Biomass, biochemical conversion, biogas generation. • Geothermal energy tidal energy, Hydro electricity.	3
Module 3	• Solar energy, its importance. • Storage of solar energy, Solar pond. • Non convective solar pond.	2
Module 4	• Applications of solar pond and solar energy, solar water heater, flat plate collector. • Solar distillation, solar cooker, solar green houses. • Solar cell, absorption air conditioning.	3
Module 5	• Need and characteristics of photovoltaic (PV) systems, PV models. • Equivalent circuits. • Sun tracking systems.	2

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Module 6	• Fundamentals of Wind energy. • Wind Turbines and different electrical machines in wind turbines. • Power electronic interfaces, and grid interconnection topologies.	2
Module 7	• 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.	3
Module 8	• Geothermal Resources • Geothermal Technologies	2
Module 9	• Hydro power resources, hydro power technologies. • Environmental impact of hydro power sources.	2
Module 10	• 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.	3

Module 11	• Linear generators, physics mathematical models.
	• Recent applications.....
	  • Carbon captured technologies, cell, batteries, power consumption.
	  • Environmental issues and Renewable sources of energy, sustainability.
		3

Demonstrations and Experiments		
Module 1	• Demonstration of Training modules on solar energy, wind energy. • Conversion of vibration to voltage using piezoelectric materials • Conversion of thermal energy into voltage using thermoelectric modules.	3

SEMESTER-IV **CC- 1D: WAVES AND OPTICS (Theory)**		**Class**
Module 1	• Linearity and Superposition Principle. • Oscillations having equal frequencies, • Oscillations having different frequencies (Beats).	4
Module 2	• Graphical and Analytical Methods. • Lissajous Figures with equal an unequal frequency and their uses.	3
Module 3	• Transverse waves on a string. • Travelling and standing waves on a string. • Normal Modes of a string.	2
Module 4	• Group velocity, Phase velocity. • Plane waves and Spherical waves. • Wave intensity.	3
Module 5	• Surface Tension: Synclastic and anticlastic surface - Excess of pressure • Application to spherical and cylindrical drops and bubbles-variation of surface tension with temperature - Jaegar's method.	4
Module 6	• Viscosity: Viscosity - Rate flow of liquid in a capillary tube - Poiseuille's formula. • Determination of coefficient of viscosity of a liquid. • Variations of viscosity of a liquid with temperature lubrication.	3

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Module 7	• Physics of low pressure - production and measurement of low pressure. • Rotary pump- Diffusion pump -Molecular pump. • Knudsen absolute gauge - penning and pirani gauge – Detection of leakage.	3
Module 8	• Simple harmonic motion - forced vibrations and resonance. • Fourier's Theorem • Application to saw tooth wave and square wave - Intensity and loudness of sound.	4
Module 9	• 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.	4
Module 10	• Electromagnetic nature of light. Definition and Properties of wave-front. • Huygens Principle. • Interference: Division of amplitude and division of wave-front.	3
Module 11	• Young's Double Slit experiment. • Lloyd's Mirror and Fresnel's Biprism. • Phase change on reflection: Stokes' treatment	4
Module 12	• Interference in Thin Films: parallel and wedge-shaped films. • Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). • Newton's Rings: measurement of wavelength and refractive index.	4
Module 13	• **Michelson'sInterferometer:** Idea of form of fringes (no theory needed). • Determination of wavelength, Wavelength difference. • Determination of Refractive index and Visibility offringes.	4
Module 14	• Fraunhofer diffraction: Single slit • Double Slit • Multiple slits & Diffraction grating	3
Module 15	• Fresnel Diffraction: Half-period zones. Zone plate. • Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.	3
Module 16	• Transverse nature of light waves. • Plane polarized light – production and analysis. • Circular and elliptical polarization.	3
CC- 1D: WAVES AND OPTICS (Practical)		
Module 1	• To determine the angle of prism by (i) Rotating telescope or (ii) Rotating prism method.	4
Module 2	• To determine the Refractive Index of the Material of a given Prism using Sodium Light.	4
Module 3	• To determine Dispersive Power of the Material of a given Prism using Mercury Light	4
Module 4	• To determine the Resolving Power of a Prism.	3
Module 5	• To determine wavelength of sodium light using Newton's Rings.	3
Module 6	• To determine wavelength of Sodium light using plane diffraction Grating.	4
Module 7	• To determine the Resolving Power of a Plane Diffraction Grating.	4
Module 8	• To determine the refractive index of a liquid by travelling microscope.	4
Module 9	• To determine the focal length of a concave lens by combination method.	4

