SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 5)

Subject: Physics

Course: US05CPHY21

Classical Mechanics

(Four Credit Course –4 Hours per week)

(Effective from June-2020)

Course Objectives:

- To provide training of the generalized coordinates to deal with mechanics of classical systems through Lagrangian formulation.
- To create awareness about rotating co-ordinate systems and its application to study the motion of Earth, rigid body motions, motion of symmetric top etc..
- To provide an exposure to the mathematical techniques of calculus of variation and its applications to physical systems through Lagrangian and Hamiltonian method.

UNIT- I Lagrangian Formulation

Constraints, Generalized co-ordinates, D'Alembert's principle, Lagrange's equations, A General expressions for kinetic energy, Symmetries and the laws of conservation, Cyclic or Ignorable coordinates, Illustrations, Velocity dependent potential of electromagnetic field, Rayleigh's dissipation function

UNIT- II Moving coordinate systems and motion of a rigid body

Coordinate systems with relative translation motions, Rotating coordinate systems, The Coriolis force, Motion on the earth, Effect of Coriolis force on freely falling particle, Euler's Theorem, Angular momentum and kinetic energy, The inertia tensor, Euler's equations of motion, Torque free motion, Euler's angles, Motion of a symmetric top

UNIT-III Variational Principle

Configuration space, Some techniques of calculus of variation, The δ Notations, Applications of the variational principle, Hamilton's principle, Equivalence of Lagrange's and Newton's equations, Advantages of the Lagrangian Formulation – Elecro–Mechanical analogies, Lagrange's undetermined multipliers, Lagrange's equations for Non holonomic systems, Applications of the Lagrangian method of undetermined multipliers

UNIT- IV Hamiltonian Formulation

Hamilton's equations of motion , Some applications of the Hamiltonian formulation, Phase Space, Comments on the Hamiltonian formulation, Gauge Transformation, Canonical transformation, Conditions for transformation to be Canonical, Illustrations of Canonical transformations, Poisson brackets

Learning Outcomes:

- At the end of the course students will be able to understand the generality of generalized coordinates and will be able to apply for the study of the mechanics of classical systems.
- Students will be able to understand the effect of rotational motion of the earth and its effect on weather conditions.

- They will get an idea of inertia and symmetry of rigid bodies, variational method for motion of the system as another formulation to solve mechanical problems.
- Students will be able to understand the production of Hamiltonian function and use of Lagrangian and Hamiltonian formulation for the study related to motion of classical systems.

Books Recommended:

1. Introduction to Classical Mechanics
   R G Takwale and P S Puranik
   Tata McGraw Hill Education Pvt Ltd.
2. Classical Mechanics
   Herbert Goldstein, Charles P. Poole and John Safko
   Third Edition, Pearson
3. Classical Mechanics
   Aruldhas
   PHI Learning Pvt Ltd, New Delhi

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 5)

Subject: Physics

Course: US05CPHY22

Mathematical Methods

(Four Credit Course –4 Hours per week)

(Effective from June-2020)

Course Objectives:

- To provide the concept of generalized curvilinear coordinates and their vector differential operators and its deduction for the cases of rectangular, cylindrical and spherical coordinates.
- To provide the basic definition and applications of Beta, Gamma and harmonic functions to solve physical problems.
- To train the students in the applications of Fourier series for solving certain special classes of physical problems.
- To provide various numerical techniques useful for the scientific data analysis as well as to train how to find the differentiation and integration of numerical data.

UNIT – I Curvilinear Co-ordinate System and Beta, Gamma Functions

Curvilinear Coordinate System: Curvilinear Coordinates, Orthogonal curvilinear coordinates, Condition for orthogonality, Reciprocal sets of two triads of mutually orthogonal vectors, Gradient in terms of orthogonal curvilinear coordinates, Divergence in terms of orthogonal curvilinear coordinates, Curl in terms of curvilinear coordinates, Laplacian in terms of orthogonal curvilinear coordinates, Equivalent expression for $\nabla\emptyset, \nabla \cdot \boldsymbol{F}$ and $\nabla \times \boldsymbol{F}$ (gradient, div and curl) in rectangular coordinates, Cylindrical coordinates as a special curvilinear system, Spherical polar coordinates as a special curvilinear system, Related Numerical, **Beta, Gamma Functions** Definitions, Fundamental property of Gamma Functions, Transformation of Gamma Function, Relation:$\beta(m,n) = \beta(n,m)$, Different forms of Beta function, Relation between Beta and Gamma Functions

