DEPARTMENT OF PHYSICS

Syllabus for

Undergraduate Programmes (Honours)

Under Credit Semester System

(Outcome Based Education with Effect from 2024 Admissions)

St Berchmans College
Founded 1922
AUTONOMOUS | College with Potential for Excellence | A+ in the Fifth Cycle of Reaccreditation by NAAC
Changanassery, Kerala, India 686101 | Affiliated to Mahatma Gandhi University, Kottayam

BOARD OF STUDIES

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Name	Official Address
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ALUMNI REPRESENTATIVE

Name	Official Address
Mr. Libin Scaria	Medical Physicist - C (Scientific), Tata Memorial Hospital, under DAE, Mumbai

REPRESENTATIVE FROM MEDIA/INDUSTRY AND ALLIED AREAS

Name	Official Address
Mr. Shyam Kumar S	Technical Head, Bharath Social Solutions, Karukachal, Kottayam

TEACHERS FROM THE DEPARTMENT NOMINATED BY THE PRINCIPAL TO THE BOARD OF STUDIES

Name
Mr. Ajai Jose
Mr. Justin John
Dr. Sajith Mathews T
Dr. Joshy Jose
Mr. Benny Joseph
Dr. Lijo Jose
Dr. Sinu Mathew
Dr. Loji K Thomas

PROGRAMME OUTCOMES

PO1: Develop in-depth conceptual knowledge and skills in the discipline for vertical growth and scholarly pursuits

PO2: Integrate and apply interdisciplinary knowledge incorporating historical, theoretical, scientific, technological, economic, philosophical, cultural, aesthetic and ethical perspectives to address complex challenges in diverse settings

PO3: Demonstrate communication skills promoting adaptability, collaboration and resilience in global and local contexts

PO4: Develop problem solving skills to transfer the knowledge of methods and systems of different disciplines for a sustainable and egalitarian world order

PO5: Cultivate research skills and innovative and critical thinking to contribute to societal development through the creation of sustainable solutions and advancements in the respective fields

PROGRAMME SPECIFIC OUTCOMES

On successful completion of the programme, the graduates will be able to:

PSO1: Develop competency in theoretical and experimental physical sciences, mathematical skills and linguistic proficiency to explore the scientific world and appreciate natural phenomena.

PSO2: Explain and summarise principles and theoretical framework of classical physics, modern physics and applied physics.

PSO3: Apply the knowledge acquired to do related practical and to solve numerical and conceptual problems.

PSO4: Analyse theoretical and experimental data and deduce valid conclusions.

PSO5: Articulate knowledge through science enrichment programmes and create knowledge through research projects.

OUTLINE OF DISCIPLINE SPECIFIC COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24PH1DSC100	Major/ Minor	Introduction to Mechanics	5	75	4
SBU24PH1DSC101	Major/ Minor	Foundation Course in Physics	5	75	4
Semester II (Course Level: 100 - 199)					
SBU24PH2DSC100	Major/ Minor	Electricity and Magnetism	5	75	4
SBU24PH2DSC101	Minor	Perspectives of Modern Physics	5	75	4
Semester III (Course Level: 200 - 299)					
SBU24PH3DSC200	Major	Basic Electronics	5	75	4
SBU24PH3DSC201	Major	Properties of Solids and Fluids	5	75	4
SBU24PH3DSC202	Minor	Wave Optics	5	75	4
Semester IV (Course Level: 200 - 299)					
SBU24PH4DSC200	Major	Thermodynamics and Statistical Mechanics	5	75	4
SBU24PH4DSC201	Major	Mathematical Foundations and Dynamics	5	75	4
SBU24PH4DSC202	Minor	Properties of Matter	5	75	4
SBU24PH4INT200	Major	Internship	-	-	2
Semester V (Course Level: 300 - 399)					
SBU24PH5DSC300	Major/ Minor	Classical Mechanics - I	5	75	4
SBU24PH5DSC301	Major/ Minor	Advanced Electronics	5	75	4
Semester VI (Course Level: 300 - 399)					
SBU24PH6DSC300	Major/ Minor	Quantum Mechanics	5	75	4
SBU24PH6DSC301	Major/ Minor	Basic Solid State Physics	5	75	4
SBU24PH6DSC302	Major/ Minor	Electrodynamics - I	5	75	4
Semester VII (Course Level: 400 - 499)					
SBU24PH7DSC400	Major/ Minor	Mathematical Methods in Physics	4	60	4
SBU24PH7DSC401	Major/ Minor	Atomic and Molecular Physics	4	60	4
SBU24PH7DSC402	Major/ Minor	Classical Mechanics - II	4	60	4
SBU24PH7DSC403	Major/ Minor	Nuclear and Particle Physics	4	60	4
SBU24PH7DSC404	Major/ Minor	Computational Physics	5	75	4
SBU24PH7DSC405	Major/ Minor	Classical and Quantum Statistical Physics	4	60	4
Semester VIII (Course Level: 400 - 499)					
SBU24PH8DSC400	Major	Electrodynamics - II	4	60	4
SBU24PH8DSC401	Major	Advanced Quantum Mechanics	4	60	4
SBU24PH8DSC402	Major	Condensed Matter Physics	4	60	4
SBU24PH8PRJ400	Major	Project			12

OUTLINE OF DISCIPLINE SPECIFIC ELECTIVE COURSES

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24PH3DSE200	Elective	Basic Nuclear Physics and Astrophysics	4	60	4
SBU24PH3DSE201	Elective	Renewable Energy Technology	4	60	4
Semester IV (Course Level: 200 - 299)					
SBU24PH4DSE200	Elective	Physical Optics and Fourier Optics	4	60	4
SBU24PH4DSE201	Elective	Fundamentals of Atmospheric Science	4	60	4
Semester V (Course Level: 300 - 399)					
SBU24PH5DSE300	Elective	Photonics	4	60	4
SBU24PH5DSE301	Elective	Photovoltaics	4	60	4
SBU24PH5DSE302	Elective	Dynamical Systems	4	60	4
SBU24PH5DSE303	Elective	Nanoscience and Nanotechnology	4	60	4
SBU24PH5DSE304	Elective	Oscillation, Waves, Music and Acoustics	4	60	4
Semester VI (Course Level: 300 - 399)					
SBU24PH6DSE300	Elective	Nanoscience at Surfaces and Interfaces Using Scanning Probe Microscopy	4	60	4
SBU24PH6DSE301	Elective	Statistical Tools and Introduction to Machine Learning	4	60	4

OUTLINE OF MULTIDISCIPLINARY COURSES (MDC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester I (Course Level: 100 - 199)					
SBU24PH1MDC100	MDC	Physics in Daily Life	4	60	3
Semester II (Course Level: 100 - 199)					
SBU24PH2MDC100	MDC	Physics of Electricity and Sound	4	60	3
SBU24PH2MDC101	MDC	A Journey Through Space: An Introduction to Astronomy Observational	4	60	3
Semester III (Course Level: 200 - 299)					
SBU24PH3MDC200	MDC	Physics of Motion, Matter, Devices and Energy	3	45	3

OUTLINE OF SKILL ENHANCEMENT COURSES (SEC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester IV (Course Level: 200 - 299)					
SBU24PH4SEC200	SEC	Electrical and Electronic Circuit Design	3	45	3
Semester V (Course Level: 300 - 399)					
SBU24PH5SEC300	SEC	Python Programming	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24PH6SEC300	SEC	Introduction to Digital Design and IOT	3	45	3

OUTLINE OF VALUE ADDITION COURSES (VAC)

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
Semester III (Course Level: 200 - 299)					
SBU24PH3VAC200	VAC	Physics for Society	3	45	3
Semester IV (Course Level: 200 - 299)					
SBU24PH4VAC200	VAC	Research Methodology and Publication Ethics for Physics	3	45	3
Semester VI (Course Level: 300 - 399)					
SBU24PH6VAC300	VAC	Environmental Studies and Human Rights	3	45	3

SEMESTER I

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24PH1DSC100	Major/ Minor	Introduction to Mechanics	5	75	4
SBU24PH1DSC101	Major/ Minor	Foundation Course in Physics	5	75	4
SBU24PH1MDC100	MDC	Physics in Daily Life	4	60	3

SBU24PH1DSC100: INTRODUCTION TO MECHANICS

Type of Course	Major/Minor		
Course Level	100 – 199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Higher Secondary level Physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the fundamental concepts of mechanics by recalling and defining the basic principles such as scalars, vectors, and Newton's laws of motion.	R
CO2	Understand mathematical formulations related to motion in one and two dimensions	U
CO3	Showcase the application of theoretical knowledge related to Newton's laws of motion to real-world scenarios	A
CO4	Critically analyse rotational kinematics, dynamics and gravitational principles, and apply their understanding to solve complex problems	An
CO5	Apply experimental procedures to investigate concepts such as laws of motion, elasticity, fluid motion, and rotational mechanics	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1					1				
CO2	1					1				
CO3			1			1				
CO4			1						1	
CO5			1			1				

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x	x				x
CO2		x		x		x
CO3		x			x	x
CO4			x		x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Kinematics and Dynamics (15 Hrs)				
Introduction to Mechanics and Scalars vs. Vectors				
Definition and scope of mechanics	1.1	1	1	Lecture
Scalars and vectors	1.2	2	1	Lecture
Vector operations: addition, subtraction, multiplication	1.3	3	2	Lecture and Problem Solving
Motion in One Dimension				
Position, displacement, and distance	1.4	3	1	Lecture
Speed, velocity and Acceleration	1.5	3	1	Lecture and Problem Solving
Equations of motion for constant acceleration	1.6	3	2	Lecture and Problem Solving
Motion in Two Dimensions				
Vector representation of motion	1.7	2	1	Lecture
Projectile motion	1.8	3	2	Lecture and Problem Solving
Relative motion	1.9	3	1	Lecture
Circular motion and centripetal and centrifugal acceleration	1.10	4	3	Lecture and Problem Solving
Module 2: Newtonian Mechanics (15 Hrs)				
Newton's Laws of Motion				
Newton's first law	2.1	1	1	Lecture
Newton's second law and the concept of force	2.2	2	2	Lecture and Problem Solving
Newton's third law and action-reaction pairs	2.3	3	1	Lecture and Problem Solving
Applications of Newton's Laws				
Free-body diagrams	2.4	3	1	Lecture and Problem Solving
Friction and its types	2.5	3	1	Lecture
Tension in ropes and strings	2.6	4	2	Lecture and Problem Solving
Inclined plane, banking of roads	2.7	4	3	Lecture and Problem Solving
Work, Energy, and Conservation Laws				
Work done by a force	2.8	1	1	Lecture
Kinetic energy and the work-energy theorem	2.9	3	1	Lecture
Potential energy and conservative forces	2.10	3	1	Lecture
Conservation of energy	2.11	3	1	Lecture
Module 3: Rotational Motion and Gravitation (15 Hrs)				
Rotational Kinematics and Dynamics				
Angular displacement, velocity, and acceleration	3.1	1	2	Lecture and Problem Solving

Torque and moment of inertia	3.2	2	2	Lecture and Problem Solving
Rotational analogues of Newton's laws	3.3	2	2	Lecture and Problem Solving
Angular momentum and its conservation	3.4	3	2	Lecture and Problem Solving
Gravitation				
Law of universal gravitation	3.5	1	1	Lecture and Problem Solving
Gravitational field and potential	3.6	2	2	Lecture
Kepler's laws	3.7	3	2	Lecture and Problem Solving
Satellite motion	3.8	4	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Halliday, Resnick, and Walker, Fundamentals of Physics, 10th Edition, Wiley, 2013
2. Serway and Jewett, Physics for Scientists and Engineers, 9th Edition, Brooks/Cole, 2013
3. HC Verma, Concepts of Physics, 1st Edition, Bharati Bhawan, 2022

Reference

1. Khan Academy, Physics - One-dimensional motion, Two-dimensional motion (Online Resource)
2. MIT Open Courseware, Classical Mechanics (Online Resource)
3. Young and Freedman, University Physics with Modern Physics, 14th Edition, Pearson, 2015
4. John R. Taylor, Classical Mechanics, University Science Books, 2005
5. Hyper Physics, Rotational Motion and Gravity (Online Resource)

Practical
Physics -I (Mechanics)

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: (13 Hrs)				
Symmetric Compound Pendulum – Determination of acceleration due to gravity (g), radius of gyration (K) and moment of inertia (I)	5.1	5	4	Demonstration and peer learning
Asymmetric Compound Pendulum- Determination of moment of inertia and Acceleration due to gravity (g)	5.2	5	3	Demonstration and peer learning
Kater's Pendulum – Determination of acceleration due to gravity	5.3	5	3	Demonstration and peer learning
Projectile motion - range and angle	5.4	5	3	Demonstration and peer learning
Module 6: (8 Hrs)				
Concurrent forces - parallelogram law- determination of unknown weight	6.1	5	4	Demonstration and peer learning

Inclined plane - angle of friction	6.2	5	4	Demonstration and peer learning
Module 7: (9 Hrs)				
Torsion pendulum – Determination of Rigidity modulus and moment of inertia	7.1	5	3	Demonstration and peer learning
Flywheel – Determination of Moment of inertia	7.2	5	3	Demonstration and peer learning
Determination of moment of inertia of rotationally symmetric body (solid sphere OR cylinder OR disc) from their period of oscillation on a torsion axle	7.3	5	3	Demonstration and peer learning

Textbooks

1. CL Arora,BSc Practical Physics, S. Chand Limited, 2001
2. P. R. Sasi Kumar, Practical Physics, PHI Learning Pvt. Ltd., 2011
3. Debasish Chattopadhyay, Phatik Chandra Rakshit, An Advanced Course in Practical
4. Physics, New Central Book Agency**,** 2013

Course designed by: Justin John

SBU24PH1DSC101: FOUNDATION COURSE IN PHYSICS

Type of Course	Major/Minor		
Course Level	100 – 199		
Credit	4		
Course Delivery Duration	**Theory (hours)**	**Practical (hours)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Physics course at the Higher Secondary.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Students get introduced to the basic ideas of Error analysis and apply them in college physics laboratory	A
CO2	Describes error propagation and the statistical methods with which the random uncertainties are evaluated and apply them.	A
CO3	Describes the main properties of atoms and nuclei.	U
CO4	Understands the mechanism of nuclear decay and apply them.	A
CO5	Develops experimental skills and analyse the process and outcomes of an experiment quantitatively and qualitatively.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	2	3	-	3	2	3	2	2
CO2	3	2	2	2	-	3	-	-	2	2
CO3	-	2	2	-	-	-	1	2	2	-
CO4	-	2	2	-	-	-	1	-	2	-
CO5	1	2	-	-	3	-	-	2	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Spot assignment	Written test	Problem based Assignment	
CO1	x			x	x	x
CO2		x	x	x	x	x
CO3			x		x	x
CO4	x	x		x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Measurements (15 Hrs)				
Measurements- Least Count, Concept of uncertainty in measurement.	1.1	1	1	Lecture
Vernier Callipers, Screw Gauge, Spectrometer, Travelling Microscope	1.2	1	4	Lecture, Demonstration, Assignment
How to report and use uncertainties	1.3	1	3	Lecture and problem solving
Propagation of Uncertainties	1.4	2	3	Lecture and problem solving
Statistical Analysis of Random Uncertainties	1.5	2	4	Lecture and problem solving
Module 2: Introduction to Atomic Physics -1 (15 Hrs)				
Atoms, Atomic Parameters, Atomic mass unit, Avogadro's Number and Mole.	2.1	3	2	Lecture and problem solving
Thomson's Discovery of the Electron	2.2	3	1	Lecture
Millikan's Oil drop Experiment	2.3	3	1	Lecture and problem solving
Rutherford and the Nuclear Atom	2.4	3	1	Lecture
Nuclear Properties, Nuclear Force, Binding Energy, Binding Energy Curve	2.5	3	2	Lecture and problem solving
Mass Spectrometers	2.6	3	1	Lecture
Radioactivity, Alpha, Beta, Gamma rays	2.7	4	1	Lecture and problem solving
Exponential Decay Law, Mean life, Half Life	2.8	4	3	Lecture and problem solving
Radioactive Dating	2.9	4	2	Lecture and problem solving
Beta decay and the neutrino	2.10	4	1	Lecture
Module 3: Introduction to Atomic Physics -2 (15 Hrs)				
Nuclear Reactions	3.1	4	1	Lecture
Identification of Proton as Nuclear Constituent	3.2	3	1	Lecture
Discovery of the Neutron	3.3	3	1	Lecture
Nuclear Fission and Fusion	3.4	3	3	Lecture and problem solving
Accelerators- Linear Accelerator, Cyclotron	3.5	4	4	Lecture and problem solving
Particle detectors-	3.6	3	2	Lecture
Units of Radiation	3.7	3	1	Lecture and problem solving
Elementary Particles- (Qualitative)	3.8	3	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Module 1- John R. Taylor; An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements, Univ. Science Books
2. Module 2 and 3- John R. Taylor, Chris D. Zafiratos, Michael A. Dubson; Modern Physics For Scientists and Engineers, Second Edition, PHI , 2013

Reference

1. Arthur Beiser; Concepts of Modern Physics; TMH
2. Paul G Hewitt; Conceptual Physics; Tenth Edition; Pearson
3. Hugh D. Young, Roger A. Freedman; Sears and Zemansky's University Physics; 12th Edition; Pearson
4. Jearl Walker, David Halliday, Robert Resnick; Principles of Physics; 10th Edition; WileyR. Murugeshan, Kiruthiga Sivaprasath; Modern Physics; 18th Edition; S Chand

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5 (9 Hrs)				
Vernier Callipers – Volume of a cylinder, sphere and hollow cylinder	5.1	5	3	Demonstration and peer learning
Screw Gauge – Volume of a sphere and glass plate	5.2	5	3	Demonstration and peer learning
Spherometer – Thickness of a glass plate, radius of curvature of a convex surface and a concave surface	5.3	5	3	Demonstration and peer learning
Module 6 (11 Hrs)				
Spectrometer – Angle of Prism	6.1	5	4	Demonstration and peer learning
Liquid Lens – Determination of optical constants of a convex lens	6.2	5	3	Demonstration and peer learning
Prism i-d curve	6.3	5	4	Demonstration and peer learning
Module 7 (10 Hrs)				
Multimeter I – Measurement of resistance, potential difference, current	7.1	5	3	Demonstration and peer learning
Multimeter II – Checking of capacitor, diode, inductance and transistor	7.2	5	3	Demonstration and peer learning
Cathode Ray oscilloscope – Calibration and measurement of frequency and amplitude	7.3	5	4	Demonstration and peer learning

Textbook

1. M.N. Srinivasan, S, Balasubramanian, R. Ranganathan; A Textbook of Practical Physics; Sultan Chand & Sons

Reference

1. Amrutha Virtal lab; https://vlab.amrutha.edu
2. Kumar, P.R. Sasi; Practical Physics; PHI Learning

Course designed by: Ajai Jose

SBU24PH1MDC100: PHYSICS IN DAILY LIFE

Type of Course	MDC		
Course Level	100 – 199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)	Class 10 level physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe reflection, refraction and interference of light	R
CO2	Describe mirrors, lenses, dispersion	U
CO3	Describe defects of eye and correction using lenses	U
CO4	Describe temperature, heat, thermal expansion, heat transfer mechanisms, greenhouse effect, solar power	R
CO5	Develops experimental skills and analyse the process and outcomes of an experiment quantitatively and qualitatively.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2				1	1			
CO2	3	2				1	1			
CO3	3	2				1	1			
CO4	3	2				1	1			
CO5	3	2				1	1			

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x			x	x	x
CO2		x	x	x	x	x
CO3			x	x	x	x
CO4		x		x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Light (15 Hrs)				
Reflection, refraction, refractive index, interference	1.1	1	3	Lecture, Practical
Total internal reflection	1.2	1	1	Lecture, Practical
Examples from daily life	1.3	1	2	Lecture
Concave and convex mirrors	1.4	2	1	Lecture, Practical
Lenses – focal length, power of a lens,	1.5	2	1	Lecture, Practical
Refractive index, prism, dispersion	1.6	2	2	Lecture, Practical
Human eye – image formation	1.7	3	1	Lecture
defects of the eye – myopia, hypermetropia, presbyopia and astigmatism	1.8	3	2	Lecture
Correction of eye defects using lenses	1.9	3	2	Lecture
Module 2: Heat (15 Hrs)				
Temperature, heat, measuring temperature	2.1	4	2	Lecture, Practical
Specific heat, high specific heat capacity of water	2.2	4	2	Lecture
Thermal expansion- examples, expansion of water	2.3	4	3	Lecture
Heat transfer- conduction- examples	2.4	4	2	Lecture
convection, radiation, examples	2.5	4	2	Lecture
Absorption and reflection of radiant energy - cooling at night	2.6	4	2	Lecture
Greenhouse effect, Solar power	2.7	4	2	Lecture

Textbook

1. Paul G Hewitt, Conceptual Physics, Tenth Edition, Pearson International, 2006

Reference

1. Arthur Beiser, Fundamentals of Physics with Applications by, TMH
2. Arthur Beiser, Schaum's outline Applied Physics, McGraw Hill

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 3: Light (26 Hrs)				
Reflection at different angles of incidence	1.1	5	3	Demonstration and peer learning
Calculation of focal length of a convex lens	1.2	5	4	Demonstration and peer learning
Calculation of focal length of a concave mirror	1.3	5	3	Demonstration and peer learning
Calculation of apparent depth, true depth	1.4	5	4	Demonstration and

				peer learning
Demonstration of dispersion using a prism	1.5	5	4	Demonstration and peer learning
Demonstration of dispersion using a grating	1.6	5	4	Demonstration and peer learning
Using laser and grating to observe diffraction	1.7	5	4	Demonstration and peer learning
Module 4: Heat (4Hrs)				
Temperature measurement of water using thermometer	2.1	5	1	Demonstration and peer learning
Heat transfer between hot and cold water	2.2	5	3	Demonstration and peer learning

Textbook

1. C. L. Arora, BSc Practical Physics, S. Chand

Course designed by: Dr. Loji K Thomas

SEMESTER II

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24PH2DSC100	Major/ Minor	Electricity and Magnetism	5	75	4
SBU24PH2DSC101	Minor	Perspectives of Modern Physics	5	75	4
SBU24PH2MDC100	MDC	Physics of Electricity and Sound	4	60	3
SBU24PH2MDC101	MDC	A Journey Through Space: An Introduction to Astronomy Observational	4	60	3

SBU24PH2DSC100: ELECTRICITY AND MAGNETISM

Type of Course	Major/Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic knowledge about electric charge, electric field, electrical potential, etc.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the fundamental concepts and laws in electrostatics and apply Gauss's law to certain special cases.	A
CO2	Describe the concept of electrostatic potential energy and the working of capacitors and to apply the role of dielectrics in capacitors.	A
CO3	Explain the magnetic effect of electric currents and apply the relevant theorems in solving problems in the case magnetism.	A
CO4	Describe the behavior of alternating currents in LR, CR and LCR circuits and apply network theorems to analyze DC electrical circuits.	An
CO5	Apply experimental procedures to investigate concepts in electrical and magnetic experiments and analyze the results.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	2	-	1	2	-	3	1
CO2	1	3	2	2	-	1	2	-	3	1
CO3	1	3	2	2	-	1	2	-	3	1
CO4	1	3	2	2	-	1	2	-	3	1
CO5	-	-	3	3	-	1	2	-	-	3