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SEMESTER-IV *Skill Enhancement Course:* SEC-2: WEATHER FORECASTING (Theory)		Class
Module 1	• Elementary idea of atmosphere: physical structure and composition. • Compositional layering of the atmosphere. • Variation of pressure and temperature with height.	4
Module 2	• Air temperature; requirements to measure air temperature. • Temperature sensors: types • Atmospheric pressure: its measurement; cyclones and anti cyclones: its characteristics.	5
Module 3	• Wind; forces acting to produce wind • Wind speed direction: units, its direction; measuring wind speed and direction. • Humidity, clouds and rainfall, radiation: absorption, emission and scattering in atmosphere; radiation laws.	5
Module 4	• Global wind systems air masses and fronts. • Classifications: jet streams, local thunderstorms • Tropical cyclones: classification; tornadoes; hurricanes.	4
Module 5	• Climate: Its classification; causes of climate change. • Global warming and its outcomes; air pollution; aerosols, ozone depletion. • Acid rain, environmental issues related to climate.	4
Module 6	• Weather forecasting: analysis and its historical background. • Need of measuring weather. • Types of weather forecasting; weather forecasting methods.	4
Module 7	• Criteria of choosing weather station; basics of choosing site and exposure. • Satellites observations in weather forecasting. • Weather maps; uncertainty and predictability; probability forecasts.	4

SEMESTER-V *Discipline Specific Elective Course:* DSE-1A: ELEMENTS OF MODERN PHYSICS (Theory)		Class
Module 1	• Planck's quantum, Planck's constant and light as a collection of photons. • Photo-electric effect and Compton scattering. • De Broglie wavelength and matter waves; Davisson – Germer experiment.	4
Module 2	• Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra. • Bohr's quantization rule and atomic stability. • Calculation of energy levels for hydrogen like atoms and their spectra.	5
Module 3	• Position measurement- gamma ray microscope thought experiment; Wave-particle duality. • Heisenberg uncertainty principle- impossibility of a particle following a trajectory. • Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle.	5
Module 4	• Two slit interference experiments with photons. • Atoms and particles; linear superposition principle as a consequence. • Matter waves and wave amplitude.	4

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Module 5	• Schrodinger equation for non- relativistic particles. • Momentum and Energy operators. • Stationary states; physical interpretation of wave-function.	4
Module 6	• Probabilities and normalization. • Probability and probability current densities in one dimension.l	3
Module 7	• One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization. • Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier.	5
Module 8	• Size and structure of atomic nucleus and its relation with atomic weight • Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. • Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.	4
Module 9	• Radioactivity: stability of nucleus • Law of radioactive decay. • Mean life & half-life	4
Module 10	• α decay; β decay - energy released. • Spectrum and Pauli's prediction of neutrino. • γ-ray emission.	4
Module 11	• Fission and fusion-mass deficit, relativity and generation of energy • Fission-nature of fragments and emission of neutrons. • Nuclear reactor: slow neutrons interacting with Uranium-235. • Fusion and thermonuclear reactions.	6
DSE-1A: ELEMENTS OF MODERN PHYSICS (Practical)		
Module 1	• To determine the value of Boltzmann constant using the V-I characteristic of the PN diode.	4
Module 2	• Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light.	4
Module 3	• To determine the value of e/m by magnetic focusing.	4

SEMESTER-V ***Skill Enhancement Course:*** **SEC-3: COMPUTATIONAL PHYSICS (Theory)**		**Class**
Module 1	• Importance of computers in Physics, paradigm for solving physics problems for solution. Usage of linux as an Editor.	1
Module 2	• Algorithm: Definition, properties and development. • Flowchart: Concept of flowchart, 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

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Module 3	• Some fundamental Linux Commands (Internal and External commands). • Development of FORTRAN, Basic elements of FORTRAN:CharacterSet, Constants and their types • Variables and their types, Keywords, Variable Declaration and concept of instruction and program.	3
Module 4	• 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.	3
Module 5	• 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, DO-WHILE, 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, openafile, writing in a file, reading from a file. Examples from physics problems.	7
Module 6	• Exercises on syntax on usage of FORTRAN • Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write our ces codes in FORTRAN. • To print out all natural even/odd numbers between given limits. • To find maximum, minimum and range of a given set of numbers. • Calculating Euler number using exp(x) series evaluate datx=1	4
Module 7	• 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.	3
Module 8	• 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.	3
Module 9	• 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.	3