UNIT – II Harmonics with Special Functions

Legendre differential equation(Solution in descending power of x), Legendre polynomials(without corollary), Generating functions for $P_n(x)$, Recurrence formulas for $P_n(\mu)$, Rodrigue's formula, Orthogonal properties of Legendre polynomials of the first kind, Bessel's differential equation, Generating functions for$J_n(x)$, Recurrence formula for $J_n(x)$, Orthogonal properties of Bessel's polynomials, Hermite's differential equation, Hermite polynomials, Recurrence formula for $H_n(x)$, Orthogonal properties of Hermite polynomials

UNIT – III Fourier series, Diffusion Equation and Wave Equation

Definition and expansion of a function of x, Complex representation of Fourier's series, Physical application of Fourier's series: Fourier series involving phase angles, Effective values and the average of a product, Thermal state, Transverse vibration of a string, Diffusion equation or Fourier equation of heat flow, Independent derivation of one dimensional diffusion equation, Solution of one dimensional diffusion equation when both the ends of a bar at temperature zero, Two-dimensional diffusion equation, **The Wave Equations:** Derivation of one-dimensional wave equation, Derivation of Two-dimensional wave equation, Related Numerical

UNIT – IV Numerical Techniques

Curve Fitting: Introduction, **The Least squares method**: Fitting a straight line, Fitting a parabola, Fitting a curve of the form $y = ax^b$, Fitting an exponential curve$y = ae^{bx}$ **Interpolation:** Introduction, Finite difference operator: Forward, Backward and Central Differences, Shift, Average and Differential operator, Newton's forward difference interpolation formula, Newton's backward difference interpolation formula, Lagrange's interpolation formula **Numerical differentiation and integration:** Differentiation using difference operators (Forward and Backward), Newton-Cotes Integration formula, The Trapezoidal Rule, Simpson's (1/3) Rule, Related Numerical

Learning Outcomes:

At the end of course students will be expected to have learnt

- The general features of curvilinear coordinate systems and its deductions to any particular coordinate system.
- The importance of some special harmonic functions and their properties.
- How Fourier series can be applied to solve certain types of differential equations.
- The students will be able to apply the numerical methods for solving various physical problems which are difficult to study analytically as well as how to analyze the experimental data.

Books Recommended:

1. Mathematical Physics
   B D Gupta (4thEdition)
   Vikas Publishing House Pvt.Ltd.
2. Mathematical Methods in Physical Science
   Mary L Boas (2nd Edition)
   John Wiley & Sons
3. Mathematical Methods for Physics
   George B. Arfken and Hans J. Weber (4th Edition)
   Academic Press, INC
4. Numerical Methods for Scientists and Engineers
   K Sankara Rao (3rd Edition)
   PHI Learning Pvt. Ltd.
5. Numerical Methods
   E Balagurusamy
   Tata McGraw Hill Publishers
6. Numerical Mathematical Analysis
   J B Scarborough
   Oxford & IBH Publishing Pvt. Ltd.

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 5)

Subject: Physics

Course: US05CPHY23

Thermodynamics and Statistical Mechanics

(Four Credit Course –4 Hours per week)

(Effective from June-2020)

Course Objectives:

- To provide the fundamentals of thermodynamics and their applications to study of thermal characteristics of different states of matter.
- To provide the fundamental concept of Classical Statistical Mechanics.
- To create awareness about the importance of partition functions and statistical distribution of particles for the better understanding of many body systems.