Mapping of CO to Assessment Tools (Theory)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Spot quiz	Exit slip	Spot assignment	Written test	Problem based assignments	
CO1	x	x		x	Assignment	x
CO2		Quiz	x	x	x	x
CO3			x		x	x
CO4	x	x		Quiz	x	x

Mapping of CO to Assessment Tools (Practical)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Name	Name	Name	Name	Name	
CO1						
CO2						
CO3						
CO4						
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Electrostatics (15 Hrs)				
The concept of electric charge and an electric dipole - electric field due to a point charge, an electric dipole and a uniform distribution of electric charges.	1.1	1	3	Lecture and problem solving
Impact of an electric field on a point charge and an electric dipole.	1.2	1	1	Lecture and problem solving
Gauss's Law and applications - fields due to a spherical conductor, uniformly charged wire, infinite plane sheet of charge, electric field at a point between two oppositely charged parallel plates.	1.3	1	3	Lecture and problem solving
Electric potential energy and electric potential - potential due to point charges, group of point charges and an electric dipole.	1.4	2	3	Lecture and problem solving
Dielectrics- polar and nonpolar molecules – Polarization.	1.5	2	2	Lecture
Capacitance and capacitors - spherical capacitors and cylindrical capacitors - energy storage in an electric field – capacitors with dielectric – charging and discharging of capacitors.	1.6	2	3	Lecture demonstration and problem solving
Module 2: Magnetic Effect of Electric Current and Magnetism (15 Hrs)				
Moving charges and magnetism – magnetic poles	2.1	3	0.5	Lecture
Magnetic force on a moving charge – effect of a combined electric and magnetic fields	2.2	3	1	Lecture and problem solving
Circulating charges and cyclotron motion.	2.3	3	0.5	Lecture
Magnetic force on a current carrying conductor and torque on a current carrying loop.	2.4	3	1	Lecture and problem solving
The magnetic field due to a moving charge - magnetic field due to a current carrying straight wire segment and a current carrying circular loop – interaction between two parallel currents.	2.5	3	3	Lecture and problem solving
Magnetic field of a solenoid – Ampere’s law and applications.	2.6	3	3	Lecture and problem solving
Faraday’s law of electromagnetic induction and Lenz’s law – generators and motors – eddy currents.	2.7	3	1	Lecture
The magnetic dipole – atomic and nuclear magnetism – magnetic field and magnetic field lines – magnetisation	2.8	3	2	Lecture
Magnetic materials – classification – the	2.9	3	2	Lecture

magnetism of planets				
Gauss law of magnetism	2.10	3	1	Lecture
Module 3: Alternating Currents and Circuits (15 Hrs)				
Inductance – expressions for inductance of a solenoid and toroid – behaviour of an LR circuit to a direct current - energy transfer in an LC circuit and LC oscillations (qualitative).	3.1	4	4	Lecture and problem solving
General representation of alternating currents- average value of an AC current and voltage during a half cycle - power, peak factor and form factor of an AC.	3.3	4	3	Lecture
The phasor representation of AC through a resistance, a capacitance and an inductor,	3.4	4	2	Lecture
AC through an LCR series and the phenomenon of resonance-Q factor of the circuit-application in radio tuning.	3.5	4	2	Lecture and problem solving
Parallel LCR circuit-parallel resonant circuit and power factor- the concept of wattles current and skin effect	3.6	4	2	Lecture and problem solving
Network theorems- Thevenin's theorem, Norton's theorem, superposition theorem and maximum power transfer theorem.	3.7	4	2	Lecture and problem solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks:

1. David Halliday, Robert Resnick and Kenneth S Krane, Physics volume -II, Wiley India Edition, Fifth Edition
2. R Murugeshan, Electricity and Magnetism, S. Chand & Company Ltd.

References

1. J H Fewkes& John Yarwood, Electricity and Magnetism, University tutorial press
2. Dr E.D Dias, Santhosh P Jose, Electrodynamics made simple, Clare Publishers.
3. A S Mahajan and AA Rangwala, Electricity and Magnetism, TMH 4thEdn.
4. Matthew N Sadiku, Electromagnetics, Oxford 4th Edn.
5. Kraus/Fleish, Electromagnetics with applications, TMH, 5th Edn.
6. J A Edminister, Electromagnetics 2nd Edn, TMH
7. TVS Arunmurthi, Electromagnetic Fields, S. Chand

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: (14 Hrs)				
Carey Foster's Bridge – Measurement of resistivity	5.1	5	2	Demonstration and peer learning
Carey Foster's Bridge – Temperature Coeffcient of resistance	5.2	5	2	Demonstration and peer learning
Potentiometer – Standardization of the	5.3	5	2	Demonstration and peer

potentiometer wire.				learning
Potentiometer – Measurement of resistivity	5.4	5	2	Demonstration and peer learning
Potentiometer – Calibration of ammeter	5.5	5	2	Demonstration and peer learning
Conversion of galvanometer into ammeter	5.6	5	2	Demonstration and peer learning
Conversion of galvanometer into voltmeter	5.7	5	2	Demonstration and peer learning
Module 6: (8 Hrs)				
Verification of Kirchhoff's Laws	6.1	5	2	Demonstration and peer learning
LCR series and parallel resonant circuit analysis	6.2	5	2	Demonstration and peer learning
Verification of Thevenin and Norton theorems	6.3	5	2	Demonstration and peer learning
Verification of Superposition and Maximum power transfer theorems.	6.4	5	2	Demonstration and peer learning
Module 7: (8 Hrs)				
Tangent galvanometer – Ammeter Calibration	7.1	5	2	Demonstration and peer learning
Field along the axis of a circular coil – moment of magnet- Null method	7.2	5	2	Demonstration and peer learning
Searle's Vibration Magnetometer – Magnetic moment	7.3	5	2	Demonstration and peer learning
Deflection and vibration magnetometer – m and B_H	7.4	5	2	Demonstration and peer learning

Textbook

1.M.N. Srinivasan, S, Balasubramanian, R. Ranganathan; A Textbook of Practical Physics; Sultan Chand & Sons

Reference

1.Amrutha Virtal lab; https://vlab.amrutha.edu

2. Kumar, P.R. Sasi; Practical Physics; PHI Learning

Course Designed by: Dr. Joshy Jose

SBU24PH2DSC101: PERSPECTIVES OF MODERN PHYSICS

Type of Course	Minor		
Course Level	100-199		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic knowledge about light and matter.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understands the quantization of light and the experiments that led to it, and apply the principles.	A
CO2	Familiarise with the atomic energy levels and their implications and apply them.	A
CO3	Introduced to the dual nature matter and apply them.	A
CO4	Familiarise the quantum mechanical description of the atomic phenomena.	A
CO5	Develops experimental skills and analyse the process and outcomes of an experiment quantitatively and qualitatively.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	-	2	1	1	2	1
CO2	2	2	2	2	-	2	-	1	2	1
CO3	2	2	2	2	2	2	1	1	2	1
CO4	1	2	-	1	2	-	-	2	2	2
CO5	-	-	3	3	-	1	2	-	-	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Spot assignment	Written test	Problem based assignments	
CO1	x	x		x	x	x
CO2		Quiz	x	x	x	x
CO3	x		x	x	x	x
CO4	x		x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment		Summative Assessment			ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Quantization of Light (15 Hrs)				
Quantization of Light	1.1	1	1	Lecture
Planck and Blackbody Radiation	1.2	1	2	Lecture and problem solving
Photoelectric Effect	1.3	1	3	Lecture and problem solving
X-rays and Bragg diffraction	1.4	1	3	Lecture and problem solving
X-ray spectra	1.5	1	2	Lecture and problem solving
Compton Effect	1.6	1	3	Lecture and problem solving
Particle – Wave duality	1.7	1	1	Lecture
Module 2: Quantization of Atomic Energy Levels (15 Hrs)				
Atomic Spectra	2.1	2	2	Lecture
Balmer- Rydberg Formula	2.2	2	2	Lecture and problem solving
Bohr's Explanation of Atomic Spectra	2.3	2	2	Lecture
Bohr Model of hydrogen Atom	2.4	2	4	Lecture and problem solving
Explanation of Characteristic X-rays	2.5	2	2	Lecture
Frank Hertz Experiment	2.6	2	2	Lecture and problem solving
Energy Loss Spectra	2.7	2	1	Lecture
Module 3: Matter Waves (15 Hrs)				
De Broglie's Hypothesis	3.1	3	2	Lecture and problem solving
Davisson Germer Experiment	3.2	3	2	Lecture and problem solving
The Quantum Wavefunction	3.3	3	2	Lecture
Probability Interpretation	3.4	3	2	Lecture and problem solving
Wave Packets	3.5	4	2	Lecture
Uncertainty relation for Position and Momentum	3.6	4	2	Lecture and problem solving
Heisenberg's Microscope	3.7	4	2	Lecture
Velocity of Wave Packet	3.8	4	1	Lecture and problem solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook:

1. John R. Taylor, Chris D. Zafiratos, Michael A. Dubson; Modern Physics for Scientists and Engineers, Second Edition, PHI, 2013

References

1. Arthur Beiser; Concepts of Modern Physics; TMH
2. Paul G Hewitt; Conceptual Physics; Tenth Edition; Pearson
3. Hugh D. Young, Roger A. Freedman; Sears and Zemansky's University Physics; !2th Edition; Pearson
4. Jearl Walker, David Halliday, Robert Resnick; Principles of Physics; 10th Edition; Wiley
5. R. Murugeshan, Kiruthiga Sivaprasath; Modern Physics; 18th Edition; S Chand

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: (6 Hrs)				
Travelling Microscope – Radius of a capillary tube	1.1	5	3	Demonstration and peer learning
Measurement of density of a solid – Sensibility method to find mass using beam balance	1.2	5	3	Demonstration and peer learning
Module 6:(12 Hrs)				
Spectrometer – Refractive index of material of prism	2.1	5	4	Demonstration and peer learning
Liquid Lens – Determination of refractive index of a liquid – water and unknown liquid	2.2	5	4	Demonstration and peer learning
Spectrometer – Hollow Prism – Determination of refractive index of liquid	2.3	5	4	Demonstration and peer learning
Module 7: (12 Hrs)				
Potentiometer – Standardization of the potentiometer wire	3.1	5	4	Demonstration and peer learning
Potentiometer – Calibration of ammeter	3.2	5	4	Demonstration and peer learning
Carey Foster's Bridge – Measurement of resistivity	3.3	5	4	Demonstration and peer learning

Textbook

1. M.N. Srinivasan, S, Balasubramanian, R. Ranganathan; A Textbook of Practical Physics; Sultan Chand & Sons

Reference

1. Amrutha Virtual lab; https://vlab.amrutha.edu
2. Kumar, P.R. Sasi; Practical Physics; PHI Learning

Course designed by: Mr Ajai Jose

SBU24PH2MDC100: PHYSICS OF ELECTRICITY AND SOUND

Type of Course	MDC		
Course Level	100 -199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)	Class 10 level physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe electric charges, Ohm's law,	U
CO2	Describe electric power, energy requirements, devices	U
CO3	Describe transformer, hydroelectric power generation	U
CO4	Describe waves, Sound, Doppler effect, shock waves, musical instruments	U
CO5	Develops experimental skills and analyse the process and outcomes of an experiment quantitatively and qualitatively	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2				1	1			
CO2	3	2				1	1			
CO3	3	2				1	1			
CO4	3	2				1	1			
CO5	3	2				1	1			

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x			x	x	x
CO2		x	x	x	x	x
CO3			x	x	x	x
CO4		x		x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Electricity (15 Hrs)				
Electrical forces, charges, atoms, conservation of charge	1.1	1	2	Lecture
Conductors and insulators, semiconductors, superconductors	1.2	1	2	Lecture
Voltage and current, Ohms law and electric shock	1.3	1	2	Lecture, Practical
Direct current and alternating current	1.4	1	1	Lecture, Practical
Electric energy, electric power,	1.5	2	2	Lecture
Electric circuits- series and parallel, overloading, safety fuses	1.6	2	2	Lecture, Practical
calculation of energy requirement of electric appliances	1.7	2	2	Lecture
Transformer, generator, hydroelectric power generation	1.8	3	2	Lecture, Practical
Module 2: Sound (15Hrs)				
Wave description, Wave speed, Longitudinal and transverse waves	2.1	4	2.5	Lecture
Origin of sound, Nature of sound in air, media that transmit sound, speed of sound in air	2.2	4	2.5	Lecture
Reflection and refraction of sound- ultrasound scanning, bats and dolphins	2.3	4	2	Lecture, Practical
Natural frequency, resonance, interference	2.4	4	2	Lecture, Practical
Doppler effect, shock waves	2.5	4	2	Lecture
Musical sound- graphical representation of noise and music	2.6	4	1	Lecture, Practical
Sound intensity and loudness	2.7	4	1	Lecture
Musical instruments	2.8	4	1	Lecture
Compact discs	2.9	4	1	Lecture

Textbook

1. Paul G Hewitt, Conceptual Physics, Tenth Edition, Pearson International, 2006

Reference

1. Arthur Beiser, Fundamentals of Physics with Applications by, TMH
2. Arthur Beiser, Schaum's outline Applied Physics, McGraw Hill

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 3: (23 Hrs)				
Multimeter – measurement of resistance	1.1	5	3	Demonstration and peer learning

Multimeter – measurement of DC voltage	1.2	5	3	Demonstration and peer learning
Cathode Ray oscilloscope - display of different waveforms- sinusoidal, square, triangular	1.3	5	4	Demonstration and peer learning
VI characteristics of resistor	1.4	5	5	Demonstration and peer learning
VI characteristics of p-n junction diode	1.5	5	4	Demonstration and peer learning
Using a breadboard to set up a simple circuit	1.6	5	4	Demonstration and peer learning
Module 4:(7 Hrs)				
Setting up stationary waves in a sonometer wire	2.1	5	4	Demonstration and peer learning
Making musical notes with glasses of varying water heights	2.2	5	3	Demonstration and peer learning

Textbook

1. C. L. Arora, BSc Practical Physics, S. Chand

Course designed by: Dr. Loji K Thomas

SBU24PH2MDC101: A JOURNEY THROUGH SPACE - AN INTRODUCTION TO ASTRONOMY OBSERVATIONAL

Type of Course	MDC		
Course Level	100-199		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	30	30	60
Pre-requisite (if any)	Class 10 level Physics and Maths		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the historical development of astronomy, key concepts of observational astronomy, models of solar system and laws	U
CO2	Understand the working of different types of telescopes.	U
CO3	Understand how to interpret the night sky, the phases and characteristics of the Moon, the Sun and its effects	U
CO4	Understand the characteristics of planets, meteors, and other small bodies within the solar system.	U
CO5	Apply theoretical knowledge to gain expertise in constructing and handling different tools for observational astronomy	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1					1		1		
CO2	1	1	1			1				
CO3	1	1	1			1				
CO4	1	1				1				
CO5	1	1				1		1	1	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit Slips	Quiz	Assignments	Written test	Viva	
CO1	x	x		x	x	x
CO2	x	x		x	x	x
CO3		x	x	x	x	x
CO4		x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	**Observation of practical skills**	**Practical Assignment**	**Laboratory report**	**Interview**	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Observational Astronomy (7 hours)				
Ancient Astronomy- Astronomy around the World, Early Greek and Roman Cosmology, Ptolemy's Model of the Solar System, Astrology and Astronomy	1.1	CO1	2	Lecture
The Celestial Sphere, Celestial Poles and Celestial Equator, Rising and Setting of the Sun, Fixed and Wandering Stars, Constellations	1.2	CO1	2	Lecture Demo Practical
The Birth of Modern Astronomy-Copernicus, The Heliocentric Model, Galileo and the Beginning of Modern Science, Galileo's Astronomical Observations, Kepler's Laws of Planetary Motion, Orbits in the Solar System.	1.3	CO1	3	Lecture Practical
Module 2: Telescopes (8 hours)				
Telescopes The human eye, the use of a telescope or pair of binoculars to see fainter objects, The effect of diffraction on the resolution of a telescope, magnification of a telescope, Image contrast	2.1	CO2	3	Lecture Practical
Types of telescopes- optical Telescopes- Reflective telescopes, Refractive telescopes, The Cassegrain telescope	2.2	CO2	2	Lecture Practical
Modern telescopes- Gemini, Keck telescopes, The South Africa Large Telescope (SALT), The Very Large Telescope (VLT), Hubble Space Telescope, James Webb Space Telescopes. Radio telescopes- GMRT.	2.3	CO2	3	Lecture
Observing the Night Sky (15 hours)				
Darkness and Light, Finding Your Way around the Sky, Cosmic Protractor, Special Effects, Night Vision, The Milky Way	3.1	CO3	2	Lecture Practical
Moon: Phases of Moon, Characteristics, Moonrise, Moonset, Moon Illusion, Sightseeing on the moon, Lunar topography, Formation, Lunar Eclipse	3.2	CO3	3	Lecture Practical
Sun, how seasons happen, Sun paths, telling time by the Sun, A visit to the sun, Power house, Storms on Sun, How the Sun formed, Our sun is born	3.3	CO3	3	Lecture Demo
Solar Eclipse, How Are Eclipse of the Sun and Moon the Same-and Different? Why Can't We Look at the Sun? What to take eclipse-watching?	3.4	CO3	2	Lecture Demo Practical

Planets: Earth's siblings in the sky, Star or Planet? Sky Wanderer, Roaming around Solar system, Terrestrial & Jovian Planets, Small solar system Bodies, Meet the eight planets	3.5	CO4	3	Lecture Demo Practical
Meteors, Meteor Showers and Asteroids	3.6	CO4	1	Lecture Practical
How the Solar System Formed, Comets, Other suns and their Solar Systems	3.7	CO4	1	Lecture Video

Textbook

1. Astronomy by Andrew Fraknoi, David Morrison, and Sidney C. Wolff, OpenStax CNX
2. Sky Gazing- A Guide to the Moon, Sun, Planets, Stars, Eclipses, and Constellations by MegThacher, Storey Publishing.
3. Ian Morison, Introduction to astronomy and cosmology, John Wiley & Sons, UK, 2008
4. Asteroids, comets, and meteors by Ron Miller, Worlds beyond

Reference

1. The Joy of Skywatching by Biman Bose, National Book Trust, India.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Observational Astronomy (7 hours)				
Familiarization of Astronomy software stellarium	1.1	CO5	2	Demonstration and peer learning
Identify constellations using stellarium	1.2	CO5	2	Demonstration and peer learning
Observe and sketch the map of constellations observable in any one night	1.3	CO5	3	Demonstration and peer learning
Module 2: Telescopes (12 hours)				
Familiarization of a reflecting telescope	2.1	CO5	3	Demonstration
Illustration of visible spectrum using prism and telescope**.**	2.2	CO5	2	Demonstration and peer learning
Make your own telescope (Group activity)	2.3	CO5	4	Demonstration and peer learning
Take a Photo of Moon using Telescope and Mobile phone and identify any Five features on Moon.	2.3	CO5	3	Demonstration and peer learning
Module 3: Observing the Night Sky (11 hours)				
Making models of any astronomical phenomena or objects (Solar system, Phases of Moon, Lunar-solar eclipse etc)	3.1	CO5	3	Peer learning
Identify Orion Constellation and prepare a report on important stars in this constellation.	3.2	CO5	2	Peer learning
Identifying and documenting planets/stars	3.3	CO5	2	Peer learning
Observe a Solar and Lunar eclipse using stellarium.	3.4	CO5	2	Peer learning

Go to NASA Eclipse website and make a report on important Solar and Lunar Eclipses that can be observed from your place.				
Seasonal Sky gazing Northern Hemisphere – identify November, December & January Stars. (Constellations Orion, Canis Major, Lepus, Taurus, Gemini, Auriga)	3.5	CO5	2	Peer learning

Textbook

1. Moché, Dinah L. Astronomy. A self-teaching guide. Seventh Edition, John Wiley and Sons 1993.
2. Basu, Biman Joy of star watching by, National Book Trust, India 2017.

