Girijananda Chowdhury University, Assam

Course Structure and detailed syllabi for three semesters for

Four Year Under Graduate Programme (FYUGP) in Physics

SUMMARISED COURSE STRUCTURE									
SEM	**DSC (Major)**	**DSC (Minor)**	**MDC**	**AEC**	**SEC**	**VAC**	**Internship/ Dissertation/ project**	**Credit**	**Exit option**
I	4	4+4	3	2	3	2		22	Certification
II	4	4+4	3	2	3	2		22	
III	4	4+4	3	2	3	-		20	Diploma
IV	16	-	-	2		2		20	
V	16	-	-		-		4	20	Bachelor Degree
VI	20	-	-	-	-	-		20	
Credit							**Total**	**124**	
VII	8	4+4	-	-	-	-	Project/Dissert ation I (4)/ Core(4)	20	Bachelor Degree (Honours)/ Honours (with Research)
VIII	12	-	-	-	-	-	Project/Dissert ation II (8)/ Core(4+4)	20	
Credit							**Total**	**164**	

YEAR – 1

First Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Introductory Physics	Core	4-0-0	4
	*MINOR-1	Minor	4-0-0	4
	*MINOR-2	Minor	4-0-0	4
	**MDC-I	MDC	3-0-0	3
	AEC-I	AEC	2-0-0	2
	SEC-I	SEC	3-0-0	3
	VAC-I	VAC	2-0-0	2
			TOTAL	22

Second Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Physics in Everyday Life	Core	4-0-0	4
	*MINOR-3	Minor	4-0-0	4
	*MINOR-4	Minor	4-0-0	4
	**MDC-II	MDC	3-0-0	3
	AEC-II	AEC	2-0-0	2
	SEC - II	SEC	3-0-0	3
	VAC -II	VAC	2-0-0	2
			TOTAL	22

EXIT OPTION WITH CERTIFICATION. However, such students who desire to exit after 1 year of study need to undertake a vocational course (4 credits).

*Refer AnnexureI, **Refer AnnexureII

YEAR – 2

Third Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Mathematical Physics-I	Core	3-0-2	4

	*MINOR-5	Minor	3-0-2	4
	*MINOR-6	Minor	4-0-0	4
	**MDC-III	MDC	3-0-0	3
	AEC – III	AEC	2-0-0	2
	SEC - III	SEC	3-0-0	3
			TOTAL	20

Fourth Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Mechanics and Properties of Matter	Major	4-0-0	4
	Electricity and Magnetism	Major	4-0-0	4
	Mechanics and Properties of Matter - Lab	Major	0-0-4	2
	Electricity and Magnetism-Lab	Major	0-0-4	2
	***Elective-1	Major	In Annexure III	4
	AEC-IV	AEC	2-0-0	2
	VAC-III	SEC	2-0-0	2
			TOTAL	20

*** Refer Annexure-I, ** Refer Annexure-II, ***Refer Annexure-III**

N.B: Course Codes of the courses offered from department is provided.

EXIT OPTION WITH DIPLOMA. However, such students who desire to exit after 2 years of study need to undertake a vocational course (4 credits).

YEAR – 3

Fifth Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Analog Electronics	Major	4-0-0	4
	Waves and Optics	Major	4-0-0	4
	Analog Electronics-Lab	Major	0-0-4	2

	Waves and Optics-Lab	Major	0-0-4	2
	***Elective-2	Major	4-0-0	4
	Internship	Major	0-0-8	4
			TOTAL	20

***Refer Annexure III

Sixth Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Thermal Physics	Major	4-0-0	4
	Digital Electronics	Major	4-0-0	4
	Quantum Mechanics	Major	4-0-0	4
	Thermal Physics- Lab	Major	0-0-4	2
	Digital Electronics-Lab	Major	0-0-4	2
	***Elective-3	Major	4-0-0	4
			TOTAL	20

***Refer Annexure III

EXIT OPTION WITH THREE YEARS BACHELOR'S DEGREE

(A)FOUR YEARS BACHELOR'S DEGREE (HONOURS)

Seventh Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Condensed Matter Physics	Major	3-0-2	4
	Research Methodology	Major	4-0-0	4
	***Elective-4	Major	4-0-0	4
	*MINOR-7	Minor	3-0-2	4
	*MINOR-8	Minor	3-0-2	4
			TOTAL	20

*Refer Annexure I, *** Refer Annexure III

Eight Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Electromagnetic Theory	Major	3-0-2	4
	Statistical Mechanics	Major	3-0-2	4

	Modern Physics	Major	3-0-2	4
	Introductory Astrophysics	Major	4-0-0	4
	Mathematical Physics-II	Major	4-0-0	4
			TOTAL	20

EXIT OPTION WITH FOUR YEARS BACHELOR DEGREE (HONOURS)

(B)FOUR YEARS BACHELOR'S DEGREE (HONOURS WITH RESEARCH)

Seventh Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Condensed Matter Physics	Major	3-0-2	4
	Research Methodology	Major	4-0-0	4
	Research Project(Phase-I)	Major	0-0-8	4
	*MINOR-7	Minor	3-0-2	4
	*MINOR-8	Minor	3-0-2	4
			TOTAL	20

***Refer Annexure I**

Eight Semester				
Code	**Course**	**Category of Course**	**L-T-P**	**Total Credit**
	Electromagnetic Theory	Major	3-0-2	4
	Statistical Mechanics	Major	3-0-2	4
	Modern Physics	Major	3-0-2	4
	Research Project(Phase-II)	Major	0-0-16	8
			TOTAL	20

EXIT OPTION WITH DEGREE (HONOURS WITH RESEARCH)

LIST OF COURSES:

ANNEXURE-I: (MINOR COURSES)				
Course	**Semester**	**Name of the Course**	**L-T-P**	**Total Credit**
MINOR-1	I	Introductory Physics	4-0-0	4
MINOR-2	I	Renewable Energy Resources	4-0-0	4
MINOR-3	II	Physics in Everyday Life	4-0-0	4
MINOR-4	II	Atmospheric Physics	4-0-0	4

MINOR-5	III	Mathematical Physics-I	3-0-2	4
MINOR-6	III	Sports Science	4-0-0	4
MINOR-7	VII	Mechanics	3-0-2	4
MINOR-8	VII	Electricity, Magnetism and Electromagnetic Theory	3-0-2	4

ANNEXURE-II: (MDC COURSES)				
Course	**Semester**	**Name of the Course**	**L-T-P**	**Total Credit**
MDC-1	I	Physics For All	3-0-0	3
MDC-2	II	Physics of Earth	3-0-0	3
MDC-3	III	Indian Contribution to Science	3-0-0	3

ANNEXURE-III: (ELECTIVE COURSES)					
Course	**Semester**	**Name of the Course**	**Course Code**	**L-T-P**	**Total Credit**
Elective-1	IV	(a) Laser and Nonlinear Optics		4-0-0	4
		(b) Computational Physics		3-0-2	
		(c) Introduction into Nanoscience		4-0-0	
Elective-2	V	(a) Sustainability Science		4-0-0	4
		(b) Crystal Analysis		4-0-0	
Elective -3	VII	(a) Plasma Physics		4-0-0	4
		(b) Spectroscopy		4-0-0	
Elective -4	VIII	(a) Nuclear Physics		4-0-0	4
		(b) Advanced Quantum Mechanics		4-0-0	

Detailed Syllabi for six semesters:

SEMESTER-I

DSC (Major+Minor)	**Introductory Physics**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Pre-requisite: Basic Science					
Course Objectives:					

1. To provide the fundamental knowledge of measurements and dimensions
2. To enable students to develop an understanding of different types of matter and their properties.
3. To make students familiar with motion, force and work from the point of view of Physics
4. To introduce the basic ideas about sound propagation through various media.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: remember the units of fundamental quantities, the basic constituents and nature of matter, motion , force, work and sound.

CO 2: understand the fundamental properties of matter, gravitational forces, work done and sound.

CO 3: analyse the action of forces on bodies and energy and work done.

CO 4: apply the knowledge gained to measure fundamental physical quantities.

Module 1: PHYSICAL WORLD AND ITS MEASUREMENTS	**8 hours**

Physics and its scope, Units and Measurements, Errors in Measurements, Dimensional Analysis

Activity :

1) To measure fundamental quantities – length (using slide calipers), diameter (using screw gauge), time (using stop clock), weight (using physical balance)

Module 2: MATTER – NATURE AND BEHAVIOUR	**20 hours**

Definition of matter, solid, liquid and gas, characteristics – shape, volume and density, change of state – melting (absorption of heat, freezing, evaporation, condensation, sublimation

Elements, compounds and mixtures – heterogeneous and homogeneous mixtures

Atoms and molecules, Chemical formula for common compounds, atomic and molecular masses

Electrons, protons and neutrons, valency, atomic number and mass number, isotopes and isobars.

Activity :

1) Determination of melting point of ice and boiling point of water.

2) Preparation of mixture and compound

Module 3: MOTION, FORCE AND WORK	**22 hours**

Distance and displacement, velocity, uniform and non-uniform motion along a straight line, acceleration, distance-time and velocity-time graphs for uniform motion and uniformly accelerated motion, elementary idea of uniform circular motion.

Gravitation, Universal Law of Gravitation, force of gravitation of the earth (gravity), acceleration due to gravity, mass and weight, free fall

Work done by a force, energy, power, kinetic and potential energy, Law of conservation of energy (excluding commercial unit of energy)

Module 4: SOUND	**10 hours**

Nature of sound and its propagation through various media, speed of sound, range of hearing in humans, ultrasound, reflection of sound, echo

Total Lecture hours	**60 hours**
Activity : 1) Determination of melting point of ice and boiling point of water. 2) Preparation of mixture and compound.	

Text Book(s)

1.	Science Textbook for classes IX and X, NCERT Publication
2.	Physics, Part I for class XI, NCERT Publication

Reference Books

1.	Fundamentals of Physics, David Halliday, Robert Resnick, Jearl Walker, (John Wiley & Sons Inc.)

DSC (Minor)	Renewable Energy Resources	L	T	P	C
		4	0	0	4

Pre-requisite: Basic Science

Course Objectives:

1. To provide knowledge about the depleting non-renewable energy sources and alternative energy sources
2. To enable students to develop an understanding of the different applications of renewable energy
3. To make students aware of wind energy and its harvesting and solar energy
4. To develop fundamental idea regarding ocean energy and its potential as an energy resource.
5. To provide fundamental knowledge regarding geothermal energy and hydro energy.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: understand and appreciate the need to shift to renewable energy resources.

CO 2: remember the fundamentals of fossil fuels, solar energy, wind energy, ocean energy and geothermal and hydro energy.

CO 3: analyze the harvesting of non-conventional sources of energy.

CO 4: apply the knowledge of renewable energy resources gained to practical situations.

Module 1: FOSSIL FUELS AND ALTERNATE SOURCES OF ENERGY — **9 hours**

Fossil fuels and nuclear energy and their limitation, need of renewable energy, non-conventional energy sources. An overview of developments in offshore wind energy, tidal energy, wind energy systems, solar energy, biomass, biochemical conversion, biogas generation, hydroelectricity

Module 2: SOLAR ENERGY — **18 hours**

Solar energy, its importance, storage of solar energy, solar pond, solar water heater, solar cooker, solar green houses, solar cell, absorption air conditioning, need and characteristics of photovoltaic(PV) systems, PV models and equivalent circuits, sun tracking systems.

Activity :

1) To build a solar greenhouse

2) To build a solar box cooker

Module 3: WIND ENERGY HARVESTING — **18 hours**

Fundamentals of wind energy, wind turbines and different electrical machines in wind turbines, power electronic interfaces and grid interconnection topologies, wind energy conversion, wind mill, basic components of wind mill conversion system, types of wind mills, conversion and efficiency.

Activity :

3) To construct a vertical wind turbine.