UNIT-I Thermodynamical Laws and Entropy

Thermodynamical laws: Refrigerator, Clausius statement of the second law, Carnot's theorem and corollary, Kelvin temperature scale, Absolute zero, Equality of ideal gas temperature and Kelvin temperature. **Entropy:** Clausius' theorem, Entropy and the mathematical formulation of the second law, Entropy of an ideal gas, T – S diagram, Entropy and reversibility, Entropy and irreversibility, Entropy and non equilibrium states, Principle of increase of entropy, Application of the entropy principle, Entropy and unavailable Energy, Entropy and disorder, Entropy and direction, Absolute entropy, First-order Transition, Clapeyron's equation, Second-order Transition, Ehrenfest's equations

UNIT-II Heat and Thermodynamics

Properties of pure substances: T-S diagram for a pure substance, Gibb's U-V-S surface, Enthalpy, Helmholtz function, Gibb's function, Names and symbols for the thermodynamic functions. **Applications of Thermodynamics to pure substances:** Two mathematical theorems, Maxwell's equations, First and second T-dS equations, Energy equations, Difference and ratio of heat capacities, Expansivity, Compressibility, Joule-Kelvin effect (porous plug experiment)

UNIT-III Fundamentals of Classical Statistical Mechanics

Macroscopic and Microscopic states, Phase space, Liouville's theorem, Fluctuations in a physical quantity, **Microcanonical Ensemble:** Microcanonical distribution, Equal a priori probability, Entropy, Entropy of a perfect gas in a Microcanonical ensemble, Gibbs paradox, Removal of Gibbs paradox, Thermodynamic quantities in a Microcanonical ensemble, Average energy per particle, Specific heat at constant volume, Sackur-Tetrode formula, Nernst's heat theorem, **Canonical Ensemble:** Canonical distribution, Canonical average, Canonical partition function, Related Numerical

UNIT-IV Partition Functions and Statistical Distribution

Grand Canonical Ensemble: Grand Canonical distribution, Grand Canonical average, Grand Canonical partition function.

Three Distributions: Maxwell-Boltzmann Distribution, Fermi-Dirac distribution, Bose-Einstein Distribution, Applications of Maxwell-Boltzmann Distribution: Energy distribution function, Energy distribution law, Partition function, Most probable energy, Total number of particles, Average energy, Velocity distribution function, Total number of particles, Most probable velocity, Average velocity and Root mean square velocity, Related Numerical

Learning Outcomes:

By the end of the course, the students will be expected to have learnt

- The laws and mathematical formulations of thermodynamics, the concept of entropy etc.
- The behavior of different states of matter under thermal environment.
- The fundamental concept of statistical mechanics like phase space, micro canonical ensemble as isolated system and canonical ensembles which allows exchange of energy.
- The partition functions and MB, BE, FD statistical distribution of particles with distinct intrinsic properties such as classical gas, Fermionic gas and Bosonic gas etc.

Books Recommended:

1. Heat & Thermodynamics
   Mark W. Zemansky (4^{th} Edition)
   McGraw-Hill Book Company, Inc.
2. A textbook of Statistical Mechanics
   Suresh Chandra
   CBS Publishers & Distributers
3. Heat and Thermodynamics
   Brijlal and Subrahmanyam
   S Chand Publication.
4. Statistical Mechanics
   B K Agarwal and Melvin Eisner
   New Age International Limited Publishers
5. Fundamentals of Statistical Mechanics
   B. B. Laud
   New Age International publishers

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120
B.Sc. (Semester - 5)
Subject: Physics
Course: US05CPHY24

Analog and Digital Circuits

(Four Credit Course –4 Hours per week)
(Effective from June-2020)

Course Objectives:

- To train the students on the analog and digital electronic circuits and their applications in Voltage and power amplifications.
- To provide exposure to the working and wide applications of operational amplifiers.
- To train the students in the basics of digital logic circuits and the working and applications of digital circuits as registers, counters etc.