Reference

1. A Guide to Smartphone Astrophotography by Dr. Sten Odenwald, a free e-book from NASA https://spacemath.gsfc.nasa.gov/SMBooks/AstrophotographyV1.pdf
2. https://stellarium.org/
3. https://va-iitk.vlabs.ac.in/?page=exp1
4. https://www.zooniverse.org/projects/zookeeper/galaxy-zoo/
5. https://eclipse.gsfc.nasa.gov/

SEMESTER III

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24PH3DSC200	Major	Basic Electronics	5	75	4
SBU24PH3DSC201	Major	Properties of Solids and Fluids	5	75	4
SBU24PH3DSC202	Minor	Wave Optics	5	75	4
SBU24PH3DSE200	Elective	Basic Nuclear Physics and Astrophysics	4	60	4
SBU24PH3DSE201	Elective	Renewable Energy Technology	4	60	4
SBU24PH3MDC200	MDC	Physics of Motion, Matter, Devices and Energy	3	45	3
SBU24PH3VAC200	VAC	Physics for Society	3	45	3

SBU24PH3DSC200: BASIC ELECTRONICS

Type of Course	Major		
Course Level	200 – 299		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	Basic information about electronics components and circuits.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Summarize the basic concepts in semiconductor electronics and working of different types of semiconductor diodes.	U
CO2	Explain the working of different diode circuits like rectifiers, voltage regulators and wave shaping circuits using diodes and apply appropriate theoretical techniques in solving numerical problems.	A
CO3	Understand the working of a transistor and apply transistor biasing methods to achieve desired operating points and optimize circuit performance.	A
CO4	Apply the principles and theories governing the working of transistors to demonstrate electronic circuits like amplifiers and oscillators, demonstrating a proficiency in practical applications	A
CO5	Apply experimental procedures to investigate the output in electronics experiments using semiconductor diodes and transistors.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	2	-	1	2	-	3	1
CO2	1	3	2	2	-	1	2	-	3	1
CO3	1	3	2	2	-	1	2	-	3	1
CO4	1	3	2	2	-	1	2	-	3	1
CO5	-	-	3	3	-	1	2	-	-	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Spot assignment	Written test	Assignment/ Problem based assignments	
CO1	x	x		x	x	x
CO2		Quiz	x	x	x	x
CO3			x		x	x
CO4	x	x		Quiz	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment		Summative Assessment			ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: P-N Junction Diodes and Diode Circuits (15 Hrs)				
Classification of materials into metals, insulators and semiconductors - the process of doping - intrinsic and extrinsic semiconductors	1.1	1	2	Lecture
P-N junction diode - barrier formation in a P-N Junction diode — current flow mechanism - forward and reverse biasing of diodes.	1.2	1	2	Lecture, Practical
V-I characteristics of a P-N junction diode – diode equation (no derivation) - static and dynamic resistances — junction capacitance, ideal diode	1.3	1	2	Lecture, Practical
Special type of diodes: Zener diode, Tunnel diode, Varactor diode, PIN diode, Schottky diode – LED - Photo diode.	1.4	1	3	Lecture, Practical
Rectifiers: Half wave rectifiers, centre tapped full wave and bridge rectifiers — circuit diagram, working, output waveforms, expressions for I_{dc} and I_{rms}, ripple factor and efficiency.	1.5	2	4	Lecture, Practical
Filter circuits: Shunt capacitor filter, series inductor filter — LC filter — CLC π filter (qualitative)	1.6	2	2	Lecture, Practical
Module 2: Diode circuits and introduction to transistor (15 Hrs)				
Zener diode voltage regulation - Line regulation and Load regulation	2.1	2	1	Lecture, Practical
Clipping circuits: Positive clipper, negative clipper, combination clipper and biased clipper - circuit diagrams, working and wave forms,	2.2	2	2	Lecture, Practical
Clamping circuits : Positive clamper and negative clamper — circuit diagrams, working, input and output waveforms, voltage multipliers	2.3	3	2	
Transistor construction — transistor action — working of NPN and PNP transistors	2.4	3	3	Lecture
Common base, common emitter and common collector configurations, characteristics - active, saturation and cut off regions, current gains α, β, γ and their relationships, comparison of CE, CB and CC configurations.	2.5	3	4	Lecture, Practical
Transistor Biasing— load line and Q-point - different methods of transistor biasing — fixed bias, fixed bias with emitter resistor, voltage divider bias	2.6	3	3	Lecture, Practical
Module 3: Transistor Applications (15 Hrs)				
Transistor as an amplifier — small signal operation of CE amplifier, phase reversal, voltage gain, power-gain	3.1	4	4	Lecture, Practical
Feedback in amplifiers: Positive and negative	3.2	4	4	Lecture,

feedback, effects on input impedance, output impedance and gain				Practical
Negative feedback in transistor amplifiers -CE amplifier without emitter bypass capacitor, Emitter follower	3.3	4	3	Lecture
Transistor as an Oscillator: Barkhausen criterion for self-sustained oscillations - Hartley Oscillator, RC Phase shift oscillator	3.4	4	4	Lecture, Practical
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Text Books

1. A Text Book of Applied Electronics-R.S. Sedha: S. Chand Co. Revised Edn. (2008)
2. Basic Electronics-B.L. Theraja: S. Chand Co. (2007)
3. Principles of Electronics -V.K. Metha, Rohit Mehta, 11th ed.; S. Chand and Company Ltd, 2011

References

1. Electronic principles, 7th Edition, -Albert Malvino and David J Bates; TMH Edn. Pvt Ltd.
2. Electronic Devices and circuits -Allen Mottershead; PHI
3. Electronic Principles-Sahdev, Dhanpat Rai Co.
4. Electronic Devices and Circuit Theory-Robert L Boylestad&Louis Nashelsky; PHI, Pearson
5. Electronic Principles and Applications- Schuler; McGrawHill
6. Foundations of Electronics-D Chattopadhyay, P.C. Rakshit, B Saha, N.N. Purkait; New age International Publishers
7. Electronic Devices and Circuits-Sajeev Gupta; Dhanpat Rai Publications
8. Basic Electronics and Linear Circuits-N.N. Bhargava, D.C. Kulshreshtha & S.C. Gupta;Tata Mc Graw Hill
9. Introduction to Semiconductor Devices - Kevin & Brennan; Cambridge Univ. Press
10. The Art of Electronics, Paul Horowitz and Winfield Hill; Cambridge Univ. Pres

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5 (16 Hrs)				
Multimeter – measurement of voltage, current and resistance.	5.1	5	1.5	Demonstration and peer learning
Cathode Ray oscilloscope – Calibration and measurement of frequency and amplitude	5.2	5	1.5	Demonstration and peer learning
PN junction diode characteristics	5.3	5	2	Demonstration and peer learning
LED characteristics	5.4	5	1.5	Demonstration and peer learning
Photodiode characteristics	5.5	5	1.5	Demonstration and peer learning
Zener diode characteristics	5.6	5	2	Demonstration and peer learning

Half wave rectifier with and without shunt capacitor filter-study of ripple factor	5.7	5	2	Demonstration and peer learning
Central Tapped Full wave rectifier with and without shunt capacitor filter-study of ripple factor	5.8	5	2	Demonstration and peer learning
Full wave bridge rectifier with and without shunt capacitor filter-study of ripple factor	5.9	5	2	Demonstration and peer learning
Module 6: (14 Hrs)				
V-I characteristics of a Zener diode	6.1	5	2	Demonstration and peer learning
Voltage regulation using Zener diode – study of line regulation and load regulation.	6.2	5	2	Demonstration and peer learning
Diode clippers-positive clipper, negative clipper and biased clipper-study of wave forms	6.3	5	2	Demonstration and peer learning
Diode clampers-positive clamper, negative clamper and biased clampers-study of wave forms	6.4	5	2	Demonstration and peer learning
Voltage doubler and tripler	6.5	5	2	Demonstration and peer learning
Transistor characteristics-common emitter configuration	6.6	5	2	Demonstration and peer learning
Transistor characteristics-common base configuration	6.7	5	2	Demonstration and peer learning

Textbook

1. M.N. Srinivasan, S, Balasubramanian, R. Ranganathan; A Textbook of Practical Physics; Sultan Chand & Sons
2. Principles of Electronics -V.K. Metha, Rohit Mehta, 11th ed. S. Chand and Company Ltd, 2011

Reference

1. Amrutha Virtual lab; https://vlab.amrutha.edu
2. Kumar, P.R. Sasi; Practical Physics; PHI Learning

Course Designed by: Dr. Joshy Jose

SBU24PH3DSC201: PROPERTIES OF SOLIDS AND FLUIDS

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic idea about the fundamental properties of solids and fluids		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the elastic behavior of solid materials under various loading conditions and apply the concept to calculate stress and strain, and use this information to predict material deformation and failure in physical applications	A
CO2	Utilize knowledge of torsional rigidity and to implement this understanding in the design and optimization of practical engineering components, ensuring their resilience and performance in real-world applications.	A
CO3	Apply the principles of viscosity and demonstrate proficiency in assessing the resistance of fluids to the practical implications in real-world scenarios.	A
CO4	Utilize the principles of surface tension concepts to various fluid systems and interfaces in real-world applications.	A
CO5	Apply experimental procedures pertaining to elasticity, viscosity and surface tension.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	2	-	1	2	-	3	1
CO2	1	3	2	2	-	1	2	-	3	1
CO3	1	3	2	2	-	1	2	-	3	1
CO4	1	3	2	2	-	1	2	-	3	1
CO5	-	-	3	3	-	1	2	-	-	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Spot assignment	Written test	Problem based assignments	
CO1	x	x		x	Assignment	x
CO2		Quiz	x	x	x	x
CO3	x	x			x	x
CO4	x	x		Quiz	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Name	Name	Name	Name	Name	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Elasticity (17 Hrs)				
Stress, Strain and Hooks law, stress-strain graph, elastic aftereffect, elastic hysteresis, elastic fatigue and factors affecting elasticity.	1.1	1	2	Lecture
Young's Modulus, Bulk Modulus, Modulus of Rigidity	1.2	1	1	Lecture
Work done per unit volume during longitudinal strain, volume strain and Shearing strain	1.3	1	1	Lecture
Poisson's ratio and relation connecting elastic constants	1.4	1	1	Lecture and problem solving
Bending of beams-uniform and non-uniform bending - axis of bending, plane of bending, neutral surface, neutral axis. Bending moment, Flexural rigidity.	1.5	1	1	Lecture
Cantilever – derivation of depression at the free end of a loaded cantilever, Experiment for the determination of Young's Modulus.	1.6	1	2	Lecture and problem solving
Expression for the elevation at the midpoint of a beam supported symmetrically on two knife edges	1.7	1	2	Lecture and problem solving
Expression for the depression at the midpoint of a beam supported at the ends and loaded at the center/midpoint	1.8	1	2	Lecture and problem solving
Twisting couple on a cylinder-expression for the couple for unit twist and rigidity modulus of the material of a wire or cylinder-comparison of the couple per unit twist of a hollow cylinder and a solid cylinder	1.9	2	3	Lecture and problem solving
Experimental Determination of rigidity modulus of a wire/ cylindrical rod - Static method using static torsion apparatus and dynamic method using torsion pendulum.	1.10	2	2	Lecture and problem solving
Module 2: Viscosity (15 Hrs)				
Rate of Flow or Discharge of fluids, streamline flow and turbulent flow	2.1	3	1	Lecture
Continuity equation in one and three dimensions-derivation	2.2	3	2	Lecture
Energies possessed by a fluid under motion, Derivation of Euler's equation of motion and Bernoulli's Theorem.	2.3	3	3	Lecture
Velocity of efflux of a liquid-the Torricelli's theorem-Some important applications of Bernoulli's theorem-working of venturi meter, atomizer and Bunsen burner	2.4	3	3	Lecture
Viscosity of a fluid, velocity gradient and critical velocity-Reynold's number and its significance	2.5	3	1.5	Lecture

Derivation of Poiseuille's formula, limitations and correction to the Poiseuille's formula.	2.6	3	1.5	Lecture
Experimental measurement of coefficient of viscosity by using Poiseuille's equation – constant pressure head method and variable pressure head method	2.7	3	1	Lecture and problem solving
Motion of bodies in a viscous medium – terminal velocity-The Stokes' formula and the experimental determination of viscosity of a liquid by Stoke's method. Application of viscosity in lubrication.	2.8	3	2	Lecture and problem solving
Module 3: Surface Tension (13 Hrs)				
Adhesive force and cohesive force - the phenomenon of surface tension-surface energy and molecular theory of surface tension.	3.1	4	2	Lecture
Excess of pressure inside a spherical liquid drop, liquid bubble and a liquid jet – case of layer of liquid between two plates	3.2	4	3	Lecture and problem solving
Shape of liquid meniscus in a capillary tube - angle of contact - case of two liquids in contact with air-Newmann's triangle.	3.3	4	2	Lecture
Rise or fall of a liquid in a capillary tube –derivation of Jurin's equation - experimental measurement of surface tension of a liquid by using capillary rise method-rise of liquid in a tube of insufficient length.	3.4	4	3	Lecture and problem solving
Shape of liquid drops on a horizontal plate – experimental determination of surface tension of a liquid which do not wet the surface in contact – the Quincke's method.	3.5	4	2	Lecture
Factors affecting surface tension and applications of surface tension	3.6	4	1	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Text Book

1. D S Mathur, Elements of Properties of Matter, S Chand 3rd Edn

References

1. Halliday, Resnik and Walker, Fundamentals of Physics – John Wiley & sons
2. Brijlal and N Subrahmaniam, Properties of Matter– S Chand 3rd Edn

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: (20 Hrs)				
Cantilever – Pin and microscope-Determination of Youngs Modulus	5.1	5	3	Demonstration and peer learning
Cantilever – Scale and Telescope – Determination of Young's modulus	5.2	5	2	Demonstration and peer learning
Nonuniform bending – Pin and microscope-	5.3	5	3	Demonstration and

Determination of Youngs Modulus				peer learning
Uniform Bending – Optic lever – Determination of Youngs Modulus	5.4	5	2	Demonstration and peer learning
Nonuniform Bending – Optic lever – Determination of Youngs Modulus	5.5	5	2	Demonstration and peer learning
Koenig's method – Determination of Youngs Modulus	5.6	5	2	Demonstration and peer learning
Uniform Bending – Pin and Microscope – Determination of Youngs Modulus	5.7	5	2	Demonstration and peer learning
Torsion Pendulum-rigidity modulus of the material of a wire	5.8	5	2	Demonstration and peer learning
Static Torsion – Determination of Rigidity modulus	5.9	5	2	Demonstration and peer learning
Module 6: (4 Hrs)				
Capillary rise method – Determination of surface tension	6.1	5	2	Demonstration and peer learning
Quincke's method-Determination of surface tension of mercury	6.2	5	2	Demonstration and peer learning
Module 7: (6 Hrs)				
Constant pressure head – Determination of viscosity of a liquid	7.1	5	2	Demonstration and peer learning
Variable pressure head – Determination of viscosity of a liquid	7.2	5	2	Demonstration and peer learning
Stokes method – determination of viscosity of liquid	7.3	5	2	Demonstration and peer learning

Textbook

1. M.N. Srinivasan, S, Balasubramanian, R. Ranganathan; A Textbook of Practical Physics; Sultan Chand & Sons

Reference

1. Amrutha Virtual lab; https://vlab.amrutha.edu
2. Kumar, P.R. Sasi; Practical Physics; PHI Learning

Course Designed by: Dr. Joshy Jose

SBU24PH3DSC202: WAVE OPTICS

Type of Course	Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Higher secondary school physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe interference of light and apply it to thin films	A
CO2	Describe Newton's rings	U
CO3	Describe diffraction and diffraction grating	U
CO4	Describe polarisation of light	R
CO5	Apply experimental procedures pertaining to different optical instruments	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3		1			1			2	
CO2	2		2			1				
CO3	3	1	2			1				
CO4	2		1			1				
CO5	3					1				

Mapping of CO to Assessment Tools (Theory)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Spot quiz	Exit slip	Spot assignment	Written test		
CO1	x	x		x		x
CO2		Quiz	x	x		x
CO3			x	x		x
CO4	x	x		x		x

Mapping of CO to Assessment Tools (Practical)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Name	Name	Name	Name	Name	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	**Unit**	**CO**	**Hours**	**Transaction Mechanism**
Module 1: Interference (15 Hrs)				
Principle of superposition, Interference of light,	1.1	1	3	Lecture
Young's double slit experiment (division of	1.2	1	3	Lecture and

wave front),				problem solving
Newton's rings by reflected light (division of amplitude)	1.3	2	3	Lecture and problem solving
Applications of Newton's rings	1.4	2	3	Lecture, Practical
Interference in thin films- reflected light	1.5	1	3	Lecture, demonstration
Module 2: Diffraction (15 Hrs)				
Fresnel and Fraunhofer diffraction,	2.1	3	3	Lecture
Theory of Fraunhoffer diffraction of N slits	2.2	3	4	Lecture and problem solving
Plane transmission grating	2.3	3	2	Lecture and problem solving
Grating- Determination of wavelength (normal incidence)	2.4	3	4	Lecture, Practical
Resolving power and dispersive power of grating	2.5	3	2	Lecture and problem solving
Module 3: Polarization (15 Hrs)				
Introduction- polarized and unpolarized light, Elliptically and circularly polarized light, plane of vibration, plane of polarization,	3.1	4	3	Lecture
Brewsters Angle	3.2	4	1.5	Lecture and problem solving
polarization by refraction through pile of plates – law of Malus,	3.3	4	1.5	Lecture
Polarization by scattering	3.4	4	1	Lecture
polarization by selective absorption	3.5	4	1	Lecture
Uni-axial and biaxial crystals	3.6	4	1.5	Lecture
Double refraction- principal plane- polarization by double refraction	3.7	4	1.5	Lecture
Polaroid	3.8	4	1	Lecture
Quarter wave plate – Half wave plate	3.9	4	3	Lecture, problem solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1.N. Subramanyam Brijlal, M N Avadhanulu, A textbook of Optics, S. Chand, 2009

Reference

1.Optical Electronics – Ajoy Ghatak and K Thyagarajan, Cambridge
2.Optics and Atomic Physics D P Khandelwal, Himalaya Pub. House
3.Optics – Eugene Hecht, A R Ganesan, IV Edn, Pearson Education
4.Optics S K Srivastava, CBS Pub. N Delhi
5.A Text book of Optics S L Kakani, K L Bhandari, S Chand.
6.Optics - Ajay Ghatak- 6th Edition McGraw Hill Education (India) Private Limited
7.Introduction to optics – Pedrotti & Pedrotti

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module :5 (30 Hrs)				
Spectrometer – Determination of angle of prism	5.1	5	5	Demonstration and peer learning
Spectrometer – Determination of refractive index of the material of prism	5.2	5	4	Demonstration and peer learning
Newton's rings– Determination of wavelength of sodium light	5.3	5	5	Demonstration and peer learning
Air wedge – Determination of thickness of thin wire	5.4	5	4	Demonstration and peer learning
Diffraction grating Determination of wavelength of laser	5.5	5	4	Demonstration and peer learning
Laser – Determination of spot size and divergence	5.6	5	4	Demonstration and peer learning
Brewsters Angle determination	5.7	5	2	Demonstration and peer learning
Spectrometer – Dispersive power of a prism	5.8	5	2	Demonstration and peer learning

Textbook

1. C. L. Arora, BSc Practical Physics, S Chand

Reference

1.Harnam Singh, P S Hemne, BSc Practical Physics, S Chand

Course designed BY: Dr. Gijo Jose

SBU24PH3DSE200: BASIC NUCLEAR PHYSICS AND ASTROPHYSICS

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	A foundational understanding of physics, including classical mechanics, electromagnetism, and introductory quantum mechanics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Exhibit a thorough understanding of atomic nuclei, encompassing their classification, inherent properties, stability, binding energy, and phenomena including radioactivity, fission, and fusion reactions.	U
CO2	Develop proficiency in utilising various units and measurement systems in astrophysics, including coordinate systems, time scales, distances, magnitudes, colour indices, and temperature scales, facilitating accurate quantification and analysis of astronomical phenomena	A
CO3	Acquire understanding of nuclear reactions in stars, equations of stellar structure, stellar classification, and stellar evolution processes, including the formation of protostars, main sequence stars, red giants, white dwarfs, supernovae, neutron stars, and black holes.	U
CO4	Comprehend the structure, composition, and dynamics of the Sun, including its interior layers, solar activities like sunspots, solar cycles, flares, and oscillations, as well as its impact on the solar system and its origins.	U
CO5	Develop the ability to analyse and interpret astrophysical phenomena using theoretical models and observational data, enabling informed conclusions about the structure, evolution, and dynamics of celestial objects and systems	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	1	1	-	-	3	-	-	1	1
CO2	3	1	1	-	-	3	-	-	1	1
CO3	3	1	1	-	-	3	1	-	1	1
CO4	3	1	1	-	-	3	1	-	1	1
CO5	3	1	1	-	-	3	1	-	1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Spot assignment	Written test	Assignment/ Problem based assignments	
CO1	x	x		x	x	x
CO2	x		x	x	x	x
CO3			x		x	x
CO4	x				x	x
CO5	x	x		x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Basic Nuclear Physics (15 Hrs)				
Atomic Nuclei	1.1	1	1	Lecture
Classification of Nuclei	1.2	1	1	Lecture
General Properties of a Nucleai -size, density, charge, angular momentum, nuclear magnetic moment and quadrupole moment	1.3	1	2	Lecture, Problem solving
Stability of the nucleus and binding energy	1.4	1	1	Lecture
Magic numbers	1.5	1	1	Lecture
Nuclear force and properties of nuclear force	1.6	1	1	Lecture
Radioactivity – properties of alpha, beta and gamma rays	1.7	1	1	Lecture
Law of radioactive decay – half life and mean life	1.8	1	2	Lecture, Problem solving
Fission and fusion reactions	1.9	1	2	Lecture
Fusion processes in stars	1.10	1	1	Lecture
Big bang – the beginning, Primordial nucleosynthesis	1.11	5	2	Lecture
Module 2: Basic Units and Measurements in Astrophysics (15 Hrs)				
Coordinate systems, Sidereal, solar, universal, standard and ephemeris times	2.1	2	2	Lecture
Parallax, precession, nutation, aberration	2.2	2	2	Lecture
Proper motion - radial and transverse velocities, space velocity	2.3	2	3	Lecture, Problem solving
Units of distance - AU, light year and parsec	2.4	2	1	Lecture, Problem solving
Magnitude scale - magnitudes and luminosities (apparent and absolute)	2.5	2	2	Lecture
Color indices and surface temperature,	2.6	2	2	Lecture
Distance modulus – distances of stars	2.7	2	1	Lecture
Radii of stars and Masses of stars	2.8	2	2	Lecture
Module 3: Stellar structure and stellar evolution (15 Hrs)				
Nuclear reactions in stars: H burning, Helium	3.3	3	4	Lecture

burning, Neutrinos, P-P chain reaction, CNO cycle. Energy release in stars				
Basic equations of stellar structure	3.1	3	3	Lecture
Stellar classification (HD Catalogue and MK System) and HR diagram	3.2	3	3	Lecture
Evolution of stars: Protostars, main sequence stars and red giants	3.4	3	2	Lecture
White dwarfs, supernova explosion and neutron stars	3.5	3	2	Lecture
Black hole	3.6	3	1	Lecture
Module 4: The Sun as a star (15 Hrs)				
The structure and composition of the sun – Solar interior, Photosphere, corona, chromosphere, solar wind	4.1	4	4	Lecture
Solar activities – sunspots, solar cycle, flares, solar oscillations and helio-seismology, CME's.	4.2	4	4	Lecture
The solar system – general characteristics, Origin of the solar system	4.3	5	3	Lecture
Orbits of planets, satellites and comets, Exoplanets	4.4	5	4	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Arthur Beiser, Shobhit Mahajan and S Rai Choudhury, Concepts of Modern Physics, McGraw-Hill Book Co., Inc., New York
2. Basu, B., Chattopadhyay, T., & Biswas, S. N. (2010). An introduction to Astrophysics. PHI Learning Pvt. Ltd.
3. Ian Morison, Introduction to astronomy and cosmology - (John Wiley & Sons)

Reference

1. John Lilley, Nuclear Physics, Principles and applications- Wiley (2006)
2. R Murugeshan, Er. Kiruthiga Sivaprasath, Modern Physics – S. Chand Publishing- 18th Edition
3. Bradley W. Caroll, Dale A. Ostlie, Addison An Introduction to Modern Astrophysics - Wesley Publishing Company.
4. Arne A Henden and Ronald H Kaitchuck, Astronomical Photometry - A Text and Handbook for the Advanced Amateur and Professional Astronomer,

Course designed by: Dr. Prijil Mathew, Dr. Lijo Jose

SBU24PH3DSE201: RENEWABLE ENERGY TECHNOLOGY

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Explain the fundamental principles and concepts of renewable energy sources.	U
CO2	Understand the principles of solar energy conversion and the operation of solar photovoltaic (PV) and solar thermal systems.	U
CO3	Comprehend the principles of wind energy conversion, design of wind turbine systems and principles of biomass energy conversion	U
CO4	Explain the fundamental principles and concepts Hydrogen energy and fuel cells.	U
CO5	Develop basic design concepts incorporating renewable energy solutions.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	1			2	1		2	
CO2	1	2	1			2	1		2	
CO3	1	2	1			2	1		2	
CO4	1	2	1			2	1		2	
CO5	1	2	1			2	1		2	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x	x		x	x	x
CO2	x			x	x	x
CO3	x			x	x	x
CO4	x	x	x	x	x	x
CO5	x		x		x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Energy Sources (12 Hrs)				
Different classifications of energy resources and examples - non- renewable energy sources: - coal, oil, natural gas – their merits and demerits	1.1	1	3	Lecture
Reserves and production of petroleum and natural	1.2	1	3	Lecture

gas in India - hydro-electric energy - nuclear energy.				&Tutorial
Nonconventional energy sources: Introductory Ideas	1.3	1	3	Lecture &Tutorial
Introductory ideas about: Characteristics of energy, Energy parameters, Energy Planning and Energy Audit	1.4	5	3	Lecture &Tutorial
Module 3: Solar Thermal Energy & Solar Photovoltaic Systems (16 Hrs)				
Sun as a source of energy, Measurement of solar radiation: pyranometer, pyrheliometer, sunshine recorder (qualitative ideas only)	2.1	2	1	Lecture &Tutorial
Solar thermal energy collection, Collectors in various ranges and applications	2.2	2	1	Lecture
Flat plate collectors: various designs, applications, advantages, and disadvantages	2.3	2	2	Lecture
Concentrating collectors: various designs - solar water heating - solar heating of buildings	2.4	2	2	Lecture &Tutorial
Solar cooling of buildings - solar distillation – solar drying – solar cooking – solar thermal power plants	2.5	2	2	Lecture
Qualitative ideas of semiconductors and photovoltaic effect	2.5	2	2	Lecture
Solar photovoltaic cells, classification of solar cells, silicon cell modules	2.6	2	2	Lecture &Tutorial
Photovoltaic (PV) systems, advantages, and disadvantages	2.7	5	2	Lecture &Tutorial
Water pumping systems, SPV lighting systems, PV integration	2.8	2	2	Lecture
Module 3: Wind Energy & Biomass Energy (17 Hrs)				
Origin of wind, wind availability and measurement	3.1	3	1	Lecture
Basic principle of wind energy conversion and wind power, components of a wind energy conversion system	3.2	5	2	Lecture
Advantages and disadvantages of wind energy conversion systems, site selection for wind energy conversion systems.	3.3	3	2	Lecture
Classification of wind mills/machines, wind-electric generating power plant, environmental impacts of wind energy conversion systems.	3.4	3	2	Lecture& Tutorial
Introduction to biomass, biomass resources, Energy plantations	3.5	3	2	Lecture
Biomass conversion processes, methods to obtain energy from biomass, biomass gasification.	3.6	5	2	Lecture
Energy recovery from urban waste and wood.	3.7	3	2	Lecture
Biogas: advantages and applications, biogas plants- different designs and classification	3.8	3	2	Lecture
Power generation from landfill gas. biodiesel	3.9	3	2	Lecture
Module 4: Hydrogen Energy & Fuel Cells (15 Hrs)				
Properties of Hydrogen, Advantages of Hydrogen	4.1	4	3	Lecture

as fuel, Application of Hydrogen Energy				
Production of Hydrogen	4.2	4	3	Lecture & Tutorial
Hydrogen Storage, Hydrogen Transportation and Safety precautions	4.3	4	3	Lecture
Introduction to fuel cells: Advantages, Disadvantages and Applications of Fuel Cells	4.4	4	3	Lecture
Components and working theory of Fuel Cell, Classification of fuel cells, Desirable Characteristics of a Fuel Cell.	4.5	4	3	Lecture & Tutorial
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Er. R K Rajput Non-Conventional Energy Resources and Utilisation (Energy Engineering), (S Chand & Co.)