Module 4: OCEAN ENERGY — **8 hours**

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

Module 5: GEOTHERMAL ENERGY AND HYDRO ENERGY — **7 hours**

Geothermal resources, geothermal technologies

Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

Total Lecture hours — **60 hours**

Text Book(s)

1. Non-conventional Energy Sources – G. D Rai, Khanna Publications, 2001
2. Non-conventional Energy Resources – B. H. Khan, McGraw Hill, 3rd edition, 2017

Reference Books

1. Solar Energy – Suhas P. Sukhative, Tata McGraw Hill Publishing Company Limited.
2. Wind Energy System – Gary L. Johnson, Printice Hall Inc., New Jersey, 1985.

MDC	**PHYSICS FOR ALL**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite: Preliminary concept of Science and Mathematics.

Course Objective

(1)To enhance the fundamental knowledge of systems of units to be used in daily life.
(2) To have a broader concept of laws to understand planetary motion, satellites and Global Positioning System.
(3)To enhance the knowledge of basics heat and thermodynamics and understanding basics of home appliances.
(4) To enhance the knowledge of sound and its propagation.
(5) To develop the concept of different phenomena associated with light.

Course Outcome:

After successful completion of the course, the students will be able

CO1: to learn different units and laws connected with motion, heat, sound, light.
CO 2: to understand the basics of kinematics, sound, heat and light.
CO 3: to apply the concepts of physics in understanding the mechanism of various instruments.
CO 4: to apply the concepts of basic physics to learn the various facts about nature.

Module 1: Units and Measurements	**10 hours**
CGS, FPS, MKS, SI system of units, their inter conversion relations, Dimensional formula of physical quantities. Dimension analysis and its applications to simple problems, Problems on conversion among system of units, . Measured value and absolute value; Accuracy and Precision, Error in measurement and its Types, Error estimation formulae.	
Module 2: Mechanics	**10 hours**
Scalar and Vector quantities, distance, displacement, speed, velocity, acceleration, Circular motion, rotational motion , preliminary idea of angular displacement, velocity, Planetary motion, Gravitational force, acceleration due to gravity in different places, concept of inertia, Newton's laws, natural and artificial satellites, examples, introduction to global positioning system	
Module 3: Heat	**9 hours**
Concepts of Heat and Tempearture, Units of temperature: Centigrade, Fahrenheit and Kelvin scale, their inter-conversion formulae, Heat transfer processes: conduction, convection and radiation, explanation of change of states of matter, working principles of Refrigerator, Air Conditioner, Microwave Oven.	
Module 4: Sound	**8 hours**
Longitudinal nature of sound, Frequency, and its unit and Pitch, Loudness and Intensity, Production and detection of sound , Audible frequency range, infrasonic and ultrasonic sounds, Noise and Music, Principle of Loudspeaker and Microphone, vibration and production of sound in Musical Instruments	
Module 5: Light	**8 hours**
Reflection, Refraction and Dispersion of light, Application of formation of images by plane mirror, convex and concave mirror, formation of rainbow, scattering of colours during sunrise and sunset, blue colour of sky, light production in bulb, different types of light bulbs, Laser, LED, Solar spectrum	
Total Lecture hours	**45 hours**

Text Book(s)

1.	Conceptual Physics, Paul G. Hewitt, Pearson Education, 2017.

2	Physics Made Simple: A complete Introduction to the basic principles of this fundamental science, Christopher G. De Pree, Crown Publisher, 2005
3.	Concept of Physics, H.C Verma, Bharat Bhawan Publisher, 2021
Reference Books	
1.	The Basics of Physics, Rusty L. Myers, Greenwood Press, 2005
2.	AK Basics of Physics, Anil Kumar Kakodiya, 2023.

SEMESTER-II

DSC (major+ minor)	**PHYSICS IN EVERYDAY LIFE**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Pre-requisite: Preliminary concept of Science and Mathematics

Course Objectives:

(1) To enhance the fundamental knowledge of laws of motion which is helpful to understand the excitement in related activities of life.
(2)To have an overview of heat and temperature in understanding the theory behind thermometers, woodstoves etc.
(3)To develop a concept on sound waves to relate with different instruments.
(4)To create more awareness about electricity and magnetism to relate the theory to practical life.
(5)To enhance the theory of light propagation, formation of images, lasers etc.

Course Outcome:

After successful completion of the course, the students will be able
CO1: to understand the basic concepts of Physics to understand the dynamics of objects, heat and thermodynamics, sound, electricity and magnetism and light.
CO 2: to apply the fundamentals of Physics to various instruments we use in our daily life.
CO 3: to distinguish between different theories applied in applications in various instruments.
CO 4: to identify the laws of physics behind various natural phenomena and activities.

Module 1: The laws of motion	**15 hours**
Skating: Inertia, vector quantities, position, velocity, force, acceleration, mass, net force, Newton's first and second laws, inertial frames of reference, unit Falling Bodies: gravity, weight, uniform acceleration, projectile motion, vector components, support forces, Newton's third law, energy, work, conservation of energy, kinetic and potential energies, gravitational potential energy, ramp & its mechanical advantage Seesaws: rotational inertia; angular velocity; torque; angular acceleration; rotational mass, net torque; Newton's first, second, and third laws of motion; centres of mass and gravity; levers; balance Rockets and Space Travel: reaction forces, law of universal gravitation, elliptical orbits, escape velocity, Kepler's laws, speed of light, concepts of general and special relativity, equivalence principle. (Explanation is to be done with related experiments)	
Module 2: Heat and Temperature	**10 hours**
Scales: Thermal energy, Heat and Temperature, different scales of measuring temperature & their relations. Woodstoves: thermal equilibrium, chemical bonds and reactions, conduction, thermal conductivity, convection, radiation, heat capacity Water, Steam and Ice: phases of matter, phase transitions, melting, freezing, condensation, evaporation, relative humidity, latent heats of melting and evaporation, sublimation, deposition, boiling, Airconditioners.	

(Explanation is to be done with related experiments)	
Module 3: Sound	**10 hours**
Waves: wave motion, transverse and longitudinal waves. Clocks : time and space, natural resonance, harmonic oscillators, simple harmonic motion and its frequency, period, amplitude Musical Instruments: sound; music; vibrations in strings, air, and surfaces; fundamental and higher-order modes; harmonic and non harmonic overtones; sympathetic vibration; standing and travelling waves; transverse and longitudinal waves; velocity and wavelength of mechanical waves; superposition, different types of musical instruments (Explanation is to be done with related experiments)	
Module 4: Electricity and magnetism	**15 hours**
Static Electricity: electric charge, electrostatic forces, Coulomb's law, electrostatic potential energy, voltage, charging by contact, electric polarization, electrical conductors and insulators Current: electric current; electric circuits; direction of current flow; electrical resistance; voltage drops; voltage rise; relationship among current, voltage, and power; Ohm's law; resistors and their series and parallel combinations. Household Magnets: earth as a magnet, magnetic pole, magnetostatic forces, Coulomb's law for magnetism, ferromagnetism, magnetic polarization, magnetic domains, magnetic materials, magnetic fields, magnetic flux , relationship between electric and magnetic fields Electric power distribution: direct and alternating currents, superconductivity, transformers, induction, magnetic field energy, relationship between changing magnetic fields and electric fields, Lenz's law, inductors, induced emf, electrical safety, generators, motors (Explanation is to be done with related experiments)	
Module 5: Light	**10 hours**
Reflection and refraction, index of refraction, dispersion, and interference in electromagnetic waves Cameras: eye and camera, refracting optics, converging lenses, real images, focus, focal lengths, f-numbers, the lens equation, diverging lenses, virtual images, light sensors, vision and vision correction, different types of defects in human eye. LEDs and Lasers, optical fibres, metals, insulators, and semiconductors; photoconductors; p-n junction diodes; light-emitting diodes; incoherent and coherent light; spontaneous and stimulated emission; population inversion; laser amplification and oscillation; laser safety, optical fibre: structure and light propagation (Explanation is to be done with related experiments)	
Total Lecture hours	**60 hours**

Text Book(s)

1.	Physics in our daily lives, Umme Ammara, gurucool publishing
2	The Physics of Everyday Things, James KaKalios, RH US(2017)
3.	Physics in Everyday Life, Shaswant Goswami, Vedang Sati, (2016)
4.	How Things Work The Physics of Everyday Life, Louis A. Bloomfield, Wiley publishing(WileyPLUS)

Reference Books

1.	Feynmann Lectures on Physics , Matthew Sands, Richard Feynmann and Robert B.LeightonVol I, Vol II, Vol III.
2.	Storm in a Teacup: The Physics of Everyday Life, Helen Czerski, Publisher Black Swan

DSC (Minor)	**Atmospheric Physics**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Pre-requisite: Basic Physics

Course Objectives:

1. To provide fundamental knowledge regarding the earth's atmosphere
2. To give an in-depth introduction of atmospheric thermodynamics
3. To introduce atmospheric aerosols and analyse its impact on the global climate
4. To introduce students to different methods of atmospheric observation

Course Outcome:

After successful completion of the course, the students will be able to

CO1: understand the fundamentals of the earth's atmosphere and its thermodynamics, aerosols and cloud

CO 2: remember the laws involving thermodynamics, scattering and dissipation mechanism.

CO 3: analyse atmospheric observations

CO 4: apply the knowledge gained to make atmospheric observations.

Module 1: INTRODUCTION TO EARTH'S ATMOSPHERE	**14 hours**

State of the earth's atmosphere: main constituents of dry air, CO2, ozone, water vapour, aerosols; vertical thermal structure of the atmosphere : troposphere, stratosphere, mesosphere, thermosphere and exosphere; environmental lapse rate, hydrostatic equilibrium, hydrostatic equation

Module 2: ATMOSPHERIC THERMODYNAMICS	**18 hours**

Gas Laws, Ideal Gas Law, Dalton's Law, First Law of Thermodynamics, equivalence between heat and work, thermal capabilities, isothermal, isochoric, isobaric transformation, adiabatic transformation, Poisson relation, thermodynamic properties of water, latent heat, Clausius-Clapeyron's relation, Approximation and consequences of Clausius-Clapeyron relation, moist air, mean molecular weight of dry and moist air.

Module 3:AEROSOL AND CLOUD	**14 hours**

Classification of atmospheric aerosol, production and removal mechanisms, concentration and size distribution, adsorption and scattering of solar radiation, Rayleigh scattering and Mie scattering, Beer-Bouguer-Lambert Law

Macro and microphysical characteristics of cloud: droplet growth and cloud dissipation mechanism, radiative transfer in cloudy atmosphere, role of aerosol and cloud in climate.

Module 4: ATMOSPHERIC OBSERVATIONS	**14 hours**

General principles of meteorological measurements and observational procedures, conventional and self recording measurements of atmospheric variables, upper air measurements: pilot balloons, radiosonde, ozonesonde, GPS sonde.

Surface based remote sensing: working principle and applications of LIDAR, SONAR, Water RADAR, radiological satellites, multiscanner radio-meters and their applications in the observation of weather parameters.

Total Lecture hours	**60 hours**

Text Book(s)

1.	Physics of the Atmosphere and Climate – Murray L. Salby, Cambridge University Press
2.	Introduction to Atmospheric Physics – D.G. Andrews, Cambridge University Press

Reference Books

1.	An Introduction to Dynamic Meteorology- Vol. 1., James R. Holton.
2.	Remote Sensing of Aerosols, Clouds and Precipitation – T. Islam, Y. Hu, A. A. Kokhanovsky, J. Wang (Eds.) Elsevier

MDC	**Physics of the Earth**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**

Pre-requisite: Basic Physics

Course Objectives:

1. To provide fundamental knowledge regarding the earth and the universe
2. To give an in-depth introduction structure of the earth and its components

3. To introduce dynamical processes related to solid earth, hydrosphere, atmosphere and biosphere
4. To make students aware of different factors disturbing the earth's ecosystem

Course Outcome:

After successful completion of the course, the students will be able to

CO1: understand the fundamentals of planet earth, its structure, the dynamical processes involved and the factors disturbing its stability.

CO 2: remember various aspects of the structure earth and the universe

CO 3: analyse the origin of the universe and planet earth, its magnetic field, ocean circulations.

CO 4: evaluate the dynamical processes and factors disturbing the stability of the earth.

Module 1: THE EARTH AND THE UNIVERSE	**12 hours**

Origin of universe, creation of elements and earth. A holistic understanding of our dynamic planet through Astronomy, Geology, Meteorology and Oceanography.