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SEMESTER-VI DSE-1B: DIGITAL AND ANALOG CIRCUITS AND INSTRUMENTATION (Theory)		Class
Module 1	• Difference between Analog and Digital Circuits. Binary Numbers. Decimal to Binary andBinary to Decimal Conversion. • AND, Or and NOT Gates (Realization using Diodes and Transistor). • NAND and NOR Gates as Universal Gates. XOR and XNOR Gates.	4
Module 2	• De Morgan's Theorems. Boolean Laws. • Implication of Logic Circuit using Boolean Algebra. • Fundamental Products. Minterms and Maxterms.	3
Module 3	• Conversion of a Truth Table into an Equivalent Logic Circuit by (1) Sum of Products Method and (2) Karnaugh Map. • Binary Addition.Binary Subtraction using 2's Complement Method). • Half Adders and Full Adders and Subtractors, 4-bit binary Adder-Subtractor.	4
Module 4	• Semiconductor Diodes: p and n type semiconductors.Barrier Formationin PN Junction Diode. • Qualitative Idea of Current Flow Mechanism in Forward and Reverse Biased Diode.PN junction and its characteristics. • Static and Dynamic Resistance. Principle and structure of (1) LEDs (2) Photodiode (3) Solar Cell.	4
Module 5	• n-p-n and p-n-p Transistors. • Characteristics of CB, CE and CC Configurations. Active, Cutoff, and Saturation Regions. • Current gains α and β. Relations between α and β. Load Line analysis of Transistors. DC Load line and Q-point.	4
Module 6	• Voltage Divider Bias Circuit for CE Amplifier. • h-parameter Equivalent Circuit. Analysis of a single-stage CE amplifier using Hybrid Model. • Input and Output Impedance. Current, Voltage and Power Gains. Class A, B, and C Amplifiers.	4
Module 7	• Characteristics of an Ideal and Practical Op-Amp (IC 741) • Open-loop & Closed-loop Gain. • CMRR, concept of Virtual ground.	3

Module 8	• Applications of Op-Amps:
	  • Inverting and Non-inverting Amplifiers
	  • Adder
	  • Subtractor
	  • Differentiator
	  • Integrator
	  • Zero Crossing Detector
		4

Module 9	• Barkhausen's Criterion for Self-sustained Oscillations. • Determination of Frequency of RC Oscillator.	2

Module 10	• Introduction to CRO: Block Diagram of CRO.
	• Applications of CRO:
	  • Study of Waveform
	  • Measurement of Voltage, Current, Frequency, and Phase Difference.
		4

Module 11	• Power Supply: Half-wave Rectifiers. Centre-tapped and Bridge Full-wave Rectifiers. • Calculation of Ripple Factor and Rectification Efficiency. • Basic idea about capacitor filter.	3
Module 12	• Zener Diode and Voltage Regulation. • Timer IC: IC 555 Pin diagram and its application as Astable & Monostable Multivibrator.	3

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DSE-1B: DIGITAL AND ANALOG CIRCUITS AND INSTRUMENTATION (Practical)		
Module 1	• To measure (a)Voltage, and (b) Frequency of a periodic waveform using a CRO • To verify and design AND, OR, NOT and XOR gates using NAND gates. • To minimize a given logic circuit.	4
Module 2	• Half adder, Full adder and 4-bit Binary Adder. • Adder-Subtractor using Full Adder I.C. • To study I-V characteristics of PN diode and Zener diode. • To study the characteristics of a Transistor in CE configuration.	6
Module 3	• To design a CE amplifier of a given gain (mid-gain) using voltage divider bias. • To design an inverting amplifier of given gain using an Op-amp 741 and study its frequency response. • To design an non-inverting amplifier of given gain an Op-amp 741 and study its frequency response.	8

SEMESTER-VI ***Skill Enhancement Course:*** **SEC- 4: ELECTRICAL CIRCUITS AND NETWORK SKILLS**		**Class**
Module 1	• 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.	3
Module 2	• 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.	5
Module 3	• Drawing symbols. Blueprints. Reading Schematics. • Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. • Reading of circuit schematics. Tracking the connections of elements and identifying current flow and voltage drop.	3
Module 4	• DC Power sources. AC/DC generators. • Inductance, capacitance, and impedance. • Operation of transformers.	3
Module 5	• Single-phase, three-phase & DC motors. • Basic design. Interfacing DC or AC sources to control heaters & motors. • Speed & power of AC motor.	3
Module 6	• Resistors, inductors and capacitors. Diode and rectifiers. • Components in Series or in shunt. • Response of inductors and capacitors with DC or A C sources.	3
Module 7	• Relays. Fuses and disconnect switches. Circuit breakers. • Overload devices. Ground-fault protection. Grounding and isolating. • Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device).	4
Module 8	• 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.	3
Module 9	• Insulation. Solid and stranded cable. • Conduit.Cable trays. Splices: wire nuts, crimps, terminal blocks, split bolts, and solder. • Preparation of the extension board.	3

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