Reference

1. G D Rai Non – Conventional Energy Sources: (Khanna Publishers)
2. Godfrey Boyle Renewable energy-Power for a sustainable future, (Oxford university press
3. Solanki C S Renewable Energy Technologies: (Prentice-hall Of India Pvt Ltd)
4. Abbasi, Renewable Energy Sources & Their Environmental Impact: (Prentice-hall of India Pvt Ltd)
5. N.S. Rathore N.L .Panwar, Renewable Energy Sources for Sustainable Development (New India Publishing Agency)
6. Ulrich Laumanns And Dieter Uh Dirk Abmann, Renewable Energy: (James & James Science Publishers)
7. Understanding Renewable Energy Systems: Volker Quaschning (James & James Science Publishers)

Course designed by: Dr. Sajith Mathews T

SBU24PH3MDC200: PHYSICS OF MOTION, MATTER, DEVICES AND ENERGY

Type of Course	MDC		
Course Level	200 - 299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)	Class 10 level physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe linear and rotational motion	U
CO2	Describe conservation of energy and momentum	U
CO3	Describe properties of solids, liquids and gases	U
CO4	Describe laser, microwave oven and radar	U
CO5	Describe renewable energy sources	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2				1	1			
CO3	3	2				1	1			
CO4	3	2				1	1			
CO5	3	2				1	1			

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x			x	x	x
CO2		x	x	x	x	x
CO3			x	x	x	x
CO4		x		x	x	x
CO5	x			x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Mechanics (15 Hrs)				
Speed and velocity, acceleration	1.1	1	1	Lecture, Problem solving
Newton's law of gravitation, acceleration due to gravity, mass and weight	1.2	1	1	Lecture, Problem solving
Newton's second law, Newton's third law, action and reaction on different masses	1.3	1	2	Lecture
Momentum, impulse, impulse changes momentum, conservation of momentum	1.4	2	2	Lecture, Problem solving

Work, energy, power, mechanical energy, potential energy, kinetic energy, conservation of energy	1.5	2	3	Lecture, Problem solving
Rotational motion, Moment of inertia, torque	1.6	1	2	Lecture, Problem solving
Center of mass and center of gravity- stability	1.7	1	1	Lecture
Angular momentum, conservation of angular momentum	1.8	2	2	Lecture
Projectile motion	1.9	1	1	Lecture
Module 2: Matter (15 Hrs)				
Atoms, elements, compounds, mixture, molecules	2.1	3	1	Lecture
Solids- Density, elasticity	2.2	3	2	Lecture
Liquids- pressure, buoyancy, Archimedes' principle, flotation	2.3	3	2	Lecture
Pascal's principle- hydraulic press	2.4	3	1.5	Lecture
Surface tension, capillarity	2.5	3	1	Lecture
Gases- The atmosphere, atmospheric pressure, barometer	2.6	3	1.5	Lecture, Problem solving
Boyle's law	2.7	3	1	Lecture
Buoyancy of air	2.8	3	1.5	Lecture, Problem solving
Bernoulli's Theorem and applications	2.9	3	2	Lecture, Problem solving
Plasma	2.10	3	1.5	Lecture
Module 3: Devices, Energy (15 Hrs)				
Fluorescence, phosphorescence	3.1	4	1	Lecture
Laser	3.2	4	1	Lecture
Microwave oven	3.3	4	1	Lecture
Radar	3.4	4	1	Lecture
Polarization, Polaroids	3.5	4	1	Lecture
Interference, holography	3.6	4	1	Lecture
Radioactivity, Carbon dating	3.7	4	1	Lecture
Fuel cell	3.8	5	2	Lecture
Solar energy	3.9	5	2	Lecture
Wind energy	3.10	5	2	Lecture
Ocean energy	3.11	5	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Paul G Hewitt, Conceptual Physics, Tenth Edition, Pearson International, 2006
2. G. D Rai, Non-conventional energy sources, Khanna publishers

Reference

1. Arthur Beiser, Fundamentals of Physics with Applications by, TMH
2. Arthur Beiser, Schaum's outline Applied Physics, McGraw Hill

Course designed by: Dr. Loji K Thomas

SBU24PH3VAC200: PHYSICS FOR SOCIETY

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)	Basic knowledge in Physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the historical development of physics, spanning from ancient contributions to modern advancements, including the qualitative understanding of key scientific concepts introduced by prominent physicists.	U
CO2	Apply fundamental principles of mechanics, periodic motion, fluids, electricity, magnetism, thermodynamics, optics, and nuclear energy to analyze and explain various real-world applications from everyday phenomena	A
CO3	Evaluate and differentiate between myths and facts in scientific understanding, critically examining historical misconceptions such as the flat Earth model and geocentric/heliocentric cosmologies, and appreciating the role of scientific inquiry in dispelling misconceptions.	E
CO4	Explore the intersection of science, society, and governance, recognizing the importance of scientific literacy and informed public discourse in shaping policies and attitudes towards science and technology, both globally and within the Indian context.	U
CO5	Develop critical thinking skills and a scientific temperament aligned with the principles outlined in the Indian Constitution and science policy, fostering an appreciation for evidence-based reasoning and the pursuit of knowledge in a diverse and dynamic world.Top of Form	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	2	-	1	2	-	3	1
CO2	1	3	2	2	-	1	2	-	3	1
CO3	1	3	2	2	-	1	2	-	3	1
CO4	1	3	2	2	-	1	2	-	3	1
CO5	-	-	3	3	-	1	2	-	-	3

Mapping of CO to Assessment Tools (Theory)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Home assignments	Quiz	-	Written test	Problem based assignments	
CO1		x				x
CO2		x		x		x
CO3		x			x	x
CO4	x				x	x
CO5	x			x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Development of Physics (14 Hrs)				
Development of physics in the last century	1.1	1	2	Lecture
Origin of new scientific concepts	1.2	1	1	Lecture
Scientific contributions of Galileo-Newton-Einstein-J J Thomson-Curies-Rayleigh-Max Planck, Heisenberg and Schrodinger (qualitative understanding).	1.3	1	4	Lecture
Contributions of Indian physicists: C V Raman-H J Babha -J C Bose-S N Bose-M N Saha-S Chandrasekhar-Vikram Sarabhai and ECG Sudarsan.	1.4	1	4	Lecture
Development of physics in the recent years	1.5		3	
Module 2: Direct applications of fundamental Physics (17 Hrs)				
Applications of Mechanics: Skating, Falling Objects, Ramps, Seesaws, Wheels, Spring Scales, Bouncing balls, Carousels and Roller Coasters, Bicycles, Rockets, Space Travel	2.1	2	3	Lecture
Applications of Periodic Motion (Waves & Acoustics): Clocks, Sea surfing, Musical Instruments, Sonography	2.2	2	2	Lecture
Applications of Fluids and its Motion: Balloons, Water Distributions (Hydrostatics & Hydraulics), Garden Watering, Sports, Airplanes and Aviation Industries, Skydiving	2.3	2	2	Lecture
Application of Electricity and Magnetism: Static Electricity, Xerographic Copiers, Flashlights, Household Magnets, Electric Power Distribution (DC & AC), Radio, Microwave Oven, Magnetic Storage	2.4	2	3	Lecture
Application of Thermodynamics: Woodstove, Water-Steam-Ice, Insulation and Clothing for various climate, Air Conditioners, Automobiles, Cryocoolers	2.5	2	2	Lecture
Applications of Optics: Sunlight, Discharge Lamps, Outdoor Lighting, Video Walls, Lasers Show, Laser Cutting, Microscopes (Optical and Electron), Telescope, Cameras, Optical Recording, Optical Fibres	2.6	2	3	Lecture
Applications of Nuclear Energy: nuclear weapons (Fission Bomb & Hydrogen Bomb), Nuclear Reactor and Nuclear Power Plants	2.7	2	2	Lecture
Module 3: Myths Versus Facts (14 Hrs)				
Concept of flat earth and round earth: Measurement of earth by Eratosthenes and Aristarchus	3.1	3	2	Lecture

Geocentric model: Earth is the centre -Ptolemy, Aristotle	3.2	3	2	Lecture
Heliocentric model: Sun is the centre –Copernicus	3.3	3	2	Lecture
Galileo, his Experiments and Observations	3.4	3	2	Lecture
Eclipse, Origin of Universe	3.5	3	2	Lecture
Theory of Evolution	3.6	4	1	Lecture
Need for an informed public about Science and Technology	3.7	4	2	Lecture
Scientific temper in Indian Constitution & Science Policy in India	3.8	5	1	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Vignettes in Physics- G. Venkataraman, University Press
2. How Things Work: The physics of everyday life, 6th Edition, Louis A Bloomfield, John Wiley & Sons, 2015.
3. Bala, Arun, The Dialogue of Civilizations in the Birth of Modern Science, New York, NY: Macmillan 2008.

Reference

1. Russell, Bertrand. The impact of science on society. Routledge, 2016
2. Gopalakrishnan (2006). Inventors who revolutionised our Lives. National Book Trust
3. Fundamentals of Physics, David Halliday, Robert Resnick and Jearl Walker, John Wiley & Sons, 2014
4. A Century of Physics, Bromley D. Allan, Springer-Verlag New York Inc.

Course designed by: Dr. Prijil Mathew

SEMESTER IV

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24PH4DSC200	Major	Thermodynamics and Statistical Mechanics	5	75	4
SBU24PH4DSC201	Major	Mathematical Foundations and Dynamics	5	75	4
SBU24PH4DSC202	Minor	Properties of Matter	5	75	4
SBU24PH4INT200	Major	Internship			2
SBU24PH4DSE200	Elective	Physical Optics and Fourier Optics	4	60	4
SBU24PH4DSE201	Elective	Fundamentals of Atmospheric Science	4	60	4
SBU24PH4SEC200	SEC	Electrical and Electronic Circuit Design	3	45	3
SBU24PH4VAC200	VAC	Research Methodology and Publication Ethics for Physics	3	45	3

SBU24PH4DSC200: THERMODYNAMICS AND STATISTICAL MECHANICS

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the basics of thermodynamics and apply to Carnot engine, Refrigerator and internal combustion engines to solve basic problems in the related area.	A
CO2	Solve thermodynamic problems related to Entropy, thermodynamic potentials, Maxwell's relations and laws of heat transfer.	A
CO3	Describe and apply the basic concepts and formulations of statistical Physics, thermodynamic probability, classical - quantum distribution functions and entropy-probability relation.	A
CO4	Identify and apply the mathematical tools related to thermal and statistical Physics	A
CO5	Apply the concepts of Thermodynamics and statistical Physics in simple experiments and Formulate conclusions based on the analysis, discussing the implications of any disparities between theoretical predictions and experimental outcomes.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	1	1	-	3	1	-	1	-
CO2	2	3	2	1	-	3	1	-	1	-
CO3	2	3	2	1	-	3	1	-	1	-
CO4	2	3	2	1	-	3	1	-	1	-
CO5	2	1	3	3	-	3	1	-	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Home assignments	Written test	Problem based assignments	
CO1		x		x		x
CO2	x			x		x
CO3	x			x		x
CO4		x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	-	Laboratory report	Practical Assignment	
CO5	x	x	-	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Thermal Physics (15 Hrs)				
Thermodynamic systems Thermodynamic variables and equation of state, Zeroth law-thermodynamic equilibrium	1.1	1	2	Lecture and Problem solving
First law, Isochoric process-isobaric process-adiabatic process- isothermal process-cyclic process	1.2	1	3	Lecture and Problem solving
Adiabatic equation of a perfect gas-Indicator diagram- Work done during isothermal and adiabatic process-slopes of isothermal and adiabatic	1.3	1	4	Lecture and Problem solving
Carnot's engine and cycle of operations-work done per cycle and efficiency	1.4	1	2	Lecture and Problem solving
Theory of refrigerator-coefficient of performance-	1.5	1	2	Lecture and Problem solving
Second law –Carnot's theorem	1.6	1	2	Lecture and Problem solving
Module 2: Thermodynamic Relations and Heat Transmission (15 Hrs)				
Entropy, Entropy changes in reversible and irreversible processes	2.1	2	1	Lecture and Problem solving
Entropy – temperature diagrams and equations. Physical significance of entropy	2.2	2	1	Lecture and Problem solving
Thermodynamic potentials: Enthalpy, Gibbs and Helmholtz functions	2.3	2	2	Lecture and Problem solving
Maxwell's relations and applications, Clausius Clapeyron Equation, T.dS equations	2.4	2	3	Lecture and Problem solving
Modes of heat transfer – Conduction, Convection and Radiation,	2.5	2	2	Lecture and Problem solving
Searle's & Lee's experiment, Black body radiation, Stefan Boltzmann Law, Wein's displacement law	2.6	2	4	Lecture and Problem solving
Rayleigh -Jeans Law, Planck's law (no derivation).	2.7	2	2	Lecture and Problem solving
Module 3: Statistical Mechanics (15 Hrs)				
Micro and Macro states, Thermodynamic Probability	3.1	3	2	Lecture and Problem solving
Phase space, Ensembles	3.2	3	1	Lecture
Maxwell-Boltzmann Distribution law Thermodynamics of an ideal monoatomic gas	3.3	4	3	Lecture and Problem solving
Concept of entropy and thermodynamic probability	3.4	3	1	Lecture and Problem solving
Quantum Statistics: Need of quantum statistics- Indistinguishability of particles-Introduction to Spin and Statistics	3,5	4	2	Lecture and Problem solving
Bose Einstein distribution law, Application of	3.6	4	3	Lecture and

Bose Einstein distribution law to black body radiation				Problem solving
Fermi Dirac Statistics Application of Fermi Dirac Statistics to electron gas, Fermi Energy	3.7	4	3	Lecture and Problem solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Brijlal, N. Subrhmanyam and P. S. Hemne, Heat, thermodynamics and statistical physics- S. Chand, 2001

Reference

1. Mark W Zemaskay and Richard H Dittman, Heat and Thermodynamics, Tata McGraw Hill Publishing Co. (Special Indian Edition)
2. Greiner, Thermodynamics and Statistical Mechanics, Springer
3. Garg, S. C., R.M. Bansal, C.K. Ghosh, Thermal Physics, Kinetic Theory, Thermodynamics and Statistical Mechanics, McGraw Hill Education, New Delhi, 1993
4. Frederick Reif, Berkeley Physics Course Volume 5; Statistical Physics; McGraw Hill.
5. Saha and Srivastava, A Treatise on Heat; The Indian Press, Allahabad.
6. R.B. Singh, Thermal and Statistical Physics, New Academic Science
7. Richard P. Feynman, The Feynman Lectures on Physics, Pearson

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Thermodynamics Experiments (10 Hrs)				
Newton's law of cooling – Specific heat capacity of a liquid (Calorimeter)	5.1	5	2.5	Lab Practical
Thermal conductivity of rubber	5.2	5	2.5	Lab Practical
Thermal conductivity of bad conductor (Lee's Disc)	5.3	5	3	Lab Practical
Determination of Stefan Boltzman constant	5.4	5	2	Lab practical
Module 6: Simulation Experiments (20 Hrs)				
Computer simulation - isothermal, adiabatic, isobaric and isochoric process. - PHET Sim	6.1	5	6	Lab Practical
Plot Maxwell speed distribution function for different gases at different temperatures (Using Python /Matlab Programme)	6.2	5	7	Lab Practical
Plot Black body radiation spectrum and Verify Wien's displacement law (Using Python /Matlab Programme)	6.3	5	7	Lab Practical

Additional experiments of equivalent standard shall be incorporated

Textbook

1.C. L. Arora, BSc Practical Physics, S Chand

2.R.C Verma, P.K Ahluwalia, K.C Sharma, Computational Physics, An Introduction, New Age International Publishers

3.https://phet.colorado.edu/

Reference

1. Harnam Singh, P S Hemne, BSc Practical Physics, S Chand
2. Nicholas Giordano, Hisao Nakanishi, Computational Physics, Second Edition, Pearson Addison-Wesley,2005

Course designed by: Dr. Sajith Mathews T

SBU24PH4DSC201: MATHEMATICAL FOUNDATIONS AND DYNAMICS

Type of Course	Major		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply vector analysis concepts to solve engineering and physics problems,	A
CO2	Learn the principles of error propagation and apply them to determine the uncertainty in derived quantities.	A
CO3	Define and understand the properties of vector spaces	U
CO4	Understand and apply the principles of kinematics to describe the motion of particles and rigid bodies in both rectilinear and curvilinear coordinates.	A
CO5	Investigate the principles of kinematics through various experiments.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1	2	1		2	1		1	
CO2	2	1	2	3		2	1		1	
CO3	2	3	2	1		3	1		1	
CO4	2	3	2	1		3	1		1	
CO5	1	1	2	3	1	3	1		2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Home assignments	Written test	Problem based assignments	
CO1		x		x		x
CO2	x			x		x
CO3	x			x	x	x
CO4		x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills		Laboratory report	Practical Assignment	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Vector Analysis (16 Hrs)				
Position vector, displacement vector and separation vector.	1.1	1	1	Lecture & Problem Solving
Ordinary derivatives, gradient or del operator. Divergence and curl with geometrical interpretation.	1.2	1	2	Lecture & Problem Solving
Integral calculus- line integral, surface integral and volume integral.	1.3	1	2	Lecture & Problem Solving
Divergence Theorem and Stokes Theorem (No derivation).	1.4	1	2	Lecture & Problem Solving
Curvilinear Coordinates: Spherical Polar Coordinates, Cylindrical Coordinates	1.5	1	4	Lecture & Problem Solving
Errors Analysis: Errors as uncertainties, Inevitability of uncertainty	1.6	2	2	Lecture & Problem Solving
Propagation of uncertainties: Sums and differences, Products and Quotients	1.7	2	3	Lecture & Problem Solving
Module 2: Linear Vector Space (14 Hrs)				
Definition of linear vector space	2.1	3	2	Lecture & Problem Solving
Inner product spaces	2.2	3	2	Lecture & Problem Solving
Dual spaces and Dirac Notation	2.3	3	2	Lecture
Expansion vectors in an orthonormal Basis	2.4	3	2	Lecture & Problem Solving
Adjoint Operation	2.5	3	2	Lecture
Gram-Schmidt Theorem	2.6	3	2	Lecture & Problem Solving
Schwarz Inequalities	2.7	3	2	Lecture
Module 3: Dynamics (15 Hrs)				
Motion in plane polar coordinates - velocity and acceleration.	3.1	4	2	Lecture & Problem Solving
Physics in rotating coordinate system -time derivative of a vector in rotating coordinate system, velocity and acceleration.	3.2	4	3	Lecture & Problem Solving
Centrifugal and Coriolis force.	3.3	4	1	Lecture & Problem Solving
Dynamics of a system of particles - center of mass and center of mass coordinates.	3.4	4	2	Lecture & Problem Solving
Central forces. Central force motion as a one body problem and reduced mass.	3.5	4	2	Lecture & Problem Solving
Motion under a central force – case of gravitational force.	3.6	4	2	Lecture & Problem Solving
Equation of the orbit, energy diagram and possible trajectories	3.7	4	3	Lecture & Problem Solving
Module 4: Teacher Specific Content				

(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)
This content will be evaluated internally

Textbook

1. Daniel Kleppner & Robert J. Kolenkow, An introduction to Mechanics- McGraw Hill
2. David J Griffiths, Introduction to Electrodynamics, PHI 3rd ed.
3. R. Shankar, Principles of Quantum Mechanics, Springer, Second Edition.
4. John R Taylor, An introduction to Error Analysis, University Science Books

Reference

1. Berkeley Physics – volume 1 – Mechanics 3rd Edn
2. Mathematical Methods for Physicists, G.B. Arfken & H.J. Weber 4th Edition, Academic Press
3. Advanced Engineering Mathematics, E. Kreyszig, 7th Ed., John Wiley
4. Advanced Mathematics for Engineering and Physics, L.A. Pipes & L.R. Harvill, Tata McGraw Hill
5. Mathematical Physics, Sathyaprakash, Sultan Chand & Sons, New Delhi