General characteristics and origin of the universe, the Big Bang Theory. Age of the universe and Hubble constant, formation of galaxies, earth's orbit and spin, Asteroids: origin, types and examples, meteorites and asteroids, earth in the solar system, origin, size, shape, mass, density, rotational and revolution parameters and its age.

Module 2: STRUCTURE	**11 hours**

The Solid Earth: Mass, dimensions, shape and topography, internal structure, magnetic field, geothermal energy

The Hydrosphere: The oceans, their extent, depth, volume, chemical composition, river systems

The Atmosphere: Layers, variation of temperature with altitude, variation of density and pressure with altitude, cloud formation

The Cryosphere: Polar caps and ice sheets, mountain glaciers, permafrost.

Module 3: DYNAMICAL PROCESSES	**15 hours**

The Solid Earth: Origin of the magnetic field, source of geothermal energy, convection of the earth's core and production of its magnetic field, mechanical layering of the earth, introduction of geophysical methods of earth investigation, concept of plate tectonics; types of earth movements, Earthquake and earthquake belts, Richter scale, geophones.

Hydrosphere: Ocean circulations, oceanic current system and effect of Corioli's force, tides, tsunamis

The Atmosphere: Atmospheric circulation, weather and climate changes, earth's temperature and greenhouse effect **Biosphere**: water cycle, carbon cycle

Module 4: DISTURBING THE EARTH	**7 hours**

Contemporary dilemmas – (a) human population dynamics (b) Atmosphere: greenhouse gas emissions, climate change, air pollution (c) Hydrosphere: fresh water depletion, water pollution (d) Geosphere: chemical effluents, nuclear waste (e) Bioshpere: biodiversity loss, deforestation. Robustness and fragility of ecosystems.

Total Lecture hours	**45 hours**

Text Book(s)

1.	Physics of the Earth, Frank D. Stacey, Paul M. Davis, 2008, Cambridge University Press
2.	Planet Earth, Cosmology, Geology and the Evolution of Life and Environment, C. Emiliani, 1992, Cambridge University Press.

Reference Books

1.	The Blue Planet : An Introduction to Earth System Science, Brian J. Skimnner, Stephen C. Portere, 1994, John Wiley & Sons
2	The Solid Earth: An Introduction to Global Geophysics, C. M. R. Fowler, 1990, Cambridge University Press

SEMESTER-III

DSC (Major+Minor)	Mathematical Physics I	L	T	P	C
		3	0	2	4

Pre-requisite: Basic Physics and Mathematics

Course Objectives:

1. To provide the fundamental knowledge of calculus and differential equations.
2. To enable students to learn different properties vectors and their differentiation and integration.
3. To make students familiar with orthogonal curvilinear coordinates.
4. To introduce the dirac delta function and its properties.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: Understand the fundamentals of calculus, vector differentiation and vector integration.

CO 2: Apply the knowledge of Calculus to solve simple problems.

CO 3: Remember expressions of gradient, divergence and curl in orthogonal curvilinear coordinates.

CO 4: understand the properties of Dirac Delta function

Module 1: CALCULUS — **15 hours**

Recapitulation: Differentiation, plotting of functions, intuitive ideas of continuous, differentiable etc. functions and plotting of curves. Approximation: Taylor and Binomial series (statements only)
First Order and Second Order differential equations: First Order differential equations and Integrating factor. Homogeneous equations with constant coefficients, Wronskian and general solution.
Calculus of functions of more than one variable: Partial derivatives, exact and inexact differentials. Integrating factor , with simple examples.

Module 2: VECTOR CALCULUS — **18 hours**

Properties of vectors, Scalar product and vector product, scalar triple product and their interpretation in terms of area and volume, respectively. Scalar and vector fields.
Vector differentiation: Directional derivatives and normal derivatives. Gradient of a scalar field and its geometrical interpretation. Divergence and curl of a vector field. Del and Laplacian operators, vector identities.
Vector Integration: Ordinary integrals of vectors. Multiple integrals, Jacobian, notion of infinitesimal line, surface and volume elements. Line, surface and volume integrals of vector fields, flux of a vector field. Gauss' Divergence Theorem, Green's and Stokes Theorems and their applications (no rigorous proofs)

Module 3:ORTHOGONAL CURVILINEAR COORDINATES — **7 hours**

Orthogonal curvilinear coordinates. Derivation of gradient, divergence, curl and Laplacian in Cartesian, spherical and cylindrical coordinate systems.

Module 4: DIRAC DELTA FUNCTION AND ITS PROPERTIES — **5 hours**

Definition of Dirac delta function. Representation as a limit of a Gaussian function and rectangular function. Properties of Dirac delta function.

Total Lecture hours — **45 hours**

Text Book(s)

1. Mathematical Methods for Physicists, G.B. Arkfen, H.J. Weber, F.E, Harris, 2013, 7th edition, Elsevier
2. An Introduction to Ordinary Differential Equations, E.A. Coddington, 2009, PHIO Learning.

Reference Books

1. Mathematical Tools for Physics, Lames Nearning, 2010, Dover Publications
2. Mathematical Methods for Scientists and Engineers, S.S. McQuarrie, 2003, Viva Book

Laboratory in Mathematical Physics-I

Prerequisite : Basic Computer Skills
Course Objective :
1) Makes students gain a broad perspective about the uses of computers in engineering industry. . 2) Develops basic understanding of computers, the concept of algorithm and algorithmic thinking. 3) An ability to incorporate exception handling in object-oriented programs. 4) Develops the use of the C programming language to implement various algorithms, and develops the basic concepts and terminology of programming in general
Course Outcome:
CO1: Get the basic knowledge in fundamentals of programming, algorithms and programming technologies and fundamentals of Computer Science. CO2: The course will help to give a basic idea how to Control the sequence of the program and give logical outputs CO3: Construct programs involving decision structures and loops CO4: Get concept of Strings for writing programs related to character array.
List of Experiments :
1) Development of programs using multiple arithmetic and logical operators. Programs for addition, subtraction, multiplication etc. 2) Programs using simple control statements such as if else, while, do while etc. Making a program for a calculator for example. Extracting the digits of an integer, reversing digits, finding sum of digits etc. 3) Programs using For loop, switch statement etc. eg. Finding average of numbers, multiplication of numbers etc. Checking for primes, generation of Armstrong numbers. . 4) Generation of the Fibonacci sequence, finding the square root of a number, calculation of factorials, printing various patterns using for loop. 5) Programs using Arrays: declaring and initializing arrays. Program to do simple operations with arrays. Strings – inputting and outputting strings. Using string functions such as strcat, strlen etc. Writing simple programs for strings without using string functions.
Total Lab Hours : 30 Hours
Text Books :
1) PROGRAMMING IN ANSI C BY E. BALGURUSWAMY, TATA MC-GRAW HILL 2) PROGRAMMING WITH C, SCHAUM SERIES

DSC (minor)	**Sports Science**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Pre-requisite: Preliminary concept of Science and Mathematics					
Course Objectives: **(1)**To enhance the fundamental knowledge of dynamics which is helpful to understand the field of sports like shooting, discuss throw etc. (2) To develop the basic idea on gravitation to understand climbing, scating, swimming etc. (3)To have an outlook on food and nutrition of our body. (4)To enhance the basics of kinesiology, biomechanics and sports. (5)To be aware of mental and physical health for a positive lifestyle.					

Course Outcome:	
After successful completion of the course, the students will be able CO1: to understand the basics of dynamics required for understanding physics behind sports CO 2: to learn the conservation laws to relate with practical field of sports. CO 3: to understand the importance of food and nutrition for good health. CO 4: to understand kinesiology, biomechanics and sports. CO 5: to learn about physical fitness and positive lifestyle.	
Module 1: Dynamics	**15 hours**
Measurement: Physical quantities, Standards and Units, International system of Units, Standards of time, length and mass, Precision and significant figures **Newton's laws of motion**: Newton's first law. Force, mass. Newton's second law. Newton's third law, Mass and weight. Applications of Newton's laws. **Projectile motion**: Shooting a falling target, Physics behind Shooting, Javelin throw and Discus throw.	
Module 2: Gravitation	**10 hours**
Conservation laws: Conservation of linear momentum, collisions – elastic and inelastic. Angular momentum. (Physics behind Carom, Billiards, Racing) **Centre of mass**: Physics behind Cycling, Rock climbing, Skating **Gravitation**: Origin, Newton's law of gravitation, Archimedes's principle, Buoyancy & Physics behind swimming	
Module 3: Health	**10 hours**
Food and Nutrition: Proteins, Vitamins, Fat, Blood pressure. Problems due to the deficiency of vitamins. **Energy:** Different forms of Energy, Conservation of mass-energy **Physical exercises:** Walking, Jogging and Running, Weight management	
Module 4: Kinesiology, Biomechanics & Sports	**15 hours**
Meaning & Importance of Kinesiology & Biomechanics in Physical Education & Sports , Newton's Law of Motion & its application in sports, example of Friction and its effects in Sports, examples, Effect of exercise on the functioning of Various Body Systems. (Circulatory System, Respiratory System, Neuro-Muscular System etc)	
Module 5: Physical Fitness, Wellness & Lifestyle	**10 hours**
Components of Physical fitness, Components of Health related fitness , Components of wellness Preventing Health Threats through Lifestyle Change , Concept of Positive Lifestyle, Introduction to Yoga, mental and physical benefits of yoga.	
Total Lecture hours	**60 hours**
Text Book(s)	
1.	Yakov Perelman. Physics for Entertainment. Createspace Independent Pub, 2010.
2	Yakov Perelman. Physics Everywhere. Prodinnova Publishers, 2014.
3.	Vassilios McInnes Spathopoulos. An Introduction to the Physics of Sports. Createspace Independent Publishing Platform, 2013.
4.	Swaminathan M. Handbook of Food and Nutrition. Bangalore Press. 2012.
Reference Books	
1.	Walter Lewin.
2.	For the Love of Physics. Taxmann Publications Pvt. Ltd., 2012.
.	Srilakshmi B. Food Science. New Age International Pub. 2015.

MDC	**Indian Contribution to Science**	**L**	**T**	**P**	**C**
		3	**0**	**0**	**3**
Pre-requisite: Preliminary concept of Science and Mathematics.					
Course Objectives: **1.** To enhance the knowledge of Indian science from ancient to modern..					

2. To develop interest on ancient discoveries.
3. To identify ancient rituals and relations with modern methods.
4. To gather knowledge about the Nobel Lauretes of Indian origin.
5. To enhance the knowledge of the lives of Indian scientists.

Course Outcome:

After successful completion of the course, the students will be able

CO1: to learn the development of science from ancient to modern India.
CO 2: to learn different fields of science originated in ancient India
CO 3: to learn the traditional Indian customs and rituals, its relation to science, its effect.
CO 4: to know about Nobel Laureates of Indian origin.
CO 5: to know about the life of few scientists of India.