UNIT-I Frequency response of transistor voltage amplifiers and Power amplifiers

Frequency Response of Amplifiers: Low Frequency Response of The Transistor Amplifier, Effect of Emitter Bypass Capacitor on Low Frequency response, Effect of Coupling Capacitor on Low Frequency response, High Frequency Response of The Transistor Amplifier, High Frequency Model For The Common Emitter Amplifier, Approximate CE High Frequency Model with a Resistive Load, CE Short Circuit Gain, High Frequency Current Gain with a Resistive Load**PowerAmplifiers**: Class A Direct Coupled Resistive Load, Transformer Coupled Resistive Load Amplifier**Push-Pull Amplifiers:** Description of Operation of a Class A Push-Pull Amplifier, Theory of Operation of a Class A Push-Pull Amplifier, The Class B Push-Pull Amplifier, Crossover Distortion, Class AB Push-Pull Amplifier, Transistor Phase Inverter, Conversion Efficiency of a Class B Amplifier, Relation between maximum output power and load resistance, Other Class B Push-Pull Amplifiers, Complementary Symmetry

UNIT-II Operational Amplifiers

Operational Amplifier Characteristics: Basic Differential amplifier analysis, DC Analysis of the Bipolar Diff. Amplifier, AC Analysis of the Bipolar Diff. Amplifier, The Common mode rejection ratio – CMRR, The Ideal Operational Amplifier -Op-Amp., Inverting and Noninverting Amplifiers –Ideal case, Op-Amp Parameters –Definitions, Universal Balancing Techniques, Measurements of Op- Amp Parameters, General Description of various Stages in Op-Amp **Applications of operational amplifier:** Summing amplifier (Inverting Mode) and Difference amplifier, The Integrator and Differentiator, Current to Voltage Converter, Voltage to Current Converter- Floating Load, Logarithmic Amplifier using diode(Basic only) **Active filters:** Introduction, General characteristics of filters, Various filter responses, First-order active filters (Basic Low-Pass and High-Pass filters)

UNIT-III Number Systems, Gates and Logic Family

Number systems and codes: Decimal and binary odometer, Binary numbers, Use of binarynumbers, Binary to decimal conversion, Decimal to Binary conversion, Hexadecimal numbers,Hexadecimal-Binary conversion, Hexadecimal to decimal conversion, Decimal to hexadecimalconversion, BCD numbers, The ASCII code**Gates:** Inverters, OR gates, AND gates, Boolean algebra, NOR gates, De Morgan's first theorem, NAND gates, De Morgan's Second theorem, EXCLUSIVE-OR gates, EXCLUSIVE-NOR gates**TTL circuits:**Digital integrated circuits, 7400 devices, TTL characteristics

UNIT-IV Flip-Flops, Registers and Counters

Flip –Flops: Introduction, RS latches, Level clocking, D latches, Edge triggered D flip-flops, Edge triggered JK flip-flops, JK master slave flip flop**Registers :** Buffer registers, Shift registers, Controlled shift registers**Counters:**Ripple counters, Synchronous counters, Ring counters, MOD-10 counter, down counter, up - down counter

Learning Outcomes:

After the successful completion of the course, the students will have acquired the working knowledge of

- Transistor amplifiers and their analysis for different range of frequencies.
- The power capabilities of transistor power amplifiers and various techniques to achieve higher efficiency.
- The basic structure of Operational Amplifier and its analysis with its wide applications.
- Different number systems and different types of gates, flip-flops, registers and counters which are essential components of digital electronic technology.

Books Recommended:

1. Electronic Devices and Circuits,
   Allen Mottershead
   PHI Pvt.Ltd., New Delhi
2. Integrated Circuits,
   K R Botkar
   Khanna Publishers, New Delhi
3. Digital Computer Electronics
   P Malvino and J A Brown,
   Tata McGraw Hill Publishing Co. Ltd., New Delhi
4. Electronic Devices and Circuits,
   G K Mittal
   Khanna Publishers, New Delhi
5. Integrated electronics: Analog and Digital Circuits and Systems
   Jacob Millman and Christos C. Halkias
   Tata McGraw Hill Pub. Co. Ltd, New Delhi
6. Electronic Principles
   P Malvino
   Tata McGraw Hill Pub. Co. Ltd, New Delhi
7. Basic Electronics (Solid State)
   B L Theraja
   S. Chand & Company Ltd.

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120

B.Sc. (Semester - 5)

Subject: Physics Practical

Course: US05CPHY25

(Six Credit Course –12 Hours per week)

(Effective from June-2020)

Course Objectives:

- To learn by performing the experiments based on principles and applications of the theoretical courses.
- To have working knowledge of equipments like CRO, Interferometer and electronic circuits.
- To have the working knowledge of experiments related to optics, solid state physics, electrodynamics, analog and digital electronics etc.
- To have ability to solve problems through numerical methods.