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: (30 Hrs)				
Symmetric Compound Pendulum – Determination of acceleration due to gravity (g), radius of gyration (K) and moment of inertia	5.1	5	5	Lab Practical
Asymmetric Compound Pendulum- Determination of moment of inertia and Acceleration due to gravity (g)	5.2	5	5	Lab Practical
Katers Pendulum – Determination of acceleration due to gravity	5.3	5	5	Lab Practical
Torsion pendulum – Determination of Rigidity modulus and moment of inertia	5.4	5	5	Lab Practical
Torsion Pendulum (method of equal masses) – Determination of Rigidity Modulus and moment of Inertia	5.5	5	5	Lab Practical
Flywheel – Determination of Moment of inertia- Determination of moment of inertia of rotationally symmetric body (solid sphere OR cylinder OR disc) from their period of oscillation on a torsion axle	5.6	5	5	Lab Practical

Textbook

1. C. L. Arora, BSc Practical Physics, S Chand

Reference

1. Harnam Singh, P S Hemne, BSc Practical Physics, S Chand

Course designed by: Dr. Sajith Mathews T

SBU24PH4DSC202: PROPERTIES OF MATTER

Type of Course	Major/Minor		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Basic idea about the fundamental properties of solids and fluids		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the elastic behaviour of solid materials under various loading conditions and apply the concept to calculate stress and strain, and use this information to predict material deformation and failure in physical applications	A
CO2	Utilize knowledge of torsional rigidity and to implement this understanding in the design and optimization of practical engineering components, ensuring their resilience and performance in real-world applications.	A
CO3	Apply the principles of viscosity and demonstrate proficiency in assessing the resistance of fluids to the practical implications in real-world scenarios.	A
CO4	Utilize the principles of surface tension concepts to various fluid systems and interfaces in real-world applications.	A
CO5	Apply experimental procedures pertaining to elasticity, viscosity and surface tension.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	3	2	2	-	1	2	-	3	1
CO2	1	3	2	2	-	1	2	-	3	1
CO3	1	3	2	2	-	1	2	-	3	1
CO4	1	3	2	2	-	1	2	-	3	1
CO5	-	-	3	3	-	1	2	-	-	3

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Spot assignment	Written test	Assignment/ Problem based assignments	
CO1	x	x		x	x	x
CO2		x	x	x	x	x
CO3	x	x			x	x
CO4	x	x		quiz	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism
Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Elasticity (18 Hrs)				
Stress, Strain and Hooks law, stress-strain graph	1.1	1	1	Lecture
Young's Modulus, Bulk Modulus, Modulus of Rigidity	1.2	1	1	Lecture
Work done per unit volume during longitudinal strain, volume strain and Shearing strain	1.3	1	1	Lecture
Poisson's ratio and relation connecting elastic constants (no derivation required)	1.4	1	1	Lecture and problem solving
Bending of beams- axis of bending, plane of bending, neutral surface, neutral axis, bending moment	1.5	1	1	Lecture
Cantilever – derivation of depression at the free end of a loaded cantilever, Experiment for the determination of Young's Modulus.	1.6	1	2	Lecture and problem solving
Expression for the elevation at the midpoint of a beam supported symmetrically on two knife edges	1.7	1	2	Lecture and problem solving
Expression for the depression at the midpoint of a beam supported at the ends and loaded at the center/midpoint	1.8	1	3	Lecture and problem solving
Twisting couple on a cylinder-expression for the couple for unit twist and rigidity modulus of the material of a wire or cylinder-comparison of the couple per unit twist of a hollow cylinder and a solid cylinder	1.9	2	3	Lecture and problem solving
Experimental Determination of rigidity modulus of a wire/ cylindrical rod - Static method using static torsion apparatus and dynamic method using torsion pendulum.	1.10	2	3	Lecture and problem solving
Module 2: Viscosity (14 Hrs)				
streamline flow and turbulent flow of fluids	2.1	3	1	Lecture
Continuity equation	2.2	3	2	Lecture
Energies possessed by a fluid under motion, Derivation of Euler's equation of motion and Bernoulli's Theorem.	2.3	3	3	Lecture
Some important applications of Bernoulli's theorem-working of venturi meter, atomizer and Bunsen burner	2.4	3	1	Lecture
Viscosity of a fluid, velocity gradient and critical velocity-Reynold's number and its significance	2.5	3	1	Lecture
Derivation of Poiseuille's formula, limitations and correction to the Poiseuille's formula.	2.6	3	2	Lecture
Experimental measurement of coefficient of viscosity by using Poiseuille's equation – constant pressure head method and variable pressure head method	2.7	3	2	Lecture and problem solving
Motion of bodies in a viscous medium – terminal velocity-The Stokes' formula and the experimental	2.8	3	2	Lecture and problem

determination of viscosity of a liquid by Stoke's method. Application of viscosity in lubrication.				solving
Module 3: Surface Tension (13 Hrs)				
Adhesive force and cohesive force - the phenomenon of surface tension-surface energy and molecular theory of surface tension.	3.1	4	2	Lecture
Excess of pressure inside a spherical liquid drop, liquid bubble and a liquid jet – case of layer of liquid between two plates	3.2	4	4	Lecture and problem solving
Shape of liquid meniscus in a capillary tube - angle of contact	3.3	4	2	Lecture
Rise or fall of a liquid in a capillary tube –derivation of Jurin's equation - experimental measurement of surface tension of a liquid by using capillary rise method	3.4	4	3	Lecture and problem solving
Shape of liquid drops on a horizontal plate	3.5	4	1	Lecture
Factors affecting surface tension and applications of surface tension	3.6	4	1	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Text Book

1. D S Mathur, Elements of Properties of Matter, S Chand 3rd Edn

References

1. Halliday, Resnik and Walker, Fundamentals of Physics – John Wiley & sons
2. Brijlal and N Subrahmaniam, Properties of Matter– S Chand 3rd Edn.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: (19 Hrs)				
Cantilever – Pin and microscope- Determination of Young's Modulus	5.1	5	3	Demonstration and peer learning
Cantilever – Scale and Telescope – Determination of Young's modulus	5.2	5	2	Demonstration and peer learning
Nonuniform bending – Pin and microscope- Determination of Young's Modulus	5.3	5	3	Demonstration and peer learning
Uniform Bending – Optic lever – Determination of Young's Modulus	5.4	5	2	Demonstration and peer learning
Nonuniform Bending – Optic lever – Determination of Young's Modulus	5.5	5	2	Demonstration and peer learning
Uniform Bending – Pin and Microscope – Determination of Young's Modulus	5.6	5	3	Demonstration and peer learning
Torsion Pendulum-Rigidity modulus of the material of a wire	5.7	5	2	Demonstration and peer learning
Static Torsion – Determination of Rigidity modulus	5.8	5	2	Demonstration and peer learning

Module 6: (2 Hrs)				
Capillary rise method – Determination of surface tension	6.1	5	2	Demonstration and peer learning
Module 7: (9 Hrs)				
Constant pressure head – Determination of viscosity of a liquid	7.1	5	3	Demonstration and peer learning
Variable pressure head – Determination of viscosity of a liquid	7.2	5	3	Demonstration and peer learning
Stokes method – determination of viscosity of liquid	7.3	5	3	Demonstration and peer learning

Textbook

1. M.N. Srinivasan, S, Balasubramanian, R. Ranganathan; A Textbook of Practical Physics; Sultan Chand & Sons

Reference

1. Amrutha Virtual lab; https://vlab.amrutha.edu
2. Kumar, P.R. Sasi; Practical Physics; PHI Learning

Course Designed by: Dr. Joshy Jose

SBU24PH4DSE200: PHYSICAL OPTICS AND FOURIER OPTICS

Type of Course	DSE		
Course Level	200-299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe interference of light and apply it to thin films, Newton's rings and Michelson's interferometer	A
CO2	Describe diffraction and apply it to diffraction grating	A
CO3	Describe Fourier optics and its applications	U
CO4	Describe polarisation of light	U
CO5	Describe the working of different optical instruments related to polarisation	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1			1	1			
CO2	3	2	1			1	1			
CO3	3					1	1			
CO4	3	2	1			1	1			
CO5	3	3				1	1			

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Problem sheets			class test		
CO1	x			x		x
CO2	x			x		x
CO3	x			x		x
CO4	x			x		x
CO5	x			x		

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Interference (10 Hrs)				
Wave fronts, coherence, superposition principle	1.1	1	2	Lecture
Thin parallel film interference	1.2	1	2	Lecture and problem solving
Haidinger fringes, wedge shaped films	1.3	1	2	Lecture
Newton's rings- theory and application	1.4	1	2	Lecture and problem solving,

				Practical
Michelson interferometer –construction and working, applications	1.5	1	2	Lecture
Module 2: Diffraction and Fourier Optics (20 Hrs)				
Fresnel and Fraunhoffer Diffraction	2.1	2	1	Lecture
Theory of Fraunhoffer diffraction at a single slit	2.2	2	2.5	Lecture
Fraunhoffer diffraction of N slits	2.3	2	2	Lecture, Practical
Theory of plane diffraction grating- grating equation- Determination of wavelength using grating	2.4	2	1	Lecture, Practical
Dispersive power of grating and resolving power of grating	2.5	2	1	Lecture and problem solving
Fresnel half period zones, obliquity factor	2.6	2	0.5	Lecture
The free propagation of a spherical wave and optical disturbance from l^{th} zone,	2.7	2	1	Lecture
Optical disturbance generated by entire wavefront	2.8	2	1	Lecture
Fresnel zone plate	2.9	2	0.5	Lecture
Fourier Optics				
Fourier optics- Fourier transform- one dimensional transform, inverse Fourier transform	2.10	3	2.5	Lecture
Transform of the Gaussian function, two dimensional transforms	2.11	3	1	Lecture
Transform of the cylinder function	2.12	3	1	Lecture
The lens as a Fourier transformer	2.13	3	1	Lecture
Dirac delta function, shifting, displacements and phase shifts, sines and cosines	2.14	3	2	Lecture
Optical applications- Two-dimensional image synthesized from Fourier components	2.15	3	2	Lecture, demonstration
Module 3: Polarization (15 Hrs)				
Nature of Polarized light - Linear Polarization,	3.1	4	2	Lecture
Superposition of waves linearly polarized at right angles- Circular Polarization- Elliptical Polarization	3.2	4	2	Lecture
Effect of polarizer on transmission of polarized light – Malus Law,	3.3	4	2	Lecture
Polarization by reflection – Brewster’s law, Polarization by double refraction-	3.4	4	2	Lecture and problem solving
Anisotropic crystals- Electromagnetic theory of double refraction, Phase difference between extra ordinary ray and ordinary ray -Retarders or wave plates- Quarter wave plate –Half wave plate	3.5	5	3	Lecture and problem solving
extraordinary ray and ordinary ray - Production and detection of elliptically and circularly polarized light- Analysis of	3.6	5	2	Lecture and problem solving

polarized light				
Optical Activity -Fresnel’s explanation of Optical Rotation (Analytical treatment not needed) – Specific Rotation. Applications of polarization – LCD	3.7	5	2	Lecture and problem solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Subramanyam, Brijlal, M N Avadhanulu, Optics, S.Chand
2. Eugene Hecht, Optics, Pearson

Reference

1. Ajay Ghatak, Optics - - 6th Edition McGraw Hill Education (India) Private Limited
2. Ajoy Ghatak and K Thyagarajan, Optical Electronics –, Cambridge
3. D P Khandelwal, Optics and Atomic Physics Himalaya Pub. House
4. Eugene Hecht, A R Ganesan, Optics – IV Edn, Pearson Education
5. S K Srivastava, Optics CBS Pub. N Delhi
6. S L Kakani, K L Bhandari, A Text book of Optics S Chand.
7. Arthur Beiser, Shobhit Mahajan, S Rai Choudhury Concept of Modern Physics (2010), Tata Mc Graw Hill Co Ltd, New Delhi
8. Pedrotti & Pedrotti, Introduction to optics –

Course designed by: Dr. Loji K Thomas

SBU24PH4DSE201: FUNDAMENTALS OF ATMOSPHERIC SCIENCE

Type of Course	DSE		
Course Level	200 – 299		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Graduate level Thermodynamics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand basic structure and evolution of Earth's Atmosphere	U
CO2	Understand basic atmospheric thermodynamics	U
CO3	Understand the mechanism of radiative heat transfer in the atmosphere.	U
CO4	Understand the mechanism of production of aerosols and its effects in Atmosphere.	U
CO5	Understand the kinematics of airflow in middle and lower atmosphere	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1	1	-	3	2	1	1	1
CO2	3	2	1	1	-	3	2	1	1	1
CO3	3	2	1	1	-	3	2	1	1	1
CO4	3	2	1	1	-	3	2	1	1	1
CO5	3	2	1	1	-	3	2	1	1	1

Mapping of CO to Assessment Tools (Theory)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Quiz		Spot assignment	Class test		
CO1	x		x	x		x
CO2	x		x	x		x
CO3	x		x	x		x
CO4	x		x	x		x
CO5	x		x	x		x

Course Content & Transaction Mechanism Theory

Course Content	**Unit**	**CO**	**Hours**	**Transaction Mechanism**
Module 1: Basic Structure of Earth's Atmosphere (15 Hrs)				
Vertical structure of Atmosphere – Temperature profile, Chemical Composition, winds and precipitation	1.1	1	4	Lecture
Components of the Earth System -The Oceans, Cryosphere, Biosphere, Earth's Crust and Mantle	1.2	1	4	Lecture

Roles of Various Components of the Earth System in Climate	1.3	1	3	Lecture
A Brief History of Climate and the Earth System	1.4	1	4	Lecture
Module 2: Atmospheric Thermodynamics (15 Hrs)				
Gas Laws-Virtual Temperature, The Hydrostatic Equation, Geopotential, Scale Height and the Hypsometric Equation,	2.1	2	3	Lecture
Thickness and Heights of Constant Pressure Surfaces, Reduction of Pressure to Sea Level	2.2	2	2	Lecture
Concept of an Air Parcel, The Dry Adiabatic Lapse Rate, Potential Temperature, effect of Water Vapor in Air	2.3	2	2	Lecture
Moisture Parameters, Latent Heats, Saturated Adiabatic and Pseudoadiabatic Processes, The Saturated Adiabatic Lapse Rate,	2.4	2	2	Lecture
Equivalent Potential Temperature and Wet-Bulb Potential Temperature	2.5	2	2	Lecture and demonstration
Normand's Rule, Net Effects of Ascent Followed by Descent,	2.6	2	2	Lecture
Static Stability - Brunt–Väisälä frequency, Conditional and Convective Instability	2.6	2	2	Lecture
Module 3: Radiative heat Transfer and Aerosols (15 (Hrs)				
Laws of Blackbody Radiation, The Greenhouse Effect	3.1	3	1	Lecture
Physics of Scattering and Absorption and Emission	3.2	3	2	Lecture
Radiative Transfer in Planetary Atmospheres - Beer's Law, Reflection and Absorption by a Layer of the Atmosphere	3.3	3	2	Lecture
Absorption and Emission of Infrared Radiation in Cloud-Free Air, Vertical Profiles of Radiative Heating Rate, Passive Remote Sensing by Satellites	3.4	3	2	Lecture
Radiation Balance at the Top of the Atmosphere	3.5	3	2	Lecture
Composition of Tropospheric Air - Sources, Transport, and Sinks of Trace Gases	3.6	4	2	Lecture
Tropospheric Aerosols - Concentrations and Size Distributions, Residence Times	3.7	4	1	Lecture
Stratospheric Ozone: The Ozone Hole	3.8	4	1	Lecture
Cloud Physics: Nucleation of Water Vapor – Cloud Condensation Nuclei – effect of aerosols	3.9	4	2	Lecture
Module 4: Atmospheric Dynamics and Boundary layer Physics (15 Hrs)				
Kinematics of the Large-Scale Horizontal Flow	4.1	5	2	Lecture
Dynamics of Horizontal Flow	4.2	5	3	Lecture
The Atmospheric General Circulation	4.3	5	1	Lecture

Numerical Weather Prediction	4.4	5	1	Lecture
Deep Convection	4.5	5	1	Lecture
Tropical Cyclones	4.6	5	1	Lecture
Atmospheric Boundary layer – Turbulence	4.7	5	2	Lecture
The Surface Energy Balance, Vertical Structure of boundary layer	4.8	5	2	Lecture
Evolution of boundary layer	4.9	5	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Text Books

1. Atmospheric Science - An Introductory Survey, J. M. Wallace and P. V. Hobbs

References

1. An Introduction to Meteorology, S. Petterssen
2. Introduction to Theoretical Meteorology, S. Hess
3. Atmospheric Physics, J. V. Iribrine and H. R. Cho

Course designed by: Dr. Lijo Jose

SBU24PH4SEC200: ELECTRICAL AND ELECTRONIC CIRCUIT DESIGN

Type of Course	SEC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45		45
Pre-requisite (if any)	Students should have a foundational understanding of electrical circuits, including knowledge of Ohm's Law, series/parallel circuits, and basic electronic components such as diodes and transistors, along with their characteristics and applications in configurations, rectifiers, amplifiers and oscillators		

Course Outcomes

No.	Description	Cognitive Level
CO1	Develop a deep understanding of the principles behind basic electrical circuits.	U
CO2	Apply safety considerations and protocols in the design and implementation of electrical circuits.	A
CO3	Design and Construct Regulated Power Supplies	An
CO4	Analyze and Design Electronic Circuits viz. amplifiers and oscillators	An
CO5	Demonstrate Practical Skills in Electrical and Electronic Circuit Design	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1					1				
CO2			1			1				
CO3				1					1	
CO4				1					1	
CO5			1						1	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x	x		x		x
CO2	x	x		x		x
CO3		x			x	x
CO4		x	x		x	x
CO5		x			Mini Project	

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Electrical Circuit Design (15 Hrs)				
Introduction to Electrical Circuit Design				
Overview of electrical circuit design	1.1	1	1	Lecture, visual aids, interactive discussions
Safety considerations in circuit design	1.2	2	1	Lecture and discussions
Basic components and symbols	1.3	1	1	Visual aids, hands – on identification exercises
Dual Switch and Extension Box Design				
Dual switch wiring and configurations	1.4	1	1	Live demonstrations, circuit diagrams
Extension box design and wiring	1.5	1	2	Practical demonstrations and guided exercises.
Practical considerations and safety measures	1.6	2	1	Group discussions, safety checklists, and hands-on safety exercises.
Earth Leakage Circuit Breaker (ELCB) and Molded Case Circuit Breaker (MCCB) Design				
Function and importance of ELCB and MCCB	1.7	2	1	Lecture and case studies,
Wiring and installation guidelines	1.8	2	2	Practical demonstrations and guided exercises.
Fault detection and protection mechanisms	1.9	2	1	Case studies, problem-solving sessions,
Practical applications				
Practical demonstrations of dual switch, extension box, ELCB, and MCCB installations	1.10	5	2	Live demonstrations, guided installations, and Q&A sessions.
Troubleshooting common electrical circuit issues	1.11	5	2	Case studies, problem-solving sessions, and hands-on troubleshooting.
Module 2: Electronic Circuit Design - Part 1 (15 Hrs)				
Regulated Power Supplies				
Principles of voltage regulation	2.1	3	2	Lecture and visual aids.
Design and construction of linear regulated power supplies	2.2	3	2	Live demonstrations, circuit design discussions, and problem-solving exercises.
Introduction to switching power supplies	2.3	3	1	Lecture, concept explanations, and comparison discussions.
Practical Applications and Exercises				
Exercises related to design of regulated power supplies	2.4	3	2	Peer collaboration, and troubleshooting exercises.
Design of Amplifiers using transistors and ICs	2.5	3	3	Live demonstrations, circuit design discussions, and problem-solving exercises.

Exercises related to transistor amplifier designs	2.6	5	3	Peer collaboration, and troubleshooting exercises
Troubleshooting and analysis of electronic circuits	2.7	5	2	Case studies, problem-solving sessions, and hands-on troubleshooting.
Module 3: Electronic Circuit Design - Part 2 (15 Hrs)				
Oscillator Design				
Principles of oscillator circuits	3.1	4	2	Lecture, concept explanations, and interactive discussions.
Design of RC Phase Shift Oscillator	3.2	4	2	Live demonstrations and problem-solving exercises.
Design of Hartley oscillator	3.3	4	2	Live demonstrations and problem-solving exercises
Exercises related to Phase shift and Hartley oscillator designs	3.4	5	3	Peer collaboration, and troubleshooting exercises
Design of Colpitts Oscillator	3.5	4	2	Live demonstrations and problem-solving exercises
Design of Crystal Oscillator	3.6	4	2	Live demonstrations and problem-solving exercises
Exercises related to Colpitts and Crystal Oscillator design	3.7	5	2	Peer collaboration, and troubleshooting exercises
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Ray C. Mullin and Phil Simmons, "Electrical Wiring: Residential," 18th Edition, Cengage Learning, 2021.
2. Paul Horowitz and Winfield Hill, "Art of Electronics," 3rd Edition, Cambridge University Press, 2015.
3. Albert Malvino and David J. Bates, "Electronic Principles," 8th Edition, McGraw-Hill Education, 2015.

Reference

1. Paul Scherz, "Practical Electronics for Inventors," 4th Edition, McGraw-Hill Education, 2016.
2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory," 11th Edition, Pearson, 2012.
3. B.L. Theraja and A.K. Theraja, "A Textbook of Electrical Technology: Volume 3 - Electronic Devices and Circuits," S. Chand & Company Ltd., 3rd Edition, 2010.