Module 1: India's Contribution to Science and Technology (from Ancient to Modern)	**10 hours**
Proindependence: Water management, Iron and Steel, Farming Techniques and Fertilisers, Physics, Medicine and Surgery, Post Independence: Atomic Energy, Space, Electronics and Information Technology, Oceanography, Biotechnology, Council of Scientific and Industrial Research, The beginning of Indian Astronomy, Chemistry in Early Literature, Medicinal Tradition in Ancient India	
Module 2: Science in Ancient India	**8 hours**
Different studies on plants and animals, Biodiversity and folk traditions, Mathematics in India by early Indian astronomers, early historical period, classical period, Metallurgy in India	
Module 3: Indian Traditional Knowledge	**7 hours**
About nature, flora and fauna, Sacred groves, wildlife, Bishnois and conservation, Ayurveda, elements of nature, ways of treatment, medical instruments in ancient India, yoga, traditional knowledge in relation to science, customs and beliefs in different parts of India, positive and negative side,	
Module 4: Nobel Laureates of Indian Origin	**8 hours**
Sir Ronald Ross, Sir C.V Raman, Subrahmanyan Chandrasekhar, Har Govind Khorana, Venkataraman Ramakrisnan, their contributions.	
Module 5: Lives of few Scientists and their contributions	**12 hours**
Sushruta, Bhaskara II, Aryabhatta, Jagadish Chandra Bose, Acharya Prafulla Chandra Roy, Birbal Sahni, P.C Mahalanobis, Meghnad Saha, Satyendra Nath Bose, Srinivas Ramanujam, Salim Ali,,Panchanan Maheshwari, B.P Pal, Homi Jehangir Bhaba, Kalpana Chawla, Sunita Williams, Smt Anna Mani, E.K Janaki Ammal	
Total Lecture hours	**45 hours**

Text Book(s)

1.	A Short History of Science and Technology In India, Dr Sanjay Sen, Mahabeer Publications, 2019
2.	Doctors, Scientists, & Engineers of Ancient India, S, Narain, Kalpaz Publications, 2017
3.	From the Beginning of Time: Modern Science and the Puranic Universe, Ganesh Swaminathan, 2020

Reference Books

1.	India's Glorius Scientific Tradition, Suresh Soni, Prabhat Prakashan, 2020
2.	The Unknown, Chiranit Majumdar, Notion Press Media Pvt Ltd, 2022
3.	Lilavati's Daughters: The Women Scientists of India, Edited by Rohini Godbole and Ram Ramaswamy, Published by Indian Academy of Sciences, ISBN 978-81-8465-005-1

SEMESTER IV

DSC	MECHANICS AND PROPERTIES OF MATTER	L	T	P	C
		4	0	0	4

Pre-requisite: 12th standard Physics course

Course Objective

(1) aims to understand the concepts of fundamentals of dynamics.
(2) to be familiar with rotational motion and different parameters related to it to understand the concepts behind it.
(3) enhance the knowledge on gravitation and its related areas by understanding laws and theory behind pendulum.
(4) to have a broader perspective about the flow of liquids in viscous medium and capillary tubes.
(5) to enhance the knowledge of elasticity by understanding relations of elastic constants and bending of beams.

Course Outcome:

After successful completion of the course, the students will be able

CO1: to remember different laws which govern the dynamics of a system: a particle, system of particles, planetary motion and fluids.
CO 2: to understand the concepts of fundamentals of dynamics, flow of liquids and elasticity.
CO 3: to apply the concepts of mechanics in different systems.
CO 4: to evaluate the values of different parameters of various physical systems.
CO 5: to differentiate the physical systems by theoretical analysis.

Module 1: Fundamentals of Dynamics — **24 hours**

Reference frames, Reviews of Newton's laws, Inertial and non inertial frames, Rotating frame, Coriolis force, centripetal and centrifugal force, Other effects and applications of centrifugal force, Projectile motion, horizontal range, maximum height attained by a projectile, Dynamics of a system of particles, centre of mass

Galilean transformation equations, Galilean invariance, Lorentz transformation equations, length contraction, time dilation, transformation of velocity.

Uniform circular motion, angular velocity, angular acceleration, couple, work done by a couple, angular momentum, principle of conservation of angular momentum, rotation about a fixed axis, moment of inertia, kinetic energy of rotation, general theorems on moment of inertia, calculation of moment of inertia for rectangular, spherical and cylindrical bodies about different axes.

Module 2: Gravitation — **12 hours**

Newton's laws on gravitation, motion of a particle in central force field(motion in a plane, angular momentum is conserved, areal velocity is constant), Kepler's laws(only statement)

The simple pendulum, compound pendulum, interchangeability of the centres of suspension and oscillation, Kater's reversible pendulum.

Satellite in circular orbit and applications, Geosynchronous orbits, basic idea of global positioning system (GPS), weightlessness, physiological effects on astronauts.

Module 3: Liquids — **12 hours**

Rate of flow of liquid, Bernoulli's equation, Applications of Bernoulli's equation, Viscosity, Poiseulle's equation, critical velocity, motion of a body in viscous medium, Stoke's law.

Molecular force, molecular range, sphere of influence, surface tension, surface film and surface energy, excess pressure inside a liquid drop, rise of liquid in capillary tubes, angle of contact.

Module 4: Elasticity — **12 hours**

Elasticity, Stress and strain, equivalence of a shear to a compression and an extension at right angles to each other, Hooke's law, Different elastic constants, Strain energy per unit volume for different strains, Poisson's ratio, its limit, relation between different elastic constants, twisting couple on a cylinder

Bending of beams, bending moment, cantilever, -loaded at free end, loaded at the middle for different shapes.	
Total Lecture hours	**60 hours**
Text Book(s)	
1.	Mechanics, D.S Mathur, S.Chand and Company Limited, 2000.
2.	Physics, Resnick, Halliday and Walker 8/e.2008, Wiley.
3.	Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, TataMcGraw-Hill.
4.	Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
Reference Books	
1.	Analytical Mechanics, G.R. Fowles and G.L. Classiday.2005, Cengage Learning.
2.	Theoretical Mechanics, M. R. Spiegel, 2006,Tata McGraw Hill.
3.	Physics for Scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning.

DSC	**ELECTRICITY AND MAGNETISM**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Pre-requisite: 12th standard Physics course

Course Objective

(1) aims to enhance the concepts of electrostatics in finding out the electric intensity and electric potential in different charge distributions.
(2) to be familiar with the dielectric properties of matter by understanding the concepts of different parameters.
(3) enhance the knowledge the electromagnetic field to familiar with the concepts of different instruments.
(4) to have a broader perspective about magnetic materials by understanding the theory of different theories.
(5) to enhance the knowledge of circuits, both DC and AC.

Course Outcome:

After successful completion of the course, the students will be able

CO1: to remember different laws associated with electrostatics, magnetostatics, electromagnetic induction and dielectrics.
CO2: to understand the theories related to charge distributions, magnetic and electromagnetic behavior of various substances.
CO3: to apply the concepts of electrostatics, dielectrics and electromagnetic to different systems: charged conductors, motors, molecules, transformers etc.
CO4: to evaluate various parameters associated with charge distributions, magnetic substances, dielectrics and others viz, various instruments.
CO5: to identify the different behaviors associated with various types of substances by theoretical and experimental analysis.

Module 1: Electric Field and Electric Potential	**12 hours**

Electric field and its conservative nature, electric intensity and electric potential, Poisson's and Laplace equations, Gauss's law, applications to charge distributions with spherical, cylindrical and planar symmetry, Mechanical force experienced by unit area of a charged surface, electric intensity and potential due to an electric dipole, capacitance of a system of charged conductors, parallel plate capacitor, cylindrical capacitor, method of images and application to: (1) plane infinite sheet and
(2) sphere.

Module 2: Dielectric Properties of Matter	**12 hours**

Dielectric polarization, dielectric constant and displacement vector, external field of a dielectric medium, the electric field in a material medium, Gauss's theorem in dielectric, electric susceptibility and dielectric constant, dielectric loss, applications of dielectric material, point charge in a dielectric fluid, The Claussius-Mossotti relation, Polar molecules: The Langevin Debye Formula	
Module 3: Electromagnetic Induction and Electrical Circuits	**24 hours**
Faraday's laws on electromagnetic induction, Lenz's law, Self induction, mutual induction, unit of inductance, energy stored in an inductor, motional emf, eddy current, AC generator, DC generator, DC motor, Induction motor, Transformer, energy loss, Determination of self and mutual inductance Helmholtz equation of growth and decay of current in L-R circuit, charging of a condenser, discharging of a condenser through an inductor, charging of a capacitor through L & R, discharge of a capacitor through L & R, AC circuits, operator J, AC circuit containing inductance, AC circuit containing Resistance and Inductance, AC circuit containing Resistance and capacitance, AC circuit containing Resistance, Inductance and Capacitance(series resonance circuit and parallel resonant circuit), Power in an AC circuit	
Module 4: Magnetostatics and Electromagnetic Theory	**12 hours**
Biot-Savart's law and its applications, Magnetic materials, definitions of different parameters, diamagnetic, paramagnetic and ferromagnetic substances, ferromagnetic domains, hysteresis curve, hysteresis loss, calculation from area of hysteresis loop, soft and hard magnetic substances, Langevin theory of diamagnetism, Langevin theory of paramagnetism, Weiss's theory of ferromagnetism, Ampere's law, equation of continuity, Inconsistency of Ampere's law, Maxwell's modifications of Ampere's law, Displacement current, Maxwell's equations, Physical significance.	
Total Lecture hours	**60 hours**
Text Book(s)	
1.	Electricity, Magnetism & Electromagnetic Theory, S. Mahajan and Choudhury, 2012, Tata McGraw.
2.	Electricity and Magnetism, Edward M. Purcell, 1986 McGraw-Hill Education.
3.	Introduction to Electrodynamics, D.J.Griffiths, 3rd Edn.,1998, Benjamin Cummings.
4.	Elements of Electromagnetics, M.N.O. Sadiku, 2010, Oxford University Press.
Reference Books	
1.	Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxfor Univ. Press
2.	Feynman Lectures Vol. 2, R.P. Feynman, R.B. Leighton, M. Sands, 2008, Pearson Education.
3.	Electricity and Magnetism, D C Tayal, 1988, Himalayan Publishing House.

DSC	Mechanics and Properties of Matter - Lab	L	T	P	C
		0	0	4	2

Prerequisite : Basics of 12 standard Physics lab

Course Objective :

1) The Objective of this course is to make the students gain practical knowledge to co-relate with the theoretical studies.
2) To develop the Experimental and Analytical Skills.
3) Understanding of basic physics concepts through direct observation of empirical evidence and hands on learning
4) The laboratory will help students understand the role of direct observation in physics

Course Outcome:

CO1: Learning basic concept of measuring apparatus and gravity of earth by using Kater's pendulum and Bar pendulum
CO2: Get the knowledge of moment of inertia of a body.
CO3: To enhance the knowledge of elasticity and viscosity of materials and liquids.
CO4: The course will help to understand the stress and strain of a materials

List of Experiments :

1) To determine the Modulus of Rigidity of a Wire by Maxwell's needle.
2) To determine the value of g using Bar Pendulum.
3) To find the value of g by using Kater's pendulum
4) To find the moment of inertia of an unknown body by using moment of inertia table.
5) 5) To study the Motion of Spring and calculate (a) Spring constant, (b) g and (c)Modulus of rigidity.
6) To determine the Moment of Inertia of a Flywheel.
7) To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
8) To determine the elastic Constants of a wire by Searle's method
9) To determine the Young's Modulus of a Wire by Optical Lever Method.
10) Determination of the rigidity modulus of the material of a wire by Statical Method.

Total Lab Hours :	60 Hours

Text Books :

1. Mechanics, D.S Mathur, S.Chand and Company Limited, 2000.
2. Physics, Resnick, Halliday and Walker 8/e.2008, Wiley.
3. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, TataMcGraw-Hill.
4. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.

Reference Books:
1. Analytical Mechanics, G.R. Fowles and G.L. Classiday.2005, Cengage Learning. 2. Theoretical Mechanics, M. R. Spiegel, 2006,Tata McGraw Hill. 3. Physics for Scientists and Engineers with Modern Phys., J.W. Jewett, R.A.Serway, 2010, Cengage Learning.

DSC	**Electricity and Magnetism Lab**	**L**	**T**	**P**	**C**
		0	**0**	**4**	**2**

Prerequisite : Basics of 12 standard Physics lab

Course Objective :

1) The students will have a good foundation in the fundamentals related to the experiments included in this course and their advanced applications.
2) The students will get motivated to develop small experiments related to these techniques and develop their physical understanding.
3) Understanding of basic physics concepts through direct observation of empirical evidence and hands-on learning

Course Outcome:

CO1: Learning basic concept of measuring meter bridge, potentiometer and resonance circuit.
CO2: Get the knowledge of earth's magnetic field and meter bridge.
CO3: To enhance the knowledge of post office box and tangent galvanometer.
CO4: The course will help to understand the potential difference concept by using potentiometer.