Section: A

List of Practical:

1. Hall effect (constant magnetic field)
2. Capacitance by de Sauty's method
3. Phage angle by C. R. O.
4. Constants of ballistic galvanometer
5. Low resistance by ballistic galvanometer
6. Four probe method
7. Hysteresis curve
8. Resonance pendulum

Section: B

List of Practical:

1. Astable and Monostable Multivibrator
2. MOSFET characteristics
3. Class A amplifier
4. Operational amplifier (Inverting and non inverting modes)
5. Frequency response of OpAmp
6. Logic gates (discrete and IC based AND, OR,NOT NAND and NOR gates)
7. Flip-flops (RS, JK, D)
8. Amplitude modulation and demodulation

Section: C

List of Practical:

1. Michelson interferometer
2. Thickness of a thin wire using optical bench
3. Determination of lattice parameter by X-ray from a photograph (powder method)
4. Dissociation of I_2 molecule
5. Solar cell characteristics
6. Searl's Goniometer (Fixed distance)
7. Diagonalization of a matrix (Jacobi method)
8. Numerical differentiation (computer related)

Note: Minimum 80% practical should be performed. To provide flexibility up to the maximum of 20% of total experiments can be replaced/ added to the list by respective college.

Learning Outcomes:

By the end of the course, the students will have the ability and knowhow related to,

- The operation and functions of CRO, Interferometer, electronic circuits etc.
- The various properties of materials like resistivity, Hall coefficient, energy band gap, thickness of film etc.
- The numerical methods to analyze the observational data as well as the applications of numerical methods to solve dynamics of Physics problems.

Books Recommended:

1. Advanced Practical Physics for students
   B L Wosnop and H T Flint, Methuen and Co. Ltd., London
2. B.Sc. Practical Physics
   C L Arora, S.Chand & Co. Ltd., New Delhi
3. Advanced Practical Physics
   M S Chauhan and S P Singh, Pragati Prakashan, Meerut
4. Advanced Practical Physics
   S L Gupta and V Kumar, Pragati Prakashan, Meerut
5. An advanced course in practical Physics
   D Chattopadhyay and P C Rakshit, New Central book agency Pvt. Ltd.

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120
B.Sc. (Semester - 5)
Subject: Physics
Course: US05DPHY26

Renewable Energy Sources

(Two Credit Course –2 Hours per week)
(Effective from June-2020)

Course Objectives:

- To make the students aware about the different renewable energy sources such as solar, geothermal, wind and fuel cells and technological advancements in this field.
- To make the students aware of the importance of using nonconventional energy resources and their utilization for the present day and future energy needs.

UNIT- I Solar Thermal Energy Conversion Systems

Introduction-Subsystems, Solar Thermal Collectors, Characteristics features of a collectors, Important aspects of solar thermal Collectors, Collector Efficiency, Simple Flat plate Collectors, Installation of Flat Plate Collectors, Guidelines for Installation, Shadow Effect, Cosine loss factor and reflective Loss Factor, Heliostats with Central Receiver, Heat Transfer-fluid. **Solar Photovoltaic Systems**: Introduction to Photovoltaic systems, Merits and Limitations of Solar PV Systems, V-I characteristics of Solar Cell and Efficiency of a solar cell, Configuration of a solar PV Panel, Small and Large PV systems.

UNIT- II Geothermal Energy and Wind Energy-Fundamentals and Applications

Geothermal Energy: Introduction, Application, Geothermal Energy Resources, Origin of Geothermal Resources, Hydro Geothermal Resources. Wind Energy- Fundamentals and applications: Introduction of Wind Energy, Wind power density, Power in a wind stream, Wind turbine Efficiency, Power of a wind Turbine for given incoming Wind Velocity, Types of wind turbine –Generator Units, Mono-Blade Horizontal axis Wind turbine (HAWT), Twin- Blade Horizontal axis Wind turbine (HAWT) and Three-Blade Horizontal axis Wind turbine (HAWT).