Course designed by: Justin John

SBU24PH4VAC200: RESEARCH METHODOLOGY AND PUBLICATION ETHICS FOR PHYSICS

Type of Course	VAC		
Course Level	200-299		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)	Proficiency in physics fundamentals and research principles		

Course Outcomes

No.	Description	Cognitive Level
CO1	Develop Research Skills to conduct comprehensive literature reviews using diverse sources and effectively report their findings.	A
CO2	Understand Ethical Conduct, the ethical principles underlying research and demonstrate integrity in their scientific pursuits.	U
CO3	Proficiency in statistical methods, including measures of central tendency, probability distributions, and correlation analyses.	A
CO4	Utilize Computer Applications to employ MS Office tools and LATEX for document preparation, data analysis, and effective research communication.	A
CO5	Apply Software Tools in using plagiarism detection software and statistical analysis tools to maintain research integrity and conduct rigorous analyses	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1				2	1		1	1
CO2	1	2		1	1	2	1		1	2
CO3	2	2				2	1			2
CO4	2	1		1	2	2				2
CO5	2	1		1	2	2			1	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Home assignments	Quiz		Written test	Problem based assignments	
CO1		x				x
CO2		x		x		x
CO3		x			x	x
CO4	x				x	x
CO5	x			x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction to Research and Review of Literature (14 Hrs)				
Concept of research; Objective and motivation in research; Significances	1.1	1	2	Lecture
Review of Literature: Meaning: Need, Objectives	1.3	1	1	Lecture
Research literature survey- Primary, secondary and tertiary sources	1.4	1	1	Lecture
Reporting the Review of Literature	1.5	1	1	Lecture
Information search using digital library and internet	1.6	1	1	Lecture
Use of Internet in Research – Websites, searches Engines, E-journal and E-Library: INFLIBNET.	1.7	1	1	Lecture
Ideas of theoretical, experimental and computational research methods	1.8	1	1	Lecture
Research communications-different categories and formats-paper preparation for scientific journals	1.9	1	2	Lecture
Open Access Publication, Databases: Indexing Databases,	1.10	1	1	Lecture
Citation databases: Web of Science, Scopus;	1.11	1	1	Lecture
Research Metrics: Impact Factor, Metrics: h-Index, g-Index, i10 Index	1.12	1	2	Lecture
Module 2: Ethics and Scientific Conduct (14 Hrs)				
Ethics: Definition, Moral Philosophy, Nature of Moral Judgments and Reactions.	2.1	2	2	Lecture
Conduct: Ethics with respect to Science and Research, Intellectual Honesty and Research Integrity.	2.2	2	2	Lecture
Scientific Misconduct: Falsification, Fabrication, and Plagiarism (FFP).	2.3	2	2	Lecture
Redundant Publications: Duplicate and Overlapping Publications, Salami Slicing.	2.4	2	2	Lecture
Selective reporting and Misinterpretation of Data. Publication Ethics	2.5	2	2	Lecture
Environmental Impacts - Ethical Issues – Ethical Committees	2.6	2	1	Lecture
Commercialization – copy right – royalty – Intellectual Property rights and patent law	2.7	2	1	Lecture
Reproduction of published material – Plagiarism – Citation and Acknowledgement – Reproducibility and accountability	2.8	2	1	Lecture
Software Tools: Turnitin, Urkund and other open source software tools	2.9	2	1	Lecture
Module 3: Statistics and Computer Applications in research (17 Hrs)				
statistical data analysis on data in physics	3.1	3	2	Lecture and

contest, Measures of central tendency				problem solving
measures of deviations	3.2	3	2	Lecture
probability distribution, Binomial distribution, Poisson distribution, Lorentz distribution, Gaussian distribution	3.3	3	2	Lecture
Chi-Square test-association between variables	3.4	3	2	Lecture
Pearson correlation, Spearman correlation	3.5	3	2	Lecture and problem solving
Simple linear regression, non parametric regression	3.6	3	2	Lecture
Monte Carlo methods.	3.7	3	1	Lecture
MS office and its application in Research – MS Word, MS Power point and MS Excel	3.8	5	1	Lecture and practical sessions
LATEX documents - preparation of theses and dissertations - conference presentations in oral and poster forms	3.9	4	3	Lecture and practical sessions

Textbook

1. Kothari C.R. and Gavrav Garg (2019). Research Methodology: Methods and Techniques. New Age International Publishers, New Delhi.
2. P. Chaddah, (2018) Ethics in Competitive Research: Do not get scooped; do not get plagiarized, ISBN:978-9387480865
3. Gupta, S.C.; Kapoor, V.K. *Fundamentals of Statistics, Publisher*: Sultan Chand & Sons

Reference

1. National Academy of Sciences, National Academy of Engineering and Institute of Medicine. (2009). On Being a Scientist: A Guide to Responsible Conduct in Research: Third Edition. National Academies Press.
2. Resnik. D. B. (2011). What is ethics in research & why is it important. National Institute of Environmental Health Sciences, 1-10. Retrieved from https://www.niehs.nih.gov/reserach/bioethics/whatis/index.cfm
3. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance (2019), ISBN:978-81-939482-1-7.

Additional web-based resources

SWAYAM course https://www.classcentral.com/course/swayam-introduction-toresearch-5221/course/swayam-introduction-to-research-5221

(Web) https://swayam.gov.in/nd1 noc20 _ge22/preview

Course designed by: Dr. Prijil Mathew

SEMESTER V

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24PH5DSC300	Major/ Minor	Classical mechanics - I	5	75	4
SBU24PH5DSC301	Major/ Minor	Advanced Electronics	5	75	4
SBU24PH5DSE300	Elective	Photonics	4	60	4
SBU24PH5DSE301	Elective	Photovoltaics	4	60	4
SBU24PH5DSE302	Elective	Dynamical Systems	4	60	4
SBU24PH5DSE303	Elective	Nanoscience and Nanotechnology	4	60	4
SBU24PH5DSE304	Elective	Oscillation, Waves, Music and Acoustics	4	60	4
SBU24PH5SEC300	SEC	Python Programming	3	45	3

SBU24PH5DSC300: CLASSICAL MECHANICS - I

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Competency in mechanics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply basic concepts of classical mechanics in simple mechanical systems.	A
CO2	Explain and use the principle of virtual work, D'Alembert's Principle, Lagrange's equation, and Hamiltonian dynamics	U
CO3	Describe the correspondence between D'Alembert's Principle, Lagrange's equations, Newton's equations, Hamilton's principle, Hamilton's equations	U
CO4	Describe Lorentz transformations on space-time and its consequences, Einstein's mass-energy equivalence, Lorentz transformation for force, momentum and energy, and apply them in relevant situations.	U
CO5	Apply the concepts of classical mechanics in simple experiments and Formulate conclusions based on the analysis, discussing the implications of any disparities between theoretical predictions and experimental outcomes.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	1		3	1		1	
CO2	2	3	2			3	1		1	
CO3	2	3	2			3	1		1	
CO4	2	3	2			3	1		1	
CO5	2	1	2	2	1	3	1		1	1

Mapping of CO to Assessment Tools (Theory)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Quiz	Viva voce	Problem based assignments	Written test		
CO1	Group Tutorial work		x	x		x
CO2	x	x		x		x
CO3	x	x		x		x
CO4	x	x		x		x
CO5						

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Observation of practical skills	Viva Voce		Laboratory Report	Practical Assignment	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: : Lagrange Dynamics (17 Hrs)				
Frame of reference, Degrees of freedom, Constraints-examples	1.1	2	2	Lecture and Problem Solving
Difficulties introduced by constraints and their removal, Generalised coordinates.	1.2	2	2	Lecture and Problem Solving
Principles of virtual work, D'Alembert's Principle	1.3	2	2	Lecture and Problem Solving
Lagrange's equations from D' Alembert's principle, Newton's equations from Lagrange's equation	1.4	3	3	Lecture and Problem Solving
Applications of Lagrange's equation, Superiority of Lagrangian mechanics over Newtonian approach.	1.5	1	4	Lecture and Problem Solving Tutorials
Planetary motion	1.6	1	2	Lecture and Problem Solving
Hamilton's principle and Lagrange's equation.	1.7	3	2	Lecture and Problem Solving
Module 2: Hamiltonian Dynamics (15 Hrs)				
Symmetry properties of Space and Time and conservation Laws: Homogeneity of space, Isotropy of Space, Homogeneity of time	2.1	3	3	Lecture
Generalised momentum and cyclic coordinates	2.2	1	3	Lecture and Problem Solving
Hamiltonian function and conservation of Energy	2.3	3	3	Lecture and Problem Solving
Hamilton's equations, Hamilton's equations in different coordinate systems	2.4	2	3	Lecture and Problem Solving
Examples in Hamiltonian dynamics: Harmonic Oscillator (1D and 2D)- motion of a particle in central force field - compound pendulum.	2.5	2	3	Lecture and Problem Solving
Module 3: Special Theory of Relativity (13 Hrs)				
Inertial and non-inertial frames of reference	3.1	4	1	Lecture and Problem Solving
Galilean transformation, Significance of Michelson-Morley experiment	3.2	4	2	Lecture
Postulates of special theory of relativity, Lorentz transformation	3.3	4	2	Lecture and Problem Solving
Spatial contraction, time dilation and relativity	3.4	4	5	Lecture and

of simultaneity, Velocity transformation equations and law of addition of velocities, Relativistic variation of mass,				Problem Solving
Einstein's mass-energy equivalence, Relativistic energy and momentum, Force in relativistic mechanics and Lorentz transformation for force.	3.5	4	3	Lecture and Problem Solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. J C Upadhyaya, Classical Mechanics, Himalaya Publishing House (2019 Edition)
2. Arthur Beiser, Concepts of Modern Physics (6th Edition), TMH Publishers

Reference

1. Herbert Goldstein, Charles Poole & John Safk, Classical Mechanics - 3 rd Edition, Pearson Education
2. K. Sankara Rao, Classical Mechanics, Prentice Hall of India
3. H S Hans & s P Puri, Mechanics, TMH Education
4. N C Rana & P S Joag, Classical Mechanics, TMH Education
5. Walter Greiner, Classical Mechanics-System of Particles and Hamiltonian Dynamics, Springer International Edition.
6. Vimal Kumar Jain, Classical Mechanics- Ane Books Pvt. Ltd.
7. David Morin, Classical Mechanics, Cambridge University Press
8. Dare A Wells, Schaum's Outline of Theory and Problems of Lagrangian Dynamic, MGH

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Simulation Experiments (Using Python) (30 Hrs)				
Simulation of Planetary motion and verification of Kepler's laws	5.1	5	5	Lab practical
Projectile Motion	5.2	5	5	Lab practical
Motion of a body through a viscous Medium	5.3	5	5	Lab practical
Simple Harmonic Motion	5.4	5	5	Lab Practical
Motion of Satellite	5.5	5	5	Lab Practical
Motion of Damped Oscillator	5.6	5	5	Lab Practical

Textbooks

1. Nicholas Giordano, Hisao Nakanishi, Computational Physics, Second Edition, Pearson Addison-Wesley,2005
2. R.C Verma, P.K Ahluwalia, K.C Sharma, Computational Physics, An Introduction, New Age International Publishers

Reference

1. Richard Hamming, Numerical Methods for Scientists and Engineers, Dover publications.
2. Tao Pang, An Introduction to computational physics, Cambridge University Press, (1997)

Course designed by: Dr Sajith Mathews T

SBU24PH5DSC301: ADVANCED ELECTRONICS

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Successful completion of the course "Basic Electronics" is mandatory. Also, completion of the course "Electronic Circuit Design" is preferable.		

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate a comprehensive understanding of the principles of operation of operational amplifiers (Op-Amps), including their supply voltages, parameters, and various configurations such as inverting amplifier, non-inverting amplifier, summer amplifier, differential amplifier, integrator, and differentiator.	A
CO2	Develop proficiency in the analysis and design of power semiconductor devices, including power diodes, FETs, MOSFETs, photodetectors, p-n junction solar cells, and thyristors, along with their applications in power electronic circuits.	An
CO3	Acquire a strong foundation in digital electronics, covering topics such as binary and decimal number systems, signed binary numbers, arithmetic operations in binary, digital-to-analog converters, various types of gates, Boolean algebra, logic simplification techniques, and sequential logic circuits.	A
CO4	Demonstrate the ability to design and analyze various analog and digital electronic circuits, including operational amplifier circuits, power electronic circuits, and digital logic circuits, utilizing appropriate circuit design techniques, simulation tools, and experimental validation methods.	E
CO5	Develop practical skills in the assembly, testing, and troubleshooting of linear integrated circuits, power electronics circuits, and digital electronics circuits.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	-	-	-	1	2	-	-	1
CO2	3	2	3	2	-	1	2	-	3	1
CO3	3	2	3	2	-	1	2	-	3	1
CO4	3	2	3	3	-	1	2	-	3	1
CO5	3	1	1	3	-	1	2	-	-	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Spot Assignment	Written test	Problem based assignments	
CO1	x	x	x	x		x
CO2	x		x	x	x	x
CO3			x		x	x
CO4	x				x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Linear Integrated Circuits (15 Hrs)				
Operation Amplifier - operational Overview, Op-Amp supply voltages, Op-amp parameters	1.1	1	2	Lecture
Op-amp as Inverting Amplifier, Op-amp as Non inverting amplifier	1.2	1	1	Lecture, Practical
Op-amp as Summer Amplifier – Op-amp as Differential Amplifier	1.3	1	1	Lecture, Practical
Op-amp as – Integrator,Op-amp as – Differentiator	1.4	1	1	Lecture, Practical
Basic comparator, Zero crossing detector	1.5	1	1	Lecture, Practical
OPAMP based astable and monostable multivibrators	1.6	1	1	Lecture, Practical
Square wave generator—triangular wave generator—saw tooth wave generator	1.7	1	2	Lecture
Classification of filters and filter characteristics	1.8	1	1	Lecture,
Active filters-first order and second order low pass Butterworth filter, first and second order high pass filter Butterworth filter	1.9	1	3	Lecture, Practical
wide and narrow band pass filter, wide and narrow band reject filter, all pass filter	1.10	1	2	Lecture, Practical
Module 2: Power Electronics (15 Hrs)				
Power Electronics - power semiconductor devices - power diodes	2.1	2	2	Lecture,
Unipolar Junction Transistors, Biasing of FET	2.2	2	2	Lecture
FET devices - structure, characteristics, FET applications	2.3	2	3	Lecture, Problem solving
enhancement type MOSFET’s, depletion type MOSFET’s and Power MOSFET	2.4	2	3	Lecture, Problem solving
Photodetectors - photoconductor (Light dependent resistor- LDR)	2.5	2	3	Lecture
p-n junction solar cells	2.6	2	1	Lecture, Practical

Thyristor and its applications	2.7	2	1	Lecture, Practical
Module 3: Digital electronics (15 Hrs)				
Decimal Numbers, Binary Numbers, Decimal to Binary and Binary to Decimal Conversion	3.1	3	1	Lecture, Problem solving
Signed binary numbers - Sign-magnitude form, 1's complement form and 2's complement form	3.2	3	1	Lecture, Problem solving
Binary Addition, Subtraction, Multiplication and Division	3.3	3	1	Lecture, Problem solving
Digital to Analog converters– Weighted resistor type, R-2R ladder type.	3.4	3	2	Lecture, Practical
ADC—counter method—Successive approximation type- dual slope integrator	3.5	3	2	Lecture
The AND, OR, NOT, NAND and NOR Gates- Symbol, Truth table	3.6	3	2	Lecture, Practical
Universal Property of NAND and NOR gates, The Exclusive-OR and Exclusive-NOR Gates	3.7	3	1	Lecture, Problem solving
Boolean Operations and Expressions - Boolean addition and multiplication, Laws and Rules of Boolean Algebra, DeMorgan's Theorems and Applications, Simplification Using Boolean Algebra	3.8	3	2	Lecture, Problem solving
Half Adder and Full Adder	3.9	4	1	Lecture
Multiplexers (Data Selectors), Demultiplexers.	3.10	4	1	Lecture
Sequential Logic circuits, Latches and flip flops	3.11	4	1	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. R.S. Sedha: A Textbooks of Applied Electronics- S. Chand Co. Revised Edn. (2008)
2. Ramakant A Gayakwad, Operational Amplifiers and Linear integrated Circuits, Prentice Hall of India (2000) 4 th Edition
3. Digital Fundamentals, Thomas L. Floyd, Pearson Education; Eleventh edition (30 August 2017)

Reference

1. Microelectronic Circuits; Theory and Applications, Sedra and Smith, Oxford, 6th Edition.
2. Electronic Devices and Circuit Teory, Robert L Boylstead & L. Nashelsky – Pearson Education (Fifth Edition)
3. Electronic Devices (Electron Flow Version), 9/E Thomas L. Floyd, Pearson
4. Fundamentals of Electronic Devices and Circuits 5th Ed. David A. Bell, Cambridge.
5. Electronic Communications Dennis Roddy and John Coolen, 4th Ed. Pearson.
6. Modern Digital and Analog Communication systems, B.P. Lathi & Zhi Ding 4th Ed., Oxford University Press.
7. D. Roychoudhuri: "Linear Integrated circuits" – New Age International Publishers
8. M.S. Tyagi; "Introduction to Semiconductor Devices" (Wiley) 11. J. Millman, C, Halkias and C. D. Parikh, Integrated Electronics, Tata Mc Graw Hill (2010)

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5 (14 Hrs)				
OPAMP – adder and subtractor	5.1	5	2	Demonstration and peer learning
OPAMP Characteristics – study of CMRR and open loop gain	5.2	5	2	
OPAMP – inverter, non-inverter and buffer – study of gain	5.3	5	2	Demonstration and peer learning
Active filters – low pass and high pass-first and second order frequency response and roll off rate	5.4	5	2	Demonstration and peer learning
Band pass filter using single op-amp-frequency response and bandwidth	5.5	5	2	Demonstration and peer learning
Op-amp-triangular wave generator with specified amplitude.	5.6	5	2	Demonstration and peer learning
Design and simulate a differentiator and integrator using Op-amp. Obtain the output waveform for an input square wave.	5.7	5	2	Demonstration and peer learning
Module 5 (4 Hrs)				
Characteristics of FET	5.1	5	2	Demonstration and peer learning
Study of UJT Characteristics	5.2	5	2	Demonstration and peer learning
Module 6 (12 Hrs)				
Realization of logic gates – AND, OR and NOT – using diodes, transistors etc.	6.1	5	2	Demonstration and peer learning
Verification of truth table of NAND, NOR, XOR and XNOR gates- Using universal gates	6.2	5	2	Demonstration and peer learning
Verification of De Morgan's theorems – Using IC 7400	6.3	5	2	Demonstration and peer learning
Realization of Half adder and Full adder using gates – Verification of truth table	6.4	5	2	Demonstration and peer learning
D/A converter using IC 741 – Using binary weighed resistor / R – 2R ladder type	6.5	5	2	Demonstration and peer learning
BCD to 7 segment decoder	6.6	5	2	Demonstration and peer learning

*experiments of equal standard can be added

Textbook

1. Paul Scherz, "Practical Electronics for Inventors," 4th Edition, McGraw-Hill Education, 2016.
2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory," 11th Edition, Pearson, 2012

Reference

1. Ray C. Mullin and Phil Simmons, "Electrical Wiring: Residential," 18th Edition, Cengage Learning, 2021.
2. Paul Horowitz and Winfield Hill, "Art of Electronics," 3rd Edition, Cambridge University Press, 2015.

3. Albert Malvino and David J. Bates, "Electronic Principles," 8th Edition, McGraw-Hill Education, 2015.

Course designed by: Dr. Prijil Mathew

SBU24PH5DSE300: PHOTONICS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60		60
Pre-requisite (if any)	Knowledge in optics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the principle of lasers, types, properties and their applications	U
CO2	Describe the principle of fibres, types, properties and their applications	U
CO3	Describe the principle of recording and reconstruction of images using holograms and their applications	U
CO4	Describe the principle of optical communication and apply it in the Er doped fibre laser	A
CO5	Describe the nonlinear properties and applications	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2			2		2				
CO2	2			2				2		
CO3	2			2			2			
CO4	2			2						2
CO5	2			2		2	2		2	

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x	x		x		x
CO2	x	x		x		x
CO3		x			x	x
CO4		x	x		x	x
CO5	x		x		x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: LASER (15 Hrs)				
Interaction of electromagnetic radiation with matter - stimulated absorption, spontaneous emission, stimulated emission	1.1	1	1.5	Lecture, Assignment
Einstein's coefficients	1.2	1	1.5	Lecture

LASER, Requirements of LASER - Active medium Metastable states - Population inversion- - pumping mechanism- Optical resonant cavity	1.3	1	3	Lecture
Pumping schemes (3 level and 4 level)	1.4	1	1	Lecture
Types of Lasers: solid, liquid and gas Solid state lasers - Ruby laser, Nd- YAG laser,	1.5	1	2	Lecture
Gas Lasers - He-Ne laser, CO_2 laser	1.6	1	2	Lecture, Practical
Liquid laser - dye laser	1.7	1	1	Lecture
Semiconductor laser	1.8	1	1	Lecture
Properties of laser beams	1.9	1	1	Lecture
Applications of Laser beams	1.10	1	1	Lecture
Module 2: HOLOGRAPHY AND FIBER OPTICS (15 Hrs)				
Holograms-Distinction between Photograph and Hologram	2.1	3	1	Lecture
Construction of image in Hologram	2.2	3	2	Lecture
Image retrieval in Hologram	2.3	3	2	Lecture
Applications of Holography	2.4	3	1	Lecture
Optical waveguides- optical fibre	2.5	2	2	Lecture
Critical angle of propagation in an optical fibre, Numerical aperture, Acceptance angle and fractional change in refractive Index,	2.6	2	3	Lecture, Assignment
Step index and Graded index fibres- Single mode and Multimode fibres,	2.7	2	3	Lecture, Assignment
Applications of optical Fibres	2.8	2	1	Lecture
Module 3: OPTICAL COMMUNICATION (15 Hrs)				
Evolution of Optical Communication, Evolution of fiber types	3.1	4	2	Lecture
Guiding properties of fibers,	3.2	4	2	Lecture
single mode lasers, modulation of laser diodes,	3.3	4	2	Lecture
Photodetectors, photodetector noise, signal to noise ratio	3.4	4	2	Lecture, Assignment
optical receiver operation, WDM concepts and components, operational principle of WDM	3.5	4	3	Lecture, Assignment
Optical Amplifiers, semiconductor optical amplifiers	3.6	4	2	Lecture, Assignment
Erbium Doped Fiber Amplifiers, Gain and Power Conversion Efficiency	3.7	4	2	Lecture, Assignment
Module 4: NONLINEAR OPTICS (15 Hrs)				
Overview of nonlinear processes	4.1	5	1	Lecture
Second-order: SHG, optical rectification	4.2	5	3	Lecture
SFG, DFG/OPA, OPO & HHG	4.3	5	3	Lecture
Third order: 3G	4.4	5	2	Lecture
Kerr effect, two-photon absorption, FWM	4.5	5	3	Lecture
Saturable absorption, Gain saturation	4.6	5	1.5	Lecture
Stimulated Raman scattering, Stimulated Brillouin scattering	4.7	5	1.5	Lecture
Module 5: Teacher Specific Content				

(*This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned*)

This content will be evaluated internally

Textbook

1. Subramanyam, Brijlal, M N Avadhanulu, Optics, S. Chand,
2. Wilson and Hawkes, An introduction to Optoelectronics-, PHI, (1996)
3. Gerd Keiser, Optical Fiber Communications – 4 th Ed (2006)
4. Robert W. Boyd, Nonlinear Optics (3rd edition), Elsevier Academic Press (2007)

Reference

1. Jasprit Singh, Semiconductor optoelectronics- Tata Mc Graw Hill (1995)
2. S C Gupta, Optoelectronic devices and systems – PHI, (2005)
3. Pallab Bhattachraya, Semiconductor optoelectronic devices- PHI,
4. NPTEL Nonlinear Optics Course (2015); online material, available at https://nptel.ac.in/courses/115101008/