List of Experiments :

1) To find the value of horizontal components of earth's magnetic field by using magnetometer.
2) Compare the value of two low resistance by using drop of potential method using a meter bridge
3) Determination of ratio of two low resistance using Potentiometer.
4) Determination of Resistance of a Galvanometer using Post Office Box.
5) To determine the horizontal component (B_H) of the earth's field by using Tangent Galvanometer.
6) Determination of specific resistance of the material of a wire by meter bridge
7) Measure the average resistance per unit length of a meter bridge wire by Carey-Foster method
8) Measured the EMF of a cell by using potentiometer.
9) Measured the current flowing in a circuit by using potentiometer
10) To draw the resonance curve of a series LCR circuit and hence determine th Q-factor.

Total Hours: 60 hours

Textbooks:

1) A TEXT BOOK ON PRACTICAL PHYSICS: K. G. MAZUMDAR & B.GHOSH
2) A TEXT BOOK ON PRACTICAL PHYSICS: Dr. SAMIR KUMAR GHOSH

DSE I	Lasers and Nonlinear Optics	L	T	P	C
		4	0	0	4

Pre-requisite: Quantum Mechanics and Electricity and Magnetism.

Course Objectives:

1. To impart a comprehensive course on the operating principles – stimulated emission and population inversion, spectral properties and types of lasers.
2. To disseminate lectures on the applications of lasers in industrial, biomedical and research and development sectors.
3. To give the students an overview of nonlinear optics and the important properties of nonlinear optical materials.
4. To evaluate the connection between the properties of nonlinear optical materials and the numerous phenomena that could be attributed to such properties.

Course Outcome:

After successful completion of the course, the students will be able

CO 1: to understand the basics of the operating principles and types of lasers.
CO 2: to analyze the spectral properties of lasers and to understand the applications of lasers in industrial, biomedical and research applications.
CO 3: to comprehend the factors leading to nonlinear optical properties in materials.
CO 4: to understand the important properties and phenomena associated with nonlinear optical materials.

Module 1: Basics, Operating Principles and Types of Lasers — **20 Hours**

Introduction to lasers, Stimulated and Spontaneous Emission, Optical Cavities, Einstein Coefficients, Population Inversion, Threshold Condition, Laser Rate Equations, Three and Four level lasers, types of lasers - CW and Pulsed Lasers, Examples of Lasers – Ruby, Helium-Neon and CO_2 Lasers.

Module 2: Spectral Properties and Uses of Lasers — **10 hours**

Line Broadening Mechanisms – Natural, Collision and Doppler Broadening, Quality Factor, Industrial Applications – Laser Printing, Research Applications – Laser Induced Fusion and Laser Cooling, Biomedical Applications – Ophthalmic Surgery.

Module 3: Nonlinear Optics — **15 hours**

Overview of Nonlinear Optics, Nonlinear Polarization, 2^{nd} Harmonic Generation, Phase Matching, Sum and Difference Frequency Generation, Optical Parametric Amplification.

Module 4: Nonlinear Optical Phenomena — **15 hours**

Group Velocity Dispersion, Self-focusing, Kerr effect, Cross-Phase Modulation, Self-Phase Modulation, Four-Wave Mixing and Phase Conjugation.

Textbook (s)

1. **Optical Electronics, A. Ghatak and K. Thyagrajan, Cambridge India (2017).**
2. **Nonlinear Optics, Robert Boyd, Academic Press Inc; 3rd edition (2008).**
3. **Lasers and Nonlinear Optics, B. B. Laud, New Age International (2023).**

Reference Books

1. **Lasers – Fundamentals and Applications, K. Thyagrajan and A. Ghatak, Laxmi Publications (2019).**
2. **Introduction to Nonlinear Optics, Geoffrey New, Cambridge University Press (2011).**

DSE I	Computational Physics	L	T	P	C
		2	0	4	4

Pre-requisite: Basic Physics and Mathematics

Course Objectives:

1. To provide knowledge about the role of computers in solving physical problems.
2. To make students learn how to make flowcharts and algorithms to solve physical problems.
3. To teach programming languages Fortran and Python.
4. To provide hands-on training on computer programs for solving physical problems (applications).
5. To teach data visualization using basic commands of GNU plot, Matplotlib and Plotly.

Course Outcome:	
After successful completion of the course, the students will be able to CO1: Analyse the role of computers in solving physical problems CO 3: Undertand how to write computer programs using Fortran and Python to solve simple problems. CO 4: Apply computers for solving problems in Physics. CO 5: Learn the basic commands of GNU plot, Matplotlib and Plotly.	
Module 1: INTRODUCTION	**3 hours**
Importance of computers in Physics, paradigm for solving physics problems for solution. Introduction to various OS, Linux OS such as RedHat, Ubuntu, Scientific Linux, Usage of Basic linux commands. Text editors such as vi and Emacs.	
Module 2: BASICS OF SCIENTIFIC PROGRAMMING	**4 hours**
Algorithms and Flowcharts: 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.	
Module 3: SCIENTIFIC PROGRAMMING	**9 hours**
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. Programming with Python	
Module 4: CONTROL STATEMENTS, FUNCTIONS AND SUBROUTINES	**9 hours**
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, open a file, writing in a file, reading from a file.	
Module 5: VISUALIZATION	**5 hours**
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, curve fitting – straight line, polynomials, user defined function. Physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot. Visualization using Matplotlib, Plotly	
Total Lecture hours	**30 hours**
HANDS ON EXERCISES	**30hours**

1) Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor. 2) To print out all natural even/ odd numbers between given limits. 3) To find maximum, minimum and range of a given set of numbers. 4) Calculating Euler number using exp(x) series evaluated at x=1 5) To compile a frequency distribution and evaluate mean, standard deviation etc. 6) To evaluate sum of finite series and the area under a curve. 7) To find the product of two matrices 8) To find a set of prime numbers and Fibonacci series. 9) To write program to open a file and generate data for plotting using Gnuplot. 10) Plotting trajectory of a projectile projected horizontally. 11) Plotting trajectory of a projectile projected making an angle with the horizontally. 12) 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. 13) To find the roots of a quadratic equation. 14) Motion of a projectile using simulation and plot the output for visualization. 15) Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization. 16) Motion of particle in a central force field and plot the output for visualization.	

Total hours (Lecture + Hands on) = 60 hours

Text Book(s)

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. Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)

Reference Books

1.	Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
2.	Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)

DSE I	INTRODUCTION TO NANOSCIENCE	L	T	P	C
		4	0	0	4

Pre-requisite: Basic Physics

Course Objectives:

1. To provide fundamental knowledge about nanomaterials
2. To enable students to learn different methods of synthesis and characterization of nano structured materials.
3. To make students familiar with optical properties of nanomaterials.
4. To learn about the remarkable electron transport properties of nanomaterials.
5. To provide knowledge about application of nanomaterials.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: Understand physics at the nanoscale.
CO 2: Analyse different methods of synthesis and characterization of nanomaterials.
CO 3: Understand different features associated with optical and transport properties at the nanoscale.
CO 5: Apply properties of materials at the nanoscale in emerging areas.

Module 1: NANOSCALE SYSTEMS — **10 hours**

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.

Module 2: SYNTHESIS OF NANOSTRUCTURE MATERIALS — **8 hours**

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, Molecular Beam Epitaxy growth of quantum dots.

Module 3: CHARACTERIZATION — **8 hours**

X-Ray Diffraction, Optical Microscopy, Scanning Electron Microscopy, Transmission Electron Microscopy, Atomic Force Microscopy, Scanning Tunneling Microscopy

Module 4: OPTICAL PROPERTIES — **14 hours**

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 heterostructures and nanostructures

Module 5: ELECTRON TRANSPORT — **6 hours**

Carrier transport in nanostructures. Coulomb blockade effect, thermionic emission, enerling and hoping conductivity. Defects and impurities: Deep level and surface defects.

Module 5: APPLICATIONS — **14 hours**

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), Nanoelectromechanical Systems (NEMS).

Total Lecture hours — **60 hours**

Text Book(s)

1. C. P. Poole Jr. & F. J. Owens, *Introduction to Nanotechnology*, (Wiley-Interscience,

2. 3.	2003) S.K. Kulkarni, *Nanotechnology: Principles & Practices* (Capital Publishing Company) K.K. Chattopadhyay and A. N. Banerjee, *Introduction to Nanoscience and Technology* (PHI Learning Private Limited).
Reference Books	
1. 2.	Richard Booker, Earl Boysen, *Nanotechnology* (John Wiley and Sons). M. Hosokawa, K. Nogi, M. Naita, T. Yokoyama, *Nanoparticle Technology Handbook* (Elsevier, 2007).

Semester V

DSC	Analog Electronics	L	T	P	C
		4	0	0	4

Pre-requisite: Preliminary concept of 12th standard Physics course.

Course Objectives:

(1) To enhance the knowledge in band theory of solids and semiconductors.
(2)To have a thorough knowledge on optical excitation and devices.
(3)To have a broader concept on junctions to understand semiconductor devices.
(4) To enhance the knowledge of transistors and their applications.
(5) To develop the concept of oscillators.

Course Outcome:

After successful completion of the course, the students will be able

CO 1: to understand the basics of junction diodes, transistors, amplifiers, oscillators and CRO.
CO 2: to apply the theories of basic electronic circuits to study their characteristics curves.
CO 3: to analyze the results of different parameters related to the electronics circuits.
CO 4: to differentiate between the properties and applications of the electronic devices.
CO 5: to evaluate different parameters of the electronic devices

Module 1: Junctions Diodes	**12 hours**
Fabrication and Types of Junctions, Unbiased pn junction, energy level diagram and built in potential, diffusion and drift of carriers: Einstein relation, biased pn junction, volt-amp characteristic of pn junction, effect of temperature on I-V characteristics, DC and AC resistance of pn junction, junction capacitance, ener diode, tunnel diode, light emitting diode, point contact diode, liquid crystal display.	
Module 2: Transistors	**12 hours**
Introduction, Bipolar Junction Transistor, Transistor currents, Transistor fabrication, Transistor Configuration and Characteristics, Common base and common emitter static characteristics, Transitor alpa and beta, current and voltage notation, load line, transistor biasing:fixed bias or base bias, collectror-feedback bias, emitter- feedback bias..	
Module 3: Amplifiers	**20 hours**
Transistor Biasing and Stabilization Circuits. Fixed Bias and Voltage Divider Bias. Transistor as a 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. Differential amplifiers. Characteristics of an Ideal and Practical Op-Amp (IC 741). Open-loop and Closed-loop Gain. Frequency Response. CMRR. Slew Rate and Concept of Virtual Ground. Field effect transistors: JFET, MOSFET, FET amplified model and parameters, FET versus BJTs,	

Feedback principle.	
Module 4: Oscillators	**8 hours**
Types of oscillators, basic principle of oscillator, requirements of feedback oscillators, tuned-collector oscillator, Hartley Oscillator, Colpitts Oscillator, phase shift oscillator	
Module 5: Introduction to Cathode Ray Oscilloscope (CRO)	**8 hours**
Block Diagram of CRO. Electron Gun, Deflection System, and Time Base. Deflection Sensitivity. Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.	
Total Lecture hours	**60 hours**
Textbook(s)	
1.	Streetman, B. and Banerjee, S., Solid State Electronics, Prentice Hall India, (2006).
2	Jasprit Singh, Semiconductor Devices: Basic Principles by John Wiley & Sond ptd Ltd Singapore
3.	Donald Neamen , Dhrubes Biswas "Semiconductor Physics and Devices" McGraw-Hill Education
4.	C.T. Sah, Fundamentals of solid-state electronics, World Scientific Publishing Co Inc, 1991.
Reference Books	
1.	Y. Tsividis and M. Colin, Operation and Modeling of the MOS Transistor. Oxford Univ. Press, 2011
2.	A.K. Maini, N. Maini, All-in-One Electronics Simplified, Khanna Book Publishing, New Delhi, 2021.