UNIT- III Tidal Energy Conversion and Ocean Energy Technology

Tidal Energy Conversion: Introduction-Tidal range, high and low Tides, Tidal Energy Conversion, Tidal Power Ocean Energy Technology: Introduction to Energy from Ocean, Ocean Energy Resources, Ocean Thermal Energy, Ocean Waves, Ocean Tides, Advantages and Limitations of Ocean Energy Conversation Technologies, Ocean Energy Routes.

UNIT- IV Fuel Cells and Fuel Cell Power Plants

Introduction, Advantages of Fuel Cell Power Sources, Theory of Electro-Chemistry applied to fuel Cells, Principle and Operation of fuel Cells,H_2-O_2 Acidic fuel Cell, Alkaline H_2-O_2 fuel Cell, Classification and Types of Fuel Cells, Fuels for Fuel Cells, Performance Characteristics of Fuel Cells-Voltage V_c.-Current Density I_d Characteristic (Polarization Curve), Power per cell P_c, Cell Efficiency.

Learning Outcomes:

At the successful completion of the course, the students will be able to understand

- The various sources of renewable energy and their conversion methods.
- They will be able to gain the knowledge of various fuel cells and power plants.

Books Recommended:

1. Instrumentation Measurement and Analysis
   B C Nakra and K K Chaudhary
   Tata McGraw Hill Publishing Co. Ltd., New Delhi
2. Biomedical Instrumentation
   R S Khandpur (2nd Edition)
   Tata McGraw Hill Publishing Co. Ltd., New Delhi
3. Energy Technology Nonconventional, Renewable and Conventional
   S Rao and Dr. B B Parulekar
   Khanna Publishers

SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar-388120
B.Sc. (Semester - 5)
Subject: Physics
Course: US05DPHY27

Astronomy and Astrophysics

(Two Credit Course –2 Hours per week)
(Effective from June-2020)

Course Objectives:

- To create awareness about astronomy and astrophysics in relation to our universe
- To provide the fundamental knowledge of stars in general and our sun in particular.
- To provide observational methods to get information about planets, binary, multiple stars and our galaxy.

Unit-I Basic concepts of Astronomy and Astrophysics

Mass, length and time scale in Astrophysics, Celestial coordinates, Sources of astronomical information. Astronomy in different bands of electromagnetic radiation. The Earth's atmosphere and the electromagnetic radiation, Optical telescopes, Radio telescope, The Hubble Space Telescope (HST), Detectors and image processing

Unit-II Fundamentals of Stars and Sun

Stellar magnitude sequence, Absolute magnitude and the distance modules, The bolometric magnitude, The colour index of a star, Luminosities of stars, Harvard system of spectral classification: Henry Draper (H-D) catalogue, The Hertzsprung – Russell (H - R) diagram **The Sun:** Sun - a typical star, The photosphere: limb-darkening, Solar granulation, Faculae, Chromospheres, Solar Corona, Prominences, Solar flares, Solar wind.

Unit-III Binary and Multiple Stars

Introduction to binary and multiple stars, Visual binary, Spectroscopic binary, Eclipsing binary, Multiple Stars, Origin of binary stars, Stellar masses and mass-luminosity relation, Mass transfer in close binary systems

Unit-IV Our Galaxy

Introduction to our galaxy, The general structure of the Galaxy, Central region and nucleus, The Galactic Disc, The Galactic Halo, The mass of the Galaxy, Cosmic Rays, Continuous radio emission in the Galaxy

Learning Outcomes:

At the end of the course, the students will have the knowledge of

- Basic concept of astronomy and astrophysics and working of various tools used in astronomical observations, their sensitivity and applications.
- The Physical properties of our sun, the characterization of stars, evolution of stars etc.
- Galaxies including Milky way galaxy and other cosmic events.

Books Recommended:

1. An Introduction to Astrophysics
   Baidyanath Basu, Tanuka Chattopadhyay and Sudhindra Nath Biswas (2nd Edition)
   PHI learning Private Limited, Delhi
2. Astrophysics for Physicists
   Arnab Rai Choudhuri, Cambridge University Press, New Delhi