SBU24PH5DSE301: PHOTOVOLTAICS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the principles of semiconductor physics	U
CO2	Understand the fundamentals of solar cells, the conversion of sunlight into electrical energy, the operation of p-n junctions within solar cells and the establishment of a voltage gradient.	U
CO3	Analyse the different parameters associated with solar cells.	U
CO4	Analyse the different preparation methods of solar cells	U
CO5	Evaluate various applications of solar photovoltaic systems across different sectors, and its economic implications	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1		2		2					1	2
CO2	2					2			2	
CO3			2						2	
CO4			2						2	
CO5	2		2			2				2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit Slip	Quiz	Assignment	Written Test	Programming Assignment	
CO1	x	x		x		x
CO2	x	x		x		x
CO3		x	x		x	x
CO4		x		x	x	x
CO5		x	x		x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Solar Cell Fundamentals (15 Hrs)				
Bonding in semiconductors	1.1	1	0.5	Lecture, Assignment
Intrinsic and extrinsic semiconductors	1.2	1	0.5	Lecture
Carrier distribution function	1.3	1	1	Lecture
Electron and hole concentration in doped	1.4	1	1	Lecture

semiconductor				
Carrier motion in semiconductors- drift - motion due to electric fields	1.5	1	1	Lecture
Electric field and energy band bending	1.6	1	1	Lecture, Practical
Diffusion current - diffusion current density	1.7	1	2	Lecture
Drift and diffusion together – diffusion coefficient	1.8	1	2	Lecture
Generation of carriers	1.9	1	2	Lecture
Recombination of carriers	1.10	1	2	Lecture
Continuity of carrier concentrations.	1.11	1	2	Lecture, Assignment
Module 2: P-N junction (15 Hrs)				
An Introduction to Solar Cells - equilibrium condition – space charge region - energy band diagram	2.1	2	2	Lecture, Assignment
Junction potential-width of depletion region	2.2	2	1	Lecture
Carrier movements and current densities – carrier concentration profile	2.3	2	2	Lecture
P-N junction non - equilibrium condition - I-V relation (qualitative and quantitative analysis)	2.4	2	4	Lecture
P-N junction under illumination – generation of photo voltage (PV)	2.5	2	2	Lecture
Light generated current	2.6	2	1	Lecture, Practical
I-V equation for solar cell	2.7	3	2	Lecture
Solar cell characteristics	2.8	3	1	Lecture
Module 3: Design and production of Solar Cells (15 Hrs)				
Upper limits of solar cell parameters - short circuit current – open circuit voltage – fill factor – efficiency	3.1	3	1	Lecture, Assignment
Losses in solar cell: model of solar cell – effect of series and shunt resistance, solar radiation and temperature on solar cell efficiency	3.2	3	2	Lecture
Design of high short circuit current: requirements - choice of junction depth and orientation – minimisation of optical losses and recombination	3.3	3	2	Lecture
Design for high open circuit voltage	3.4	3	0.5	Lecture
Design for high fill factor – base resistance – emitter resistance	3.5	3	2.5	Lecture
Analytical techniques: Solar simulator I-V measurement – quantum efficiency measurement – minority carrier life time and diffusion length measurement.	3.6	4	2	Lecture, Practical
Silicon usage in solar PV – an overview	3.6	4	2	Lecture
Thin Film Solar Cell Technologies – an overview	3.7	4	1	Lecture
Emerging solar cell Technologies – an overview	3.8	4	2	Lecture
Module 4: Solar Photovoltaic Applications (15 Hrs)				
Solar Photovoltaic (SPV) Modules: SPV from	4.1	4	1	Lecture,

solar cells – series and parallel connections – mismatch in cell module				Assignment
Mismatch in series connection: hot spots in modules – bypass diode	4.2	4	1	Lecture
Mismatching parallel connection	4.3	4	1	Lecture
Design and structure of PV modules: number of solar cells - wattage of modules – fabrication of modules	4.4	4	2	Lecture
PV module power output: I-V equation of PV modules – rating of PV modules - I-V and power curves of module – effect of solar irradiation and temperature	4.5	5	2	Lecture
Balance of Solar PV Systems: electrochemical cells – factors affecting battery performance – batteries for SPV systems	4.6	5	2	Lecture, Practical
Maximum Power Point Tracking (MPPT): Constant voltage method-Hill climbing methods-Incremental conductance method	4.7	5	1	Lecture
Photovoltaic System Design and Applications: introduction to SPV systems	4.8	5	1	Lecture
Stand alone SPV system configurations: Design methodology of SPV systems – wire sizing in SPV systems - precise sizing of SPV systems - hybrid SPV systems - grid connected SPV systems - simple payback period – life cycle costing	4.9	5	4	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1.Chetan Singh Solanki, Solar Photovoltaic: Fundamentals, Technologies and Applications, 2nd Edn, PHI

Reference

1.Richard J. Komp, Practical Photovoltaics: Electricity from Solar Cells, 3rd Edn. aatec Publishers, Michigan

2.Jenny Nelson, The Physics of Solar Cells (Properties of Semiconductor Materials), Imperial College Press, London

Course designed by: Dr. Gijo Jose

SBU24PH5DSE302: DYNAMICAL SYSTEMS

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Classical Mechanics - I		

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse the behaviour of nonlinear systems described by one-dimensional flow equations	An
CO2	Investigate bifurcation types such as saddle-node, transcritical and pitchfork bifurcations.	A
CO3	Apply phase plane techniques to model and understand complex nonlinear phenomena.	An
CO4	Investigate nonlinear oscillatory systems and their mathematical descriptions.	A
CO5	Explore applications in physics, engineering, biology, and other disciplines where nonlinear dynamics play a crucial role.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	3	-	3	3	-	3	-
CO2	3	3	3	2	-	3	3	-	3	-
CO3	3	3	3	3	-	3	3	-	3	-
CO4	3	3	3	2	-	3	3	-	3	-
CO5	3	3	3	2	1	3	3	-	3	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Problem Sheet		Exam 1		
CO1	x	x		x		x
CO2	x	x		x		x
CO3	x	x		x		x
CO4	x	x		x		x
CO5	x	x		x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: One Dimensional Flows (15 Hrs)				
A dynamical view of the world. General introduction to linear and nonlinear equations	1.1	CO1	2	Lecture
Flows on the line: Introduction - Geometric way of thinking - Fixed points and stability	1.2	CO1, CO5	3	Lecture, Problem solving

Linear stability analysis - Existence and uniqueness theorem	1.3	CO1, CO5	3	Lecture, Problem solving
Impossibility of oscillations: mechanical analogy (over damped systems)	1.4	CO1, CO5	2	Lecture, Problem solving
Visualise the dynamics: potentials.	1.5	CO1	2	Lecture, Problem solving
Typical Problems and applications	1.6	CO1, CO5	3	Problem solving
Module 2: Bifurcations and flow on a line (15 Hrs)				
Bifurcations: Introduction	2.1	CO2	1	Lecture
Saddle-node bifurcation	2.2	CO2	2	Lecture, Problem solving
Transcritical bifurcation	2.3	CO2	2	Lecture, Problem solving
Pitchfork bifurcation	2.5	CO2	2	Lecture, Problem solving
Imperfect bifurcations and catastrophes: bead on a tilted wire.	2.5	CO2, CO5	2	Lecture, Problem solving
Flows on the circle: Introduction - Examples and definitions	2.6	CO2	2	Lecture, Problem solving
Uniform oscillator	2.7	CO2, CO5	1	Lecture, Problem solving
Nonuniform oscillator	2.8	CO2	1	Lecture, Problem solving
Overdamped pendulum.	2.9	CO2, CO5	2	Lecture, Problem solving
Module 3: Dynamics in Phase Plane (15 Hrs)				
Linear Systems: Introduction - Examples and definitions	3.1	CO3	1	Lecture
Classification of linear systems.	3.2	CO3	2	Lecture, Problem solving
Dynamical variables - Phase space - Phase trajectories and their properties	3.3	CO3	2	Lecture, Problem solving
Fixed points and linearization - Stability. Stable and unstable manifolds.	3.4	CO3, CO5	2	Lecture, Problem solving
Lotka-Volterra model of competition	3.5	CO3, CO5	2	Lecture, Problem solving
Conservative systems - Reversible systems.	3.6	CO3	2	Lecture, Problem solving
Phase plane analysis of pendulum – Cylindrical phase space - Damping effects.	3.7	CO3, CO5	2	Lecture, Problem solving
Index theory - Global information about the phase portrait.	3.8	CO3, CO5	2	Lecture, Problem solving
Module 4: Nonlinear Oscillations (15 Hrs)				
Limit cycles: Introduction	4.1	CO4	2	Lecture, Problem solving
Lyapunov functions	4.2	CO4	2	Lecture, Problem solving
Poincare-Bendixson theorem	4.3	CO4	2	Lecture, Problem

				solving
Lienard systems - Relaxation oscillations	4.4	CO4, CO5	3	Lecture, Problem solving
Weakly nonlinear oscillators - Perturbation theory - Two timing	4.5	CO4, CO5	3	Lecture, Problem solving
Method of averaging.	4.6	CO4	3	Lecture, Problem solving
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Steven H. Strogatz, Nonlinear Dynamics and Chaos, First Edition, Westview Press, 2015.
2. Morris W. Hirsch, Differential Equations, Dynamical Systems and an Introduction to Chaos, Second Edition, Elsevier Academic Press, 2004.

Reference

1. Richelson, Chaos and Nonlinear Dynamics, Oxford University Press, 1994.
2. M. TABOR, Chaos and Integrability in Nonlinear dynamics, John Wiley, 1989.

Course designed by: Benny Joseph

SBU24PH5DSE303: NANOSCIENCE AND NANOTECHNOLOGY

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Condensed matter Physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe electronic and optical properties of materials upon nanostructuring	A
CO2	Describe carbon bond and allotropes of carbon	U
CO3	Fabrication of nanomaterials	U
CO4	Analysis of surface and electronic properties of nanomaterials	A
CO5	The effect of nanostructuring on magnetic properties	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2		1	2	1	2		1	2
CO2	2	1				2	1			1
CO3	1	2				1	2		1	1
CO4	2	2				1	2		2	2
CO5	2	2				1	2		2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Problem Sheets			Class test		
CO1	x			x		x
CO2	x			x		x
CO3	x			x		x
CO4	x			x		x
CO5	x			x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: (15 Hrs)				
Evolution of nanoscience -colour of Lycurgus cup	1.1	1	2	Lecture
Energy bands and its formation-band structure	1.2	1	2	Lecture
Density of states - 3D (concept and derivation)	1.3	1	2	Lecture, assignment
Density of states 1D, 2D (concept and derivation), examples for 1D, 2D systems	1.4	1	3	Lecture, assignment
Properties depend of DOS-Single electron	1.5	1	3	Lecture

tunneling				
Introduction to quantum materials- (graphene, transition metal dichalcogenides), Layer dependent properties(optical)	1.6	1	3	Lecture
Module 2:(9 Hrs)				
Nature of the Carbon Bond -allotropes of carbon-graphite, CNT, diamond, graphene)	2.1	2	2	Lecture
Carbon Clusters-C60, Orientational ordering of C60, other bucky balls	2.2	2	2	Lecture
Fabrication of CNT (chemical vapor deposition, arc melting)	2.3	2	3	Lecture
CNT-electrical and mechanical Properties	2.4	2	2	Lecture
Module 3: (21 Hrs)				
Fabrication-bottom up methods-Thermal, ebeam evaporation	3.1	3	3	Lecture
Fabrication-bottom up methods- sputtering	3.2	3	3	Lecture
Fabrication-bottom up methods- PLD, MBE, self assembly,	3.3	3	3	Lecture, assignment
Fabrication- Top-down techniques-lithography- photolithography, EUV, LIL,	3.5	3	3	Lecture
Fabrication- Top-down techniques-lithography- ebeam, Focussed ion beam	3.6	3	2	Lecture
Particle Size determination using X-ray diffraction	3.7	4	3	Lecture, assignment
Scanning Electron Microscopy	3.8	4	2	Lecture, assignment
Transmission Electron Microscopy	3.9	4	2	Lecture
Module 4:(15 Hrs)				
Basics of Ferromagnetism and superparamagnetism	4.1	5	3	Lecture, assignment
Effect of nanostructuring on magnetic particles-Dynamics of Nanomagnets	4.2	5	2	Lecture,assignment
Nanocarbon-Ferromagnets	4.3	5	2	Lecture
Ferrofluids	4.4	5	2	Lecture
Magneto resistance fundamental ideas-	4.5	5	2	Lecture
Giant and Colossal Magnetoresistance	4.6	5	2	Lecture, assignment
Applications of GMR, CMR	4.7	5	2	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. K.K. Chattopadhay, A. N. Banerjee Introduction to Nanoscience and Nanotechnology, PHI India
2. T. Pradeep, Nano: The Essentials TMH 2007
3. Charles P. Poole, Jr. And Frank J. Owens, Introduction to Nanotechnology, Wiley

Reference

1. C. Dupas, P. Houdy & M. Lahmani, Nanoscience, Nanotechnologies and Nanophysics, Springer-Verlag, (2007).

2. Ben Rogers, S. Pennathur and J. Adams, “Nanotechnology: Understanding small systems”, CRC Press, Boca Raton (2008).
3. D.B. Williams and C.B. Carter, Transmission Electron microscopy: A text book for Materials Science, 2nd edn. Plenum press, New York, (1996)
4. What is What in the Nanoworld A Handbook on Nanoscience and Nanotechnology, Victor E. Borisenko and Stefano Ossicini, WILEY-VCH Verlag, (2008).

Course designed by: Dr. Sinu Mathew

SBU24PH5DSE304: OSCILLATIONS, WAVES, MUSIC AND ACOUSTICS

Type of Course	DSE		
Course Level	300 – 399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60		60
Pre-requisite (if any)	Higher secondary school level Physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Develop a comprehensive understanding of the principles underlying oscillations and wave phenomena	U
CO2	Apply the acquired knowledge to analyse and solve problems related to oscillations and waves in practical applications	A
CO3	Gain insights into the generation, propagation, and perception of sound and music.	An
CO4	Explore the principles of acoustics, focusing on how sound interacts with its environment.	E
CO5	Integrate the understanding of oscillations, waves, sound, and acoustics to do practicals and to develop creative applications in various fields.	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1					1				
CO2			1						1	
CO3			1						1	
CO4				1					1	
CO5					1					1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x	x		x		x
CO2		x		x	x	x
CO3		x	x		x	x
CO4		x	x		x	x
CO5					Mini Project	

Course Content & Transaction Mechanism

Theory

Module 1: Oscillations (15 Hrs)				
Introduction to Oscillations				
Definition, types, and significance of oscillations	1.1	1	1	Lecture, Class Discussions, presentation
Harmonic motion and simple harmonic oscillators	1.2	2	2	Lecture, Class Discussions, presentation

Damped and Forced Oscillations				
Damping effect and its implications	1.3	2	2	Lectures, Problem Solving Exercises
Forced oscillations and resonance	1.4	2	2	Lecture, Problem Solving Exercises
Wave Basics				
Characteristics of waves (amplitude, frequency, wavelength)	1.5	1	2	Lecture, Class Discussions, presentation
Types of waves (mechanical and electromagnetic)	1.6	1	2	Lecture, Class Discussions, presentation
Wave Propagation and Dispersion				
Wave equation and its solutions	1.7	2	1	Lectures, Problem Solving Exercises
Speed, intensity, and energy of waves	1.8	2	1	Lectures, Problem Solving Exercises
Dispersion phenomenon in wave propagation	1.9	2	2	Lectures, Problem Solving Exercises
Module 2: Waves - Superposition and Interference (15 Hrs)				
Superposition Principle				
Understanding superposition in wave systems	2.1	2	1	Lecture, presentation
Interference patterns and applications	2.2	2	2	Lectures, Problem Solving Exercises
Standing Waves				
Formation and properties of standing waves	2.3	5	2	Lecture, demonstration, simulation
Harmonics and overtones	2.4	5	2	Lecture, guided exercises
Nonlinear Waves and Solitons				
Introduction to nonlinear wave phenomena	2.5	5	2	Lecture, guided exercises.
Soliton solutions and applications	2.6	5	2	Lecture, guided exercises.
Review and Application				
Review of oscillation and wave concepts	2.7	5	2	Group Projects, Creative Assignments
Application of oscillation and wave principles in various fields	2.8	5	2	Group Projects, Creative Assignments
Module 3: Sound and Music (15 Hrs)				
Introduction to Sound				
Nature and properties of sound waves	3.1	3	1	Lectures, Class Discussions.
Speed of sound and its dependence on different factors	3.2	3	2	Lectures, Class Discussions.
Human Hearing and Perception				
Physiology of the human ear	3.3	3	2	Lecture, presentation
Psychoacoustics and perception of sound	3.4	3	2	Case Studies, Audio Demonstrations
Musical Scales and Instruments				
Basics of musical scales	3.5	3	2	Case Studies, Laboratory Experiments

Sound production in musical instruments	3.6	3	2	Case Studies, Laboratory Experiments
Recording and Reproduction of Sound				
Sound recording techniques	3.7	4	2	Laboratory Experiments, Real-world Applications
Audio reproduction systems	3.8	4	2	Laboratory Experiments, Real-world Applications
Module 4: Acoustics (15 Hrs)				
Room Acoustics				
Principles of room acoustics	4.1	4	2	Case Studies, Laboratory Experiments
Sound reflections, absorption, and diffusion	4.2	4	2	Case Studies, Laboratory Experiments
Noise Control and Soundproofing				
Techniques for noise control	4.3	4	2	Laboratory Experiments, Real-world Applications
Soundproofing materials and methods	4.4	4	2	Laboratory Experiments, Real-world Applications
Applications of Acoustics				
Acoustics in communication systems	4.5	5	2	Case Studies, Real-world Applications
Acoustic design in architecture	4.6	5	2	Case Studies, Real-world Applications
Review and Synthesis				
Review of sound, music, and acoustics principles	4.7	5	1	Group Projects, Creative Assignments
Synthesis of knowledge for comprehensive understanding	4.8	5	2	Group Projects, Creative Assignments
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

Module 1

1. French, A. P. (1971). Vibrations and Waves. MIT Press.
2. Stoker, J. J. (1957). Water Waves: The Mathematical Theory with Applications. Wiley.

Module 2

1. Arfken, G. B., & Weber, H. J. (2005). Mathematical Methods for Physicists (6th ed.). Academic Press.
2. Scott, A. C. (2003). Nonlinear Science: Emergence and Dynamics of Coherent Structures. Oxford University Press.

Module 3

1. Rossing, T. D., Moore, R. F., & Wheeler, P. A. (2002). The Science of Sound (3rd ed.). Addison-Wesley.
2. Yost, W. A. (1994). Fundamentals of Hearing: An Introduction (4th ed.). Academic Press
3. Benade, A. H. (1990). Fundamentals of Musical Acoustics (2nd ed.). Dover Publications.
4. Toole, F. E. (2015). Sound Reproduction: The Acoustics and Psychoacoustics of Loudspeakers and Rooms. CRC Press.

Module 4

1. Cox, T. J., & D'Antonio, P. (2016). Acoustic Absorbers and Diffusers: Theory, Design, and Application. CRC Press.
2. Ljunggren, F. (2009). Noise Control: From Concept to Application. CRC Press.
3. Long, M. (2014). Architectural Acoustics. Elsevier.

Reference

1. Kibble, T. W. B., & Berkshire, F. H. (2004). Classical Mechanics (5th ed.). Imperial College Press.
2. Marion, J. B., & Thornton, S. T. (1995). Classical Dynamics of Particles and Systems (4th ed.). Harcourt Brace Jovanovich.
3. Morse, P. M., & Feshbach, H. (1953). Methods of Theoretical Physics (Part I). McGraw-Hill.
4. Goldstein, H., Poole, C., & Safko, J. (2001). Classical Mechanics (3rd ed.). Addison-Wesley.
5. Pierce, A. D. (1989). Acoustics: An Introduction to Its Physical Principles and Applications. Acoustical Society of America.
6. N. K. Bajaj, “The physics of waves and oscillations” Tata McGraw-Hill, 1988

Course designed by: Justin John

SBU24PH5SEC300: PYTHON PROGRAMMING

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	-	45
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand fundamental Python concepts such as variables, data types, operators, and control structures.	U
CO2	Understand basic web scraping techniques to extract information from HTML and XML documents. Explore working with APIs (Application Programming Interfaces) and handling JSON (JavaScript Object Notation) data for web data access and manipulation.	A
CO3	Understand database operations such as querying data, inserting, updating, and deleting records.	A
CO4	Apply Python skills learned in the course to develop practical projects such as data analysis scripts, web scraping tools, and database-driven applications.	E
CO5	Develop and implement practical Python projects integrating data analysis, web data access, and database management concepts learned throughout the course.	Cr

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	1	3	2	1	3	1
CO2	3	-	3	3	1	3	2	1	3	1
CO3	3	-	3	3	1	3	2	1	3	1
CO4	3	-	3	3	1	3	2	1	3	1
CO5	3	-	3	3	1	3	2	1	3	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit Slip	Quiz	Assignment	Written Test	Programming Assignment	
CO1	x	x		x		x
CO2	x	x		x		x
CO3		x	x		x	x
CO4		x		x	x	x
CO5		x	x		x	x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Beginning Python Basics and Python Data Structures (15 Hrs)				
Why should you learn to write programs? Why Python? - Python Syntax compared to other programming languages - Python Install	1.1	1	2	Lecture, Demonstration or Computer Simulation
Variables, expressions, and statements	1.2	1	2	Lecture, Demonstration or Computer Simulation
Conditional execution	1.3	1	2	Lecture, Demonstration or Computer Simulation
Functions	1.4	1	2	Lecture, Demonstration or Computer Simulation
Loops and iterations	1.5	1	2	Lecture, Demonstration or Computer Simulation
Strings	1.6	1	1	Lecture, Demonstration or Computer Simulation
Files	1.7	1	1	Lecture, Demonstration or Computer Simulation
Lists	1.8	1	1	Lecture, Demonstration or Computer Simulation
Dictionaries	1.9	1	1	Lecture, Demonstration or Computer Simulation
Tuples	1.10	1	1	Lecture, Demonstration or Computer Simulation
Module 2: Using Python to Access Web Data (11 Hrs)				
Regular Expressions - Extracting data	2.1	2	2	Lecture, Demonstration or Computer Simulation
Networks and Sockets	2.2	2	2	Lecture, Demonstration or Computer Simulation
Programs that Surf the Web	2.3	2	2	Lecture, Demonstration or Computer Simulation
Web Services and XML	2.4	2, 5	2	Lecture, Demonstration or Computer Simulation
JASON and REST architecture	2.5	2, 5	3	Lecture, Demonstration or Computer Simulation
Module 3: Using Databases with Python and Visualising Databases with Python (19 Hrs)				
Object Oriented Python	3.1	3	2	Lecture, Demonstration or Computer Simulation
Basic Structured Query Language	3.2	3	2	Lecture, Demonstration or Computer Simulation
Data Models and Relational SQL	3.3	3, 5	2	Lecture, Demonstration or Computer Simulation
Many to Many Relationship in SQL	3.4	3	1.5	Lecture, Demonstration or Computer Simulation
Databases and Visualisation	3.5	3, 5	1.5	Lecture, Demonstration or Computer Simulation
Building a Search Engine	3.6	4	2	Lecture, Demonstration

				or Computer Simulation
Exploring Data Sources (Project)	3.7	4, 5	2	Lecture, Demonstration or Computer Simulation
Spidering and Modeling Email Data	3.8	4	2	Lecture, Demonstration or Computer Simulation
Accessing New Data Sources (Project)	3.9	4, 5	1	Lecture, Demonstration or Computer Simulation
Visualising Email Data	3.10	4	1	Lecture, Demonstration or Computer Simulation
Visualising New Data Sources (Project)	3.11	4, 5	2	Lecture, Demonstration or Computer Simulation
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Dr. Charles R. Severance, Python for Everybody: Exploring Data Using Python 3, First Edition, Shroff Publishers, 2017.
2. Narasimha Karumanchi, Data Structures and Algorithms With Python, Careermonk Publications, 2015.

Reference

1. Ljubomir Perkovic, Introduction to Computing with Python, Second Edition, Wiley, 2015.
2. Peter Norton, et.al., Beginning Python, Wiley, 2005.
3. https://www.coursera.org/learn/python-data.