DSC	**Waves and Optics**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Pre-requisite: Basic Physics and Mathematics					
Course Objectives:					
6. To provide the fundamental knowledge of collinear and perpendicular harmonic oscillations. 7. To enable students to learn different properties wave motion, velocity of waves and their superposition. 8. To make students familiar with electromagnetic nature of light and its properties. 9. To make students familiar with wave phenomena like interference and diffraction and interferometers.					
Course Outcome:					
After successful completion of the course, the students will be able to CO1: Apply the knowledge of collinear and perpendicular harmonic oscillations to related fields. CO 2: Learn the properties of superposition of waves and their applications. CO 3: Understand and appreciate the electromagnetic nature of light. CO 4: Understand the fundamentals of interference and diffraction and apply this knowledge to different physical phenomenon.					
Module 1: SUPERPOSITION OF COLLINEAR HARMONIC OSCILLATIONS					**8 hours**
Simple harmonic motion (SHM), linearity and superposition principle, superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (beats). Superposition of N collinear harmonic oscillations with (1) equal phase differences and (2) equal frequency differences.					
Module 2: SUPERPOSITION OF PERPENDICULAR HARMONIC OSCILLATIONS					**3 hours**
Graphical and analytical methods. Lissajous figures with equal and unequal frequencies and their uses.					
Module 3: WAVE MOTION					**9 hours**
Plane and spherical waves. Longitudinal and Transverse waves. Plane progressive (Travelling) waves.					

Wave equation. Particle and wave velocities. Pressure of a longitudinal wave. Energy transport. Intensity of Wave.	
Module 4: VELOCITY OF WAVES	**8 hours**
Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction.	
Module V: SUPERPOSITION OF TWO HARMONIC WAVES	**5 hours**
Stationary (Stationary) waves in a string: fixed and free ends. Analytical treatment. Phase and group velocities. Changes with respect to position and time.	
Module VI: WAVE OPTICS	**3 hours**
Electromagnetic nature of light. Definition and properties of wavefront. Huygen's Principle. Temporal and Spatial coherence.	
Module VII: INTERFERENCE	**9 hours**
Division of amplitude and wavefront. Young's double slit experiment. Lloyd's mirror and Fresnel's biprism, phase change on reflection: Stoke's treatment. Interference in thin films, parallel and wedge-shaped films, fringes of equal inclination (Haidinger fringes), fringes of equal thickness (Fizeau fringes). Newton's rings: Measurement of wavelength and refractive index. Interferometers (basic concept)	
Module VIII: POLARIZATION	**5 hours**
Polarized light and its mathematical representation, Production of polarized light by reflection, refraction and scattering, Polarization by double refraction and Huygen's theory, Nicol prism, production and analysis of circularly and elliptically polarized light.	
Module IX: DIFFRACTION	**10 hours**
Fraunhofer diffraction: Single slit, rectangular and circular aperture, resolving power of a telescope, double slit, multiple slits, diffraction grating, resolving power of a grating. Fresnel diffraction: Fresnel's Assumptions. Fresnel's half period zones for plane wave, explanation of rectilinear propagation of light. Theory of Zone Plate: Multiple foci of a zone plate, Fresnel's Integal, Fresnel diffraction pattern of a straight edge, a slit and a wire.	
Total Lecture hours	**60 hours**
Text Book(s)	
1.	Waves: Berkeley Physics Course, Vol. 3, Francis Crawford, 2007, Tat McGraw-Hill.
2.	Optics, Ajoy Ghatak, Tata McGraw-Hill.
Reference Books	
1.	Fundamentals of Optics, F.A. Jenkins and H.E.White, 1981, Mc-Graw Hill.
2.	Vibrations and Waves, A.P. French, 1st Edn, 2003, CRC Press.

DSC	Analog Electronics Lab	L	T	P	C
		0	0	4	2

Prerequisite : Basics of 12 standard Physics lab

Course Objective :

1) The Objective of this course is to provide an experimental foundation for the theoretical concepts introduced in the lectures.
2) To help students understand the role of direct observation in physics and to distinguish between inferences based on theory and the outcomes of experiments.
3) The students will acquire motivation to develop small experiments related to these techniques and develop their physical understanding.
4) Gain knowledge of new concept in the solution of practical oriented problems and to understand more deep knowledge about the solution to theoretical problems.

Course Outcome:

CO1: Learning basic concept of diode and Zener diode and its working principle

CO2: Get the knowledge of transistor and its working principle.

CO3: To enhance the knowledge of hall effect and band theory of semiconductors and

CO4: The course will help to understand the concept of dielectric and ferroelectric material.

List of Experiments :

1) To draw the static characteristics curves of a semiconductor diode and hence to determine its DC and AC resistance for a given current.
2) To draw the characteristics of a Zener diode.
3) To draw characteristics curves of a Transistor in CE configuration for different base currents and to determine the AC current gain from the active region of the characteristics curves.
4) To determine the Planck's constant using LEDs of at least 4 different colours.
5) Determine the Band gap of a semiconductor by four probe method
6) Measure the Hall Effect in Semiconductor.
7) Measurement of magnetic susceptibility by Quincke's tube method
8) To determine the dielectric constant of material
9) To study the half wave and full wave rectifier of a diode
10) To draw static characteristics of a junction field effect transistor(FET) and hence to determine its parameters

Total Lab Hours :	60 Hours

Text Books :

1) A TEXT BOOK ON PRACTICAL PHYSICS: K.G. MAZUMDAR & B.GHOSH.
2) A TEXT BOOK ON PRACTICAL PHYSICS: Dr. SAMIR KUMAR GHOSH.
3) ADVANCED PRACTICAL PHYSICS FOR STUDENTS, B. L. FLINT AND H.T. WORSNOP, 1971, ASIA PUBLISHING HOUSE
4) A TEXT BOOK OF PRACTICAL PHYSICS, I.PRAKASH & RAMAKRISHNA, 11THED., 2011, KITAB MAHA

DSC	Waves and Optics Lab	L	T	P	C
		0	0	4	2

Prerequisite : Basics of 12 standard Physics lab

Course Objective

1) The students will be able to interpret data (both theoretical and experimental) and subsequently learn how the important parameters can be derived from a given set of results. .
2) The students will be able to understand the operational principle of these components while using them for experimental investigations.
3) The students will learn the physics of different optical instrumentations and the ways to improve the knowledge of nature of light.

Course Outcome:

CO1: Students get the basic idea of the knowledge of nature of light.
CO2: Get the knowledge of focal length and other properties of light.
CO3: To enhance the knowledge of refractive index and diffraction of light.
CO4: The course will help to understand the nature of ultrasonic wave and different modes of wave.

List of Experiments :

1) Determine the power of a) convex lens b) concave lens.
2) Determine the focal length of a concave mirror with the help of a convex lens
3) Determine the refractive index of water by using convex lens and a mirror
4) To determine the radious of curvature of a Plano-Convex lens by using Newton's ring apparatus.
5) To determine the refractive index of the material of a prism by using Spectrometer.
6) To determine the wavelength of laser source using diffraction of single slit.
7) To determine the wavelength of laser source using diffraction of single slit.
8) To determine the wavelength of laser source by using diffraction grating.
9) To determine the velocity of a ultrasonic wave in a liquid by using spectrometer.
10) To determine the frequency of an electrically maintained tuning fork by,

a) Transverse mode of vibration b) Longitudinal mode of vibration.

Total Hours: 60 hours

Textbooks:

1) A TEXT BOOK ON PRACTICAL PHYSICS: K.G. MAZUMDAR & B.GHOSH
2) A TEXT BOOK ON PRACTICAL PHYSICS: Dr. SAMIR KUMAR GHOSH
3) ADVANCED PRACTICAL PHYSICS FOR STUDENTS, B. L. FLINT AND H.T. WORSNOP, 1971, ASIA PUBLISHING HOUSE
4) A TEXT BOOK OF PRACTICAL PHYSICS, I.PRAKASH & RAMAKRISHNA, 11THED., 2011, KITAB MAHA

DSE II	SUSTAINABILITY SCIENCE	L	T	P	C
		4	0	0	4

Pre-requisite: 12th standard Physics course

Course Objective

(1) aims to enhance the knowledge on sustainability development by means of various theories.
(2) to have a broader perspective of sustainability goals and green technology.
(3) to have a wider concept on different approaches of sustainability development.

Course Outcome:

After successful completion of the course, the students will be able

CO1: to understand sustainability development, green technologies and different approaches to sustainability development.
CO2: to apply different technologies towards achievement of sustainability.
CO3: to differentiate between various technological approaches towards sustainability.
CO4: to identify the best technique for a sustainable future.

Module 1: Sustainability and sustainable development — **20 hours**

Introduction, Objectives, Population and food, Resources and limits to growth, understanding sustainability development-pillars of sustainable development, ecological foundations of basic human needs-human needs and approaches: Abraham Maslow's Hierarchy of needs and related approaches, human scale development approach, sustainability hierarchy, equity, basic needs and ecology, principles of sustainability development, Brundtland report, post Brundtland report-evolving concept, the post Brundtland: critics, intra and Inter-generational equity in resources availability, dimensions of sustainability, Sustainable Development Goals (SDGs) and strategies to achieve the 17 SDGs

Module 2: Sustainability science and Green technology — **20 hours**

Objectives, defining sustainability science, central elements of sustainability science, goal and structure of sustainability science, sustainability science as discipline, global challenges, human population and growth rate, inequities and social disruption, gender dimension in environmental issues, climate change, rising materialism and vanishing ethical issues, Technology and society, essential components of technology- hardware and software, peopleware, management ware, systems of technology-nonmineral based versus mineral based technologies, automation versus labour intense technologies, centralized versus decentralized technologies, individual versus collective technologies, single purpose versus multi-purpose technologies, technological development and environment, evolutionary capacity of technology, concept of sustainable technology, constraints in adopting sustainable technology

Module 3: Approaches towards sustainability development — **20 hours**

Natural resource management: objectives, natural resources-classification and components, problems and issues, natural resource management-causes and depletion of natural resources, approaches applied on natural resource management-integrated approach, adaptive approach, precautionary approach, community based natural resource management, gender and natural resource management
Watershed Management: Objectives, the waters,hed, characteristics, concept and definition of watershed management-watershed management and local livelihood, watershed management in India,

Approaches-sectoral approach for watershed management, integrated watershed management. Participation in policy and planning: objectives, concepts, coordination, collaboration and cooperation, participatory development communication, tools and methodology for effective utilization of communication, Physical exposure to organizations working on sustainable practices and relevant activities, e.g., WWF-India, Climate Partner, etc.	
Total Lecture hours	**60 hours**
Text Book(s)	
1.	Jeremy L. Caradonna, *Sustainability: A History*, (2014), Oxford University Press.
2.	David Auge, Man's Search for Sustainability, (2023), AMZ Book Publishing Services.
3.	Bell, Michael and Michael, S. Carolan, *An Invitation to Environmental Sociology*, (2004), Pine Forge Press, New York.
4.	Ellent, R, *Environment, Subsistence and System*, (1983), Cambridge University Press.
Reference Books	
1.	Sustainability Science: *Managing Risk and Resilience for Sustainable Developpment*, (2023), Elsevier.
2.	Maslow, A.H, *Motivation and Human Personality* (1970), Harper, New York.

DSE II	**CRYSTAL ANALYSIS**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Pre-requisite: 12th standard Physics course

Course Objective

(1) aims to enhance the concepts of crystal structure by study of different parameters and structure of different crystals

(2) to be familiar with the properties, applications of X-rays and X-ray diffraction methods.

(3) enhance the knowledge of all experimental techniques which explains crystal structure.

(4) to have a broader perspective on the analysis of crystal composition, size, and morphology via different techniques.

Course Outcome:

After successful completion of the course, the students will be able

CO1: to understand, X-ray diffraction studies related to crystals, experimental techniques and analysis.

CO2: to remember various laws that is the basis in understanding crystals and their characteristics.

CO3: to apply the theories of crystals to study the structures pof different crystals.

CO4: to analyse the crystal structure through different theoretical and experimental techniques.

Module 1: Crystal Structure	**10 hours**
Solids: Amorphous and crystalline, space lattice, basis vectors, unit cell, lattice parameters, crystal systems, Bravais lattices, crystal plane and Miller Indices, interplanar spacing, indices of a direction, symmetry and symmetry elements.	
Module 2: X-Ray Diffraction	**20 hours**
X Rays- production, continuous and characteristic X rays, X-ray diffraction, Laue experiment, Bragg's law, Laue equations, X –ray powder diffraction, Debye- Scherrer Technique. Reciprocal lattice, Geometrical Construction of the reciprocal lattice, reciprocal lattice for simple cubic and f.c.c lattices, diffraction of X-rays on reciprocal lattice, Bragg's condition in terms of reciprocal lattice, vector form of Bragg's equation, Brillouin Zone.	
Module 3: Experimental Techniques	**15 hours**
Basics of TEM, TEM instrumentation: electron sources; electromagnetic lenses; geometric and wave	

optics applied to TEM; lens aberrations and resolution Interaction between fast electron and thin crystal, SEM, EDS, SAED (experimental details).	
Module 4: Analysis	**15 hours**
Analysis of a sample: X-ray fluorescence, X-ray diffraction, SEM, TEM, HR-TEM, EDS, SAED (students are to visit to Instrumentation centres having these facilities)	
Total Lecture hours	**60 hours**
Text Book(s)	
1.	William D. Callister, Jr., Materials Science and Engineering: An Introduction, 7th Edition, John Wiley & Sons, (2006).
2.	Maureen M. Julian, Foundations of Crystallography, Taylor & Francis Group (2008).
3.	Martin T. Dove, Structure and Dynamics-An atomic view of materials, Oxford University Press, (2003).
4.	B.D. Cullity and S.R. Stock, Elements of X-ray Diffraction, 3rd edition, Addison-Wesley Publishing Company (2001).
Reference Books	
1.	J. W. Edington, Practical Electron Microscopy in Materials Science, MacMillan, Philips Technical Library, Eindhoven (1974).
2.	M. de Graef, Introduction to Conventional Transmission Electron Microscopy, Cambridge University Press, New York (2003).

Semester VI

DSC	Thermal Physics	L	T	P	C
		4	0	0	4
Pre-requisite: Mathematical Physics and Basic Physics					
Course Objectives:					
1. To deliver a comprehensive course on the basics of thermodynamics, the laws of radiation and statistical physics at the undergraduate level. 2. To disseminate lecture on the physics behind the three laws of thermodynamics and the concepts of Entropy and Unattainability of Absolute Zero. 3. To give the students a view of why the statistical description of the photon - quanta of radiation is important in the theory of thermal radiation. 4. To analyze how the statistical concept of microstates and macrostates could explain the thermodynamic properties of materials.					
Course Outcome:					
After successful completion of the course, the students will be able CO 1: to comprehend the importance of the Zeroth and First Law of Thermodynamics in the work done in thermodynamics processes. CO 2: to understand the concept of Entropy in thermodynamic transformations and the physics of phase transitions on the basis of the Maxwell's Relations and the Clausius-Clayperon's Equation. CO 3: to understand the base of thermodynamic properties such viscosity, conductivity and diffusivity in the Kinetic Theory of Gases. CO 4: to analyze how the ultraviolet catastrophe was resolved by adopting the principles of quantum mechanics in the statistical description of radiation.					
Module 1: Fundamental Concepts and the First Law of Thermodynamics					**15 Hours**
Basic Idea of the Thermodynamic Description of a System, Zeroth Law of Thermodynamics, Thermal Equilibrium, Concept of Temperature. Exact Differentials, First Law of Thermodynamics – Internal Energy, Work Done in Thermodynamic Processes – Isothermal, Adiabatic, Isobaric and					

Isochoric, Path Dependence of Work Done, Degrees of Freedom, C_p-C_v and C_p/C_v Relation.	
Module 2: 2nd Law of Thermodynamics, Entropy and Thermodynamic Potentials	**15 hours**
Carnot Cycle, Second Law of Thermodynamics – Clausius and Kelvin-Planck Statement, Entropy, Temperature-Entropy Diagrams, Entropy Changes in Reversible and Irreversible Processes, Principle of Increase of Entropy, Third Law of Thermodynamics – Unattainability of Absolute Zero (Qualitative Idea). TdS Equations, Physics of the Thermodynamic Potentials - Internal Energy, Enthalpy, Helmholtz free energy, and Gibbs free energy, Maxwell's Relations, Joule-Thompson Expansion, Phase Transition – 1st and 2nd order and the Clausius-Clayperon Equation, Surface Films and Variation of Surface Tension with Temperature, Magnetic World and Cooling due to Adiabatic Demagnetization.	
Module 3: Kinetic Theory of Gases	**10 hours**
Basic Assumptions, Molecular Flux, Principle of Equipartition of Energy, Classical Theory of Specific Heat Capacity. Real Gas and the Van der Waals' Equation of State, Collision Cross Section, Mean Free Path, Coefficient of Viscosity, Thermal Conductivity and Diffusion.	
Module 4: Thermal Radiation and Statistical Physics	**20 hours**
Blackbody Radiation, Spectral Distribution, Rayleigh-Jean's Law, Ultraviolet Catastrophe, Planck's Postulate, Birth of Quantum Mechanics, Stefan-Boltzmann Law, Wien's Displacement Law. Energy States and Energy Levels, Necessity of Statistics in Thermodynamics, Macrostate and Microstate, Boltzmann and Shannon Entropy, Thermodynamic, Probability, Classical Statistics - Maxwell-Boltzmann Distribution, Quantum Statistics – Fermi-Dirac and Bose-Einstein Distribution.	
Textbook (s)	
1.	**Thermal Physics: with Kinetic Theory, Thermodynamics and Statistical Mechanics, S. C. Garg, R. M. Bansal and C. K. Ghosh, McGraw Hill (2017).**
2.	**Thermodynamics, Kinetic Theory and Statistical Thermodynamics, F. W. Sears and G. L. Sallinger, Narosa Publishing House (1975).**
3.	**Heat and Thermodynamics, R. H. Dittman and M. W. Zemansky, McGraw Hill (2017).**
Reference Books	
1.	**An Introduction to Thermal Physics, D. V. Schroeder, Oxford University Press (2021).**

DSC	**Digital Electronics**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Pre-requisite: Basic Physics and Mathematics					
Course Objectives:					
1. To teach students the basics of digital circuits and Boolean algebra. 2. To learn different concepts associated with arithmetic circuits and sequential circuits. 3. To make students familiar with microprocessor architecture.					
Course Outcome:					
After successful completion of the course, the students will be able to CO 1: Understand the working principle of CRO, data processing circuits, arithmetic circuits and sequential circuits. CO 2: Develop a digital logic and apply it to solve real life problems. CO 3: Gain an understanding of microprocessor architecture.					
Module 1: INTRUDUCTION TO CRO					**4 hours**
Block Diagram of CRO, Electron Gun, Deflection System and Time Base, Deflection Sensitivity, Applications of CRO: (1) Study of Waveform, (2) Measurement of Voltage, Current, Frequency, and Phase Difference.					
Module 2: DIGITAL CIRCUITS					**12 hours**
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, NAND and NOR gates as universal gates, XOR and XNOR gates.	
Module 3: BOOLEAN ALGEBRA	**10 hours**
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.	
Module 4: ARITHMETIC CIRCUITS	**6 hours**
Binary addition, binary subtraction using 2's complement, Half and Full adders, Half & Full subtractors, 4-bit binary adder/subtractor.	
Module 5: SEQUENTIAL CIRCUITS	**8 hours**
SR, D, and JK Flip-Flops, clocked (Level and Edge Triggered) Flip-Flops, Preset and Clear operations, race-around conditions in JK Flip-Flop, M/S JK Flip-Flop.	
Module 5: TIMERS	**4 hours**
IC555: Block diagram and applications: Astable multivibrator and Monostable multivibrator.	
Module 7: SHIFT REGISTERS	**6 hours**
Serial-in-Serial-out. Serial-in-Parallel-out.Parallel-in-Serial-out and Parallel-in- Parallel-out Shift Registers (only up to 4 bits).	
Module 8: INTRODUCTION TO MICROPROCESSORS	**10 hours**
8085 Microprocessor Architecture: Main features of 8085. Block diagram. Components, Pin-out diagram. Buses, Registers, ALU, Memory, Stack memory and Timing. Introduction to Assembly Language: 1-byte, 2-byte and 3-byte instructions.	
Total Lecture hours	**60 hours**
Text Book(s)	
1. Digital Principles and Applications, A.P.Malvino, D.P.Leach and Saha, 7th Ed., 2011, Tata McGraw 2. Modern digital Electronics, R. P. Jain, McGraw Hill Education, 4th Edition. 3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.	
Reference Books	
1. Digital Electronics, S.K. Mandal, 2010, 1st edition, McGraw Hill. 2. Microprocessor Architecture Programming & applications with 8085, 2002, R.S. Goankar, Prentice Hall.	

DSC	**Quantum Mechanics**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Pre-requisite: Basic Physics and Mathematics					
Course Objectives:					
1. To land on an area of new formalism of physics i.e., quantum mechanics needed to understand few critical events observed between 1900 and 1925 2. To provide knowledge of time dependent and time independent Schrodinger Equation. 3. To enable students to learn different aspects of Bound States. 4. To make students familiar with quantum theory of hydrogen-like atoms.					

5. To learn different concepts associated with atoms in electric and magnetic fields.
6. To provide knowledge about Quantum Mechanical aspects of many-electron atoms.

Course Outcome:

After successful completion of the course, the students will be able to

CO1: Apply time dependent and time independent Schrodinger Equation to solve simple problems.
CO 2: Learn the basics of Bound States and their applications.
CO 3: Understand different Quantum Mechanical aspects of hydrogen-like atoms.
CO 4: Apply the knowledge of atoms in electric and magnetic fields to solve simple problems.
CO 5: Acquire knowledge about Quantum Mechanical aspects of many-electron atoms.

Module 1: EMERGENCE OF QUANTUM MECHANICS	**5 hours**

Introduction to some critical events in physics observed between 1900 to 1925 that led to some radical theoretical proposals (called quantum theory) beyond accepted classical physics. Blackbody radiation, photoelectric effect, the Compton effect, wave properties and electron diffraction, the Bohr atom, the correspondence principle.

Module 2: WAVE MECHANICS: THE SCHRODINGER EQUATION	**15 hours**

Wave-Particle duality and concept of wave function, plane waves and wave packets, Probability Interpretation of Wave Function, the Schrodinger equation, the Heisenberg uncertainty relation: more on the probability interpretation of wave function: importance of phases, probability current densities, conditions for physical acceptability of wave functions, normalization, linearity and superposition principles; expectation values and the momentum in wave mechanics, momentum operator, wave function in momentum space, Wave Function of a Free Particle.

Module 3: TIME INDEPENDENT SCHRODINGER EQUATION (IN ONE DIMENSION)	**20 hours**

Time independent Schrodinger equation, eigenvalue equations and problem for a particle in a box, the expansion postulate and its physical interpretation, momentum eigenfunction and the free particle, normalization of free particle wave function, degeneracy and parity; some more applications to one dimensional potentials- (i) potential step, (ii) potential well with $E>0$ and $E<0$ for bound states, (iii) potential barrier and tunneling effect and (iv) harmonic oscillator.

General structure of wave mechanics: eigenfunctions and eigenvalues, Hamiltonian operator, some properties eigenvalues and eigenfunctions, Position, momentum and Energy operators; commutator of position and momentum operators, energy eigenfunctions, arbitrary wavefunction as a linear combination of energy eigenfunctions

Module 4: THE SHRODINGER EQUATION IN 3 DIMENSIONS	**5 hours**

Schrodinger equation in spherical polar coordinates; separation of variables of wavefunctions in central potential (radial and angular parts); application to hydrogen atom, its energy spectrum, degeneracy of the spectrum and origin of quantum numbers n, l and m [qualitatively introduce angular solution $Y_{lm}(\theta,\varphi)$], plots of radial and angular probability distribution in convenient forms upto second excited states.

Module 5: ATOMS IN ELECTRIC AND MAGNETIC FIELDS	**8 hours**

Electron angular momentum. Angular momentum quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Normal and Anomalous Zeeman Effect, Paschen Back Effect, Electron Magnetic Moment and Magnetic Energy, guyromagnetic ratio, Bohr magneton

Module 6: MANY ELECTRON ATOMS	**7 hours**

Pauli's Exclusion Principle. Symmetric and Anti-symmetric Wave Functions. Spin orbit coupling. Spectral Notations for Atomic States. Total angular momentum. Vector Atom Model, Spin-orbit coupling in atoms-L-S and J-J couplings, Hund's rule, Term symbol, spectra of hydrogen and alkali atom.