Course designed by: Benny Joseph T

SEMESTER VI

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24PH6DSC300	Major/ Minor	Quantum Mechanics	5	75	4
SBU24PH6DSC301	Major/ Minor	Basic Solid State Physics	5	75	4
SBU24PH6DSC302	Major/ Minor	Electrodynamics - I	5	75	4
SBU24PH6DSE300	Elective	Nanoscience at Surfaces and Interfaces Using Scanning Probe Microscopy	4	60	4
SBU24PH6DSE301	Elective	Statistical Tools and Introduction to Machine Learning	4	60	4
SBU24PH6SEC300	SEC	Introduction to Digital Design and IOT	3	45	3
SBU24PH6VAC300	VAC	Environmental Studies and Human Rights	3	45	3

SBU24PH6DSC300: QUANTUM MECHANICS

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Understanding of Calculus, Modern Physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the experiments that motivated the development of quantum mechanics and apply the basic principles to solve relevant problems.	A
CO2	Describe the mathematical methods and principles in quantum mechanics and apply the methods	A
CO3	Apply the Schrodinger equation for simple systems	A
CO4	Familiarise the quantum mechanical phenomena and their applications.	A
CO5	Develops experimental skills and analyse the process and outcomes of an experiment quantitatively and qualitatively.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	2	2	-	2	1	1	2	1
CO2	2	2	2	2	-	2	1	1	2	1
CO3	2	2	2	2	-	2	1	1	2	1
CO4	2	2	2	2	-	2	1	1	2	1
CO5	1	2	1	1	2	-	-	2	2	2

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Quiz	Written test	Assignment/ Problem based assignments	
CO1	x	x		x	x	x
CO2				x	x	x
CO3	x	x	x		x	x
CO4	x	x	x		x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Interview	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Wave Particle Duality (15 Hrs)				
Blackbody Radiation	1.1	1	2	Lecture and Problem Solving
Planck's quantum hypothesis, Planck Radiation law	1.2	1	2	Lecture and Problem Solving
Photoelectric Effect, Einstein's Photon explanation	1.3	1	2	Lecture and Problem Solving
Compton Scattering.	1.4	1	2	Lecture and Problem Solving
De-Broglie Hypothesis. Davisson-Germer Experiment.	1.5	1	2	Lecture, Problem Solving and Tutorials
Wave Packets. Group and Phase Velocities and relation between them.	1.6	1	2	Lecture and Problem Solving
Heisenberg's Uncertainty Principle (proof not required): Applications- Ground state energy of hydrogen atom, Non-existence of electron in the nucleus.	1.7	1	3	Lecture and Problem Solving
Module 2: Mathematical Formulation of Quantum Mechanics (15 Hrs)				
Wave function, Probability interpretation., Acceptable wavefunctions	2.1	2	1	Lecture and Problem Solving
Scalar product – Orthogonal functions	2.2	2	2	Lecture and Problem Solving
Normalization of Wave Function, Orthonormal functions	2.3	2	2	Lecture and Problem Solving
Operators, Linear Operator- Commutator of two operators	2.4	2	2	Lecture and Problem Solving
Hermitian Operators- Properties of Hermitian Operator	2.5	2	2	Lecture and Problem Solving
Expectation value, Eigen values and Eigen functions	2.6	2	2	Lecture and Problem Solving
Time development of a quantum system - Schrödinger equation	2.7	2	2	Lecture and Problem Solving
Time independent Schrodinger equation, Stationary states	2.8	2	1	Lecture and Problem Solving
Probability Density. Probability current density.	2.9	2	1	Lecture and Problem Solving
Module 3: Applications of Schrodinger Equation (15 Hrs)				
Free Particle	3.1	3	2	Lecture and Problem Solving
Particle in a one-dimensional box. Eigen functions and Eigen values.	3.2	3	3	Lecture and Problem Solving
Linear harmonic oscillator. Eigenfunctions and Eigen values.	3.3	4	3	Lecture and Problem Solving
Bound States of a Square-well potential.	3.4	3	2	Lecture and

				Problem Solving
Quantum Tunneling - Penetration of 1 dimensional rectangular potential barrier.	3.5	4	2	Lecture and Problem Solving
Applications of Tunneling (qualitative) - Alpha decay, Tunnel diode, STM.	3.6	4	1	Lecture and Problem Solving
Raman Effect – Quantum theory of Raman Effect.	3.7	4	2	Lecture and Problem Solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. H.C. Verma; Quantum Physics; 2nd Edition; Surya Publications

Reference

1. Arthur Beiser; Concepts of Modern Physics; TMH
2. Griffiths; Introduction to Quantum Mechanics; Pearson
3. G. Aruldhas; Quantum Mechanics; PHI
4. A. Ghatak and Lokanathan; Quantum Mechanics Theory and Applications; Macmillan

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Experiments (15 Hrs)				
Verification of Stefan's law and determination of Stefan's constant of radiation	1.1	5	3	Lab practical
Photoelectric effect – determination of Plank's constant using excel or origin	1.2	5	3	Lab practical
Frank and Hertz Experiment – determination of ionization potential	1.3	5	3	Lab practical
Planck's constant using LED's of different colours	1.4	5	3	Lab practical
Millikan's Oil Drop Experiment	1.5	5	3	Lab Practical
Module 2: Simulation Experiments (Using Python) (15 Hrs)				
Visualising wave packets using Python program.	2.1	5	3	Lab practical
Plot the probability densities of Particle in a box wavefunctions using Python program.	2.2	5	3	Lab practical
Plot the Harmonic oscillator wavefunctions using Python program.	2.3	5	3	Lab practical
Visualising Quantum tunnelling through Potential bump using Python program	2.4	5	3	Lab practical
Plot the probability densities of the Harmonic oscillator wavefunctions using Python program.	2.5	5	3	Lab practical

Experiments of equal standards can be added.

Reference

1. C.J. Babu; Practical Physics; Calicut University

Course designed by: Ajai Jose

SBU24PH6DSC301: BASIC SOLID STATE PHYSICS

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
	45	30	75
Pre-requisite (if any)	Properties of matter, Quantum Mechanics,		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the microscopic nature of crystals and crystallography	U
CO2	Apply the physics of scattering from crystals	A
CO3	Describe the physics of solids-macroscopic picture	U
CO4	Describe electron in crystal and bond formation in solids	U
CO5	Develops experimental skills and analyse the process and outcomes of an experiment quantitatively and qualitatively.	An

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1				2	2			
CO2	2	2				2	2		1	1
CO3	2	1				2	2		1	1
CO4	2	1				2	2		1	1
CO5	1	2				1	2		2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Problem Sheets			Class test		
CO1	x			x		x
CO2	x			x		x
CO3	x			x		x
CO4	x			x		x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills	Practical Assignment	Laboratory report	Lab test	
CO5	x	x	x	x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Introduction and Crystallography (16 Hrs)				
Introduction-Scope, condensed matter and solid state Physics	1.1	1	1	Lecture

2D lattices	1.2	1	1	Lecture
Bravais lattices	1.3	1	1	Lecture
Lattices with Bases, Primitive Cells, Wigner-Seitz Cells, Miller indices	1.4	1	1.5	Lecture, assignment
Symmetries- Translation and Point Groups, rotation axes, non-existence of 5, 7 fold axes	1.5	1	2	Lecture, assignment
3D lattices- Monatomic Lattices-Simple Cube	1.6	1	2	Lecture, assignment
Hexagonal lattice, close packing, Diamond Lattice	1.7	1	2	Lecture, assignment
Compounds- CsCl, Perovskite lattices	1.8	2	1	Lecture
14 Bravais Lattices and Seven Crystal Systems	1.9	2	1.5	Lecture
possibility of 32 point groups, 232 space lattices(qualitative)	1.10	2	1	Lecture
Implications of Microscopic Symmetries-Pyroelectricity, Piezoelectricity (qualitative)	1.11	1	2	Lecture
Module 2: Xray and neutron Scattering-(14 Hrs)				
Theory of Scattering from Crystals-Special Conditions, Elastic Scattering from Single atom, Wave Scattering from Many Atoms	2.1	2	3	Lecture, assignment
Structure factor	2.2	2	1	Lecture
Reciprocal Lattice, examples	2.3	2	3	Lecture, assignment
Laue Method	2.4	2	2	Lecture
Rotating Crystal, Powder Method	2.5	2	3	Lecture, assignment
Neutron scattering basic idea, advantages, disadvantages	2.6	2	2	Lecture
Module 3: Metal Physics (15 Hrs)				
Specific Heat of Solids: Boltzmann, Einstein, and Debye	3.1	3	2	Lecture
Periodic (Born–von Karman) Boundary Conditions	3.2	3	0.5	Lecture
Failure of Debye theory	3.3	3	1	Lecture
Drude theory of metals	3.4	3	1	Lecture
Electrons in an Electric Field,	3.5	3	1.5	Lecture, assignment
Electric and Magnetic Fields, Hall effect	3.6	3	1	Lecture, assignment
Thermal Transport	3.7	3	1	Lecture
Sommerfeld theory of metals	3.8	3	1	Lecture
Density of States in 3D	3.9	3	1	Lecture
Failure of free electron model	3.10	4	1	Lecture
Bonding in Solids-Metallic bonding	3.11	4	1	Lecture
Ionic bond, Covalent Bond,	3.12	4	2	Lecture
Hydrogen, van der Waals bond	3.13	4	1	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Solid state basics, Steven H. Simon (The Oxford Solid State Basics)
2. Condensed Matter Physics, Michael P. Marder, John Wiley & Sons
3. Solid State Physics by Ashcroft-Mermin (Chapter-3)
4. Solid State Chemistry: An Introduction, Lesley E. Smart, Elaine A. Moore

Reference

1. Introductory Solid State Physics, H.P. Myers, Taylor and Francis
2. Crystallography Applied to Solid State Physics, A. R. Verma and Onkar Nath Srivastava, New Age Int.
3. Introduction to Solid State Physics by Charles Kittel
4. Solid State Physics, S.O. Pillai, New Age Int.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Metal Physics and Crystal bonding (30 Hrs)				
Resistivity of semiconductor specimen–Four Probe Method	5.1	5	4	Lab practical
Hall Effect (a) carrier concentration (b) Mobility & (c) Hall coefficient	5.2	5	4	Lab practical
Electrical and thermal conductivity of copper and determination of Lorentz number	5.3	5	4	Lab practical
Young's modulus of steel using the flexural vibrations of a bar.	5.4	5	3	Lab practical
e/m of electron-Thomson's method	5.5	5	3	Lab practical
Energy gap of thermistor	5.6	5	4	Lab practical
Absorption spectrum –$KMnO_4$ solution / Iodine vapour – telescope and scale arrangement – Hartmann's formula or photographic method	5.7	5	4	Lab practical
Dielectric constant of a non-polar liquid	5.8	5	2	Lab practical
Dipole moment of an organic molecule (acetone).	5.9	5	2	Lab practical

Textbook

1.Introduction to Solid State Physics by Charles Kittel
2.Introductory Solid State Physics, H.P. Myers, Taylor and Francis
3.Solid State Physics, S.O. Pillai, New Age Int.

Course designed by: Dr. Sinu Mathew

SBU24PH6DSC302: ELECTRODYNAMICS - I

Type of Course	Major		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)	Competency in vector analysis		

Course Outcomes

No.	Description	Cognitive Level
CO1	Articulate the fundamental principles of vector analysis and electrodynamics	U
CO2	Utilize vector calculus to describe and solve problems related to electric and magnetic fields, demonstrating proficiency in the mathematical tools essential for electrodynamics.	A
CO3	Apply Faraday's Law to calculate induced electromotive forces, understand Lenz's Law, and analyze the behavior of electromagnetic induction in various situations.	A
CO4	Apply Maxwell's equations to describe and analyze the propagation of electromagnetic waves, including understanding the relationships between electric and magnetic fields in wave propagation.	An
CO5	Apply electrodynamics concepts to solve practical problems in various fields, demonstrating the ability to translate theoretical knowledge into real-world applications.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2			3	1		1	
CO2	2	3	2			3	1		1	
CO3	2	3	2			3	1		1	
CO4	2	3	2	1		3	1		1	
CO5	2	1	3	2	1	3	1		1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Home assignments	Written test	Problem based assignments	
CO1		x		x		x
CO2	x	x		x		x
CO3	x	x		x	x	x
CO4		x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills		Laboratory report	Practical Assignments	
CO5	x	x		x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Electrostatics (15 Hrs)				
Basics of vector Analysis	1.1	1	2	Lecture and Problem solving
Electric Field, Divergence and Curl of Electrostatic Fields	1.2	2	2	Lecture and Problem solving
Electric Potential	1.3	2	1	Lecture and Problem solving
Work and Energy in Electrostatics	1.4	1	2	Lecture and Problem solving
Conductors	1.5	1	1	Lecture and Problem solving
Polarization	1.6	1	2	Lecture and Problem solving
The Field of a Polarized Object	1.7	1	2	Lecture and Problem solving
The Electric Displacement	1.8	1	1	Lecture and Problem solving
Linear Dielectrics	1.9	1	2	Lecture and Problem solving
Module 2: Magnetostatics & Electrodynamics (15 Hrs)				
The Lorentz Force Law	2.1	2	1	Lecture and Problem solving
The Biot-Savart Law	2.2	2	1	Lecture and Problem solving
The Divergence and Curl of B	2.3	2	2	Lecture and Problem solving
Magnetization	2.4	1	2	Lecture and Problem solving
The Field of a Magnetized Object	2.5	1	2	Lecture and Problem solving
The Auxiliary Field H	2.6	1	1	Lecture and Problem solving
Electromotive Force	2.7	3	2	Lecture and Problem solving
Electromagnetic Induction	2.8	3	2	Lecture and Problem solving
Maxwell's Equations	2.9	3	2	Lecture and Problem solving

Module 3: Electromagnetic Waves (15 Hrs)				
Waves in One Dimension	3.1	1	2	Lecture and Problem solving
The Wave Equation for E and B	3.2	3	2	Lecture
Monochromatic Plane Waves	3.3	1	3	Lecture and Problem solving
Energy and Momentum in Electromagnetic Waves	3.4	4	1	Lecture and Problem solving
Electromagnetic Waves in Matter	3.5	4	3	Lecture and Problem solving
Propagation in Linear Media	3.6	4	3	Lecture and Problem solving
Reflection and Transmission at Normal Incidence	3.7	4	1	Lecture and Problem solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. David J Griffiths, Introduction to Electrodynamics, PHI 3rd ed.

Reference

1. R Murugeshan, Electricity and Magnetism, S. Chand & Company Ltd.
2. Dr E.D Dias, Santhosh P Jose, Electrodynamics made simple, Clare Publishers.
3. A S Mahajan and AA Rangwala, Electricity and Magnetism, TMH 4thEdn.
4. Matthew N Sadiku, Electromagnetics, Oxford 4th Edn.
5. Kraus/Fleish, Electromagnetics with applications, MH, 5th Edn.
6. J A Edminister, Electromagnetics 2nd Edn, TMH
7. TVS Arunmurthi, Electromagnetic Fields, S. Chand

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Lab Practical (6 Hrs)				
Field along the axis of a coil – Variation of magnetic field along the axis and Bh – using Deflection Magnetometer	5.1	5	2	Lab practical
Searle's Vibration Magnetometer – Magnetic moment	5.2	5	2	Lab practical
Deflection and vibration magnetometer – m and Bh	5.3	5	2	Lab practical
Module 6: Simulation Experiments (24 Hrs)				
Plot electric potential near various charge configurations using a Python program	6.1	5	4	Lab Practical
Plot electric field near various charge configurations using a Python program	6.2	5	4	Lab Practical
Motion of a charged particle in electric field	6.3	5	4	
Plot magnetic fields of a solenoid (inside and outside) using a Python program	6.4	5	4	Lab Practical

Motion of charged particle in a uniform magnetic field	6.5	5	4	Lab Practical
Motion of charged particle in combined electric and magnetic field (Cyclotron)	6.6	5	4	Lab Practical

Textbook

1. Nicholas Giordano, Hisao Nakanishi, Computational Physics, Second Edition, Pearson Addison-Wesley,2005
2. R.C Verma, P.K Ahluwalia, K.C Sharma, Computational Physics, An Introduction, New Age International Publishers

Reference

1. Richard Hamming, Numerical Methods for Scientists and Engineers, Dover publications.
2. Tao Pang, An Introduction to computational physics, Cambridge University Press, (1997)

Course Designed by: Dr Sajith Mathews T

SBU24PH6DSE300: NANOSCIENCE AT SURFACES AND INTERFACES USING SCANNING PROBE MICROSCOPY

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Basic knowledge of quantum mechanics and condensed matter physics		

Course Ou Course Outcomes

No.	Description	Cognitive Level
CO1	Describe fundamental ideas of surfaces and interfaces, forces	U
CO2	Describe Quantum tunneling and apply it to scanning tunneling microscopy- principle and methods	A
CO3	Describe atomic force microscopy- principle and methods, and apply it to AFM imaging	A
CO4	Describe other probe microscopy techniques such as SP-STM, MFM etc	U
CO5	Describe self-assembled monolayers and apply it to catalysis	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2	1			1	1			
CO2	2	2	3			1	1			
CO3	2	2	3			1	1			
CO4	3					1	1			
CO5	3	2	1			1	1			

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Problem sheets			Class test		
CO1	x			x		x
CO2	x			x		x
CO3	x			x		x
CO4	x			x		x
CO5	x			x		x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1 (15 Hrs)				
Introduction to surfaces and interfaces, forces, Physisorption, chemisorption	1.1	CO1	4	Lecture
Thermodynamics and kinetics of adsorption and desorption	1.2	CO1	4	Lecture, Problem solving

Chemical potential and equilibrium, Methods of calculating chemical potential, chemical potential of classical gas	1.3	CO1	4	Lecture, Problem solving
Langmuir adsorption isotherm- derivation, implications	1.4	CO1	3	Lecture
Module 2 (15 Hrs)				
Introduction to scanning probe microscopy (SPM), Working principles	2.1	CO2	3	Lecture
Important parts of scanning tunneling microscope (STM), imaging modes, STM Tip fabrication, tip and sample preparation	2.2	CO2	3	Lecture
Image processing and analysis, Artifacts	2.3	CO2	2	Lecture, demonstration
Atomic-resolution STM images of HOPG(0001) surface- analysis, Moiré pattern, grains	2.4	CO2	3	Lecture, demonstration
Scanning tunneling spectroscopy (STS), SP-STM, Manipulation of atoms and molecules using STM, Sensors based on SPM methods, Application of SPM	2.5	CO4	4	Lecture, demonstration
Module 3 (15 Hrs)				
Atomic force microscopy (AFM)	3.1	CO3	2	Lecture
Modes of AFM operation, spring constant, Noises in AFM	3.2	CO3	3	Lecture
Different types of SPM such as MFM, Mechanical, chemical, and electric properties- measurements	3.3	CO4	4	Lecture
Force Spectroscopy	3.4	CO2	2	Lecture
AFM image processing- FFT, autocorrelation etc	3.5	CO3	4	Lecture
Module 4 (15 Hrs)				
Self-assembled monolayers, solid-liquid interface	4.1	CO5	4	Lecture
Sub-molecular resolution imaging- Alkanethiols on gold, fattyacids on graphite, Image analysis	4.2	CO5	5	Lecture, demonstration
Atom-resolved chemical reactions	4.3	CO5	3	Lecture
Nano-catalysis, Photocatalysis	4.4	CO5	3	Lecture

Textbook

1. Kurt W. Kolsinski, Surface Science: Foundations of Catalysis and Nanoscience, 2nd edn, John Wiley & Sons Ltd, 2008
2. Sergei N. Magonov, Myung-Hwan Whangbo, Surface Analysis with STM and AFM, VCH (Germany), 1996

Reference

3. Jacob N. Israelachvili, Intermolecular and Surface Forces, 3rd edn, Academic Press, 2011
4. Hans-Jürgen Butt, Karlheinz Graf, Michael Kappl, Physics and Chemistry of Interfaces, Wiley-VCH Verlag GmbH & Co. KGaA, 2003

5. Robert Bowley, Introductory Statistical Mechanics, Oxford Science Publications
6. Roland Wiesendanger, Scanning Probe Microscopy and Spectroscopy- Methods and Applications, Cambridge University Press, 1994
7. P.R. Davies and M.W. Roberts, Atom Resolved Surface Reactions- Nanocatalysis, RSC Publishing, 2008
8. Juan Carlos Colmenares and Yi-Jun Xu, Heterogeneous Photocatalysis- From Fundamentals to Green Applications, Springer, 2016
9. Wesley C. Sanders, Atomic Force Microscopy- Fundamental Concepts and Laboratory Investigations, CRC Press, Taylor & Francis Group, 2020
10. Michael Bowker and Philip R. Davies, Scanning Tunneling Microscopy in Surface Science, Nanoscience and Catalysis, Wiey-VCH Verlag GmbH & Co. KGaA, 2010

Course designed by: Dr. Loji K Thomas

SBU24PH6DSE301: STATISTICAL TOOLS AND INTRODUCTION TO MACHINE LEARNING

Type of Course	DSE		
Course Level	300-399		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Linear algebra, Python Programming		

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply probability theory to analyse uncertain events and make probabilistic predictions in various contexts.	A
CO2	Apply probability distributions to model real-world phenomena and make statistical inferences about data.	A
CO3	Interpret regression models, evaluate model goodness-of-fit, and make predictions based on regression analysis results.	E
CO4	Understand the difference between classification and regression tasks in machine learning and explore common algorithms for each task.	A
CO5	Implement machine learning algorithms such as logistic regression, decision trees, and clustering to solve classification and clustering problems.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	-	3	3	2	3	-
CO2	3	-	3	3	-	3	3	2	3	-
CO3	3	-	3	3	-	3	3	2	3	-
CO4	3	-	3	3	-	3	3	2	3	-
CO5	3	-	3	3	-	3	3	2	3	-

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot Quiz	Quiz	Programming Assignment	Written Test		
CO1	x	x		x		x
CO2	x	x		x		x
CO3	x	x		x		x
CO4	x		x	x		x
CO5	x		x	x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Probability Theory and Random Variables (13)				
Probability: Random experiment, trial, and sample space	1.1	1	1	Lecture, Problem Solving

Events-mutually exclusive and exhaustive events.	1.2	1	2	Lecture, Problem Solving
Classical and statistical definitions of probability	1.3	1	1	Lecture, Problem Solving
Addition and multiplication theorems	1.4	1	2	Lecture, Problem Solving
Bayes theorem	1.5	1	1	Lecture, Problem Solving
Discrete and continuous random variables	1.6	1	2	Lecture, Problem Solving
Probability mass and density functions	1.7	1	2	Lecture, Problem Solving
Distribution functions, expectation and variance of a random variable	1.8	1	2	Lecture, Problem Solving
Module 2: Statistical Distributions (14)				
Discrete and continuous probability distribution	2.1	2	2	Lecture, Problem Solving
Bernoulli, Binomial and Multinomial Distributions	2.2	2	2	Lecture, Problem Solving
Poisson's Distribution and Poisson Processes	2.3	2	3	Lecture