Total Lecture hours	**60 hours**

Text Book(s)	
1.	A Text book of Quantum Mechanics, P.M.Mathews and K.Venkatesan, 2nd Ed., 2010, McGraw Hill
2.	Quantum Mechanics: Theory and Applications, (2019), (Extensively revised 6th Edition), Ajoy Ghatak and S. Lokanathan, Laxmi Publications, New Delhi.
3.	Quantum Mechanics, Leonard I. Schiff, 3rd Edn. 2010, Tata McGraw Hill.
4.	Quantum Mechanics, Robert Eisberg and Robert Resnick, 2nd Edn., 2002, Wiley.
5.	Quantum Mechanics, Bruce Cameron Reed, 2008, Jones and Bartlett Learning.
Reference Books	
1.	Introduction to Quantum Mechanics, D.J. Griffith, 2nd Edition, Pearson Education, 2005
2.	Quantum Mechanics, G. Aruldhas, 2nd Edn. 2002, PHI Learning of India.
3.	Quantum Mechanics: Foundations & Applications, Arno Bohm, 3rd Edn., 1993, Springer
4.	Quantum Mechanics for Scientists & Engineers, D. A. B. Miller, 2008, Cambridge University Press

DSC	Thermal Physics Lab	L	T	P	C
		0	0	4	2

Prerequisite : Basics of 12 standard Physics lab

Course Objective :

1) This course aims to provide a good platform to mechanical engineering students to understand, model and appreciate concept of dynamics involved in thermal energy transformation
2) Students will apply the analytical techniques and graphical analysis to the experimental data.
3) To develop intellectual communication skills and discuss the basic understanding of various experimental principles involved.

Course Outcome:

CO1: To apply the knowledge of mathematics, physics to understand the mechanical equivalent of heat and thermal conductivity phenomenon

CO2: Ability to understand the basic concepts of thermodynamic such as temperature, pressure, system, properties, process, state, cycles and equilibrium.

CO3: To get the knowledge of Thermocouple, Calorimeter and Platinum resistance thermometer.

CO4: This lab will help the students to understand specific heat and convection of heat in various environment.

List of Experiments :

1) To determine Mechanical Equivalent of Heat, J, by Joule's Calorimeter 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 by Platinum Resistance Thermometer (PRT).
5) To study the variation of Thermo-EMF of a Chromium – Aluminium Thermocouple with Difference of Temperature of its Two Junctions.
6) To find the specific heat of a liquid by using Calorimeter

7) To measure the emissivity of test plate.
8) To find the Stefan's constant.
9) Evaluate the Specific Heat of Air at constant pressure.
10) To determine average surface heat transfer coefficient for a pipe by forced convection.

Total Hours: 60 hours

Textbooks:

1) 1) A TEXT BOOK ON PRACTICAL PHYSICS: K.G. MAZUMDAR & B.GHOSH.
2) A TEXT BOOK ON PRACTICAL PHYSICS: Dr. SAMIR KUMAR GHOSH.
3) ADVANCED PRACTICAL PHYSICS FOR STUDENTS, B. L. FLINT AND H.T. WORSNOP, 1971, ASIA PUBLISHING HOUSE
4) A TEXT BOOK OF PRACTICAL PHYSICS, I.PRAKASH & RAMAKRISHNA, 11THED., 2011, KITAB MAHA

DSC	Digital Electronics Lab	L	T	P	C
		0	0	4	2

Prerequisite : Basics of 12 standard Physics lab

Course Objective :

1) To develop problem solving and critical thinking skills by observing various practical outcomes for further applications.

2) To achieve perfectness in experimental skills and the study of practical applications will bring more confidence and ability to develop and fabricate technical equipments.

3) Design of circuits using new technology and latest components and to develop practical applications of physics materials and use of principle in the right way to implement the modern technology. .

4) The students will have a good foundation in the fundamentals related to the experiments included in this course and their advanced applications.

Course Outcome:

CO1: Learning basic concept of voltage, current and measurement of their readings in CRO.

CO2: Get the knowledge of various logic gates such as OR, NOT, NAND.

CO3: To enhance the knowledge of working principle of various flip-flops

CO4: The course will help to understand the concept of OPAMP in inverting and non-inverting and buffer mode.

List of Experiments :

1) To measure (a) Voltage, and (b) Time period of a periodic waveform using CRO.
2) To study and verify the truth table of logic gates
3) To design a switch (NOT gate) using a transistor.
4) To verify and design AND, OR, NOT and XOR gates using NAND gates.
5) To design a combinational logic system for a specified Truth Table
6) To convert a Boolean expression into logic circuit and design it using logic gate ICs.

7) Half Adder, Full Adder and 4- bit binary Adder 8) To build Flip - Flop (RS, Clocked RS, D - type and JK) circuits using NAND gates. 9) To construct inverting voltage amplifier and to determine the close loop voltage gain 10) To construct inverting voltage amplifier and to determine the close loop voltage gain To construct a buffer amplifier using IC 741 and to determine voltage gain.
Total Hours: 60 hours
Textbooks:
1) A TEXT BOOK ON PRACTICAL PHYSICS: K.G. MAZUMDAR & B.GHOSH 2) A TEXT BOOK ON PRACTICAL PHYSICS: Dr. SAMIR KUMAR GHOSH 3) ADVANCED PRACTICAL PHYSICS FOR STUDENTS, B. L. FLINT AND H.T. WORSNOP, 1971, ASIA PUBLISHING HOUSE 4) A TEXT BOOK OF PRACTICAL PHYSICS, I.PRAKASH & RAMAKRISHNA, 11THED., 2011, KITAB MAHA

DSE III	**Plasma Physics**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**
Pre-requisite: Electromagnetic Theory					
Course Objectives:					
1. To deliver a comprehensive course on the basics of plasma physics, the theoretical modelling, the instabilities and the applications of plasma. 2. To disseminate lectures on the physics behind the motion of charged particles in EM fields and how this forms the basis of theoretical modelling of plasma. 3. To give the students a view of why the two-fluid model of plasma forms the major foundation of the numerous phenomena associated with it. 4. To analyze how the motion of charged particles in plasma leads to the emergence of plasma waves and instabilities in the plasma.					
Course Outcome:					
After successful completion of the course, the students will be able CO 1: to understand the basic properties and conditions for a mixture of ions to be plasma. CO 2: to analyze the motion of charged particles in uniform and non-uniform EM fields and using this, build an understanding of the fluid model of plasmas. CO 3: to comprehend the physics behind the numerous waves that arise in plasma such as Alfven, Magneto-Acoustic and Ion-Acoustic waves and the implications of dusty plasma in space plasma and the mesosphere of the earth. CO 4: to gain in-depth of the instabilities in plasma such as two-stream instability and the applications of plasma in the biomedical sector and material sciences.					
Module 1: Basics of Plasma Physics					**15 Hours**
Basic Properties of Plasma, Quasi-neutrality, Debye Shielding, Plasma Frequency, Plasma Parameter, Criteria for Plasma, Plasma Production in Laboratory: Glow Discharge Plasma and Pachen Law, Magnetically Confined Open and Closed systems (linear pinch, mirror machine and Tokamak).					
Module 2: Single Particle Motion and Fluid Description of Plasma					**20 hours**
Concept of Lorenz Force, Charged particle motion in uniform and non-uniform EM fields, Electric and Grad-*B* Drift, Curvature Drift and Magnetic Mirrors, Adiabatic Invariants - μ and J, Coulomb collisions, Characteristic Relaxation Times, Fluid Description of Plasma – Two Fluid Model, The Plasma Approximation.					

Module 3: Waves in Plasma	**15 hours**
Group velocity and Phase velocity, Normal Mode Analysis, Plasma Oscillations, Alfven waves, Dissipative Effect, Magneto-acoustic Waves, Hydro-magnetic Waves, Linear and Nonlinear Ion-Acoustic Waves and Electron Plasma Wave.	
Module 4: Instabilities and Applications of Plasma	**10 hours**
Magneto-hydrodynamic instabilities- Rayleigh-Taylor and Kelvin Helmholtz instabilities, Industrial Applications - Biomedical and Material sciences, Thermonuclear Fusion and ITER.	
Textbook (s)	
1.	**Introduction to Plasma Physics and Controlled Fusion, Francis F. Chen, Springer Nature 3rd Edition (2015).**
2.	**Physics of Fluids and Plasmas, Arnab Rai Choudhuri, Cambridge University Press (1998).**
3.	**Fundamentals of Plasma Physics, J. A. Bittencourt, Springer-Verlag New York (2010).**
Reference Books	
1.	**Introduction to Plasma Physics, R. J. Goldston, CRC Press (2020).**

DSE III	**Spectroscopy**	**L**	**T**	**P**	**C**
		4	**0**	**0**	**4**

Pre-requisite: Quantum Mechanics.

Course Objectives:

1. To impart a comprehensive course on the physics of molecular spectroscopy and its applications in unveiling the molecular structure of substances.
2. To disseminate lectures on the applications of quantum mechanics (specifically the rigid rotor and quantum harmonic oscillator model) in rotational and vibrational spectroscopy.
3. To evaluate the connection between the molecular properties of materials and the numerous types of spectroscopies that could be applied to study its properties.

Course Outcome:

After successful completion of the course, the students will be able

CO 1: to understand the basics of the physical principles that the spectroscopic methods are based on.
CO 2: to analyze the spectral properties of molecules by understanding the basics of rotational and vibrational spectroscopy.
CO 3: to comprehend the physics behind Electronic Spectroscopy and the famed Raman effect and its applications in molecular spectroscopy.
CO 4: to understand the important properties associated with the molecular structure materials.

Module 1: Basics of Spectroscopy	**5 Hours**
Interaction of electromagnetic radiation with molecules, Various types of spectra, Born-Oppenheimer approximation, Franck-Condon principle and Free Electron Model.	
Module 2: Atomic Spectroscopy	**15 hours**
Pauli's Exclusion Principle, Spectral Terms, Vector Model for Three or more Valence Electrons atoms, Branching Rule, Landé Interval Rule, LS and JJ Coupling, Energy Levels and Selection Rules, Spectra of Oxygen and Nitrogen, Zeeman Effect, Paschen-Bach effect, Stark Effect and Hyperfine Structure.	
Module 3: Rotational and Vibrational Spectroscopy	**20 hours**
Rotational Spectroscopy: Selection Rules, Intensities of Spectral Lines, Determination of Bond Lengths of Diatomic and Linear Triatomic Molecules, Isotopic Substitution. Vibrational Spectroscopy: Classical Equation of Vibration, Computation of Force Constant, Anharmonicity, Morse Potential, Dissociation Energies, Fundamental Frequencies, Overtones, Hot Bands, Degrees of Freedom for Polyatomic Molecules, Modes of Vibration, Concept of Group Frequencies.	
Module 4: Electronic and Raman Spectroscopy	**20 hours**
Electronic Spectroscopy: Electronic Transitions, Singlet and Triplet States, Fluorescence and Phosphorescence, Dissociation and Predissociation, Calculation of Electronic Transitions of Polyenes	

using Free Electron Model. Raman Spectroscopy: Qualitative Treatment of Rotational Raman Effect; Effect of Nuclear Spin, Vibrational Raman Spectra, Stokes and Anti-Stokes lines, Selection Rules.	
Textbook (s)	
1.	**Atomic and Molecular Spectroscopy: Basic Concepts and Applications, Rita Kakkar, Cambridge University Press (2015).**
2.	**Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles 2nd Edition, Robert Resnick and Robert Eisberg, Wiley (2007).**
3.	**Molecular Spectra and Molecular Structure: Spectra of Diatomic Molecules Vol.1, , Gerhard Herzberg, Krieger Publishing Company (1989).**
Reference Books	
1.	**Introduction to Spectroscopy, D. L. Pavia, Cengage India Pvt. Ltd. (2015).**
2.	**Molecular Structure and Spectroscopy, G. Arulhas, Prentice Hall India (2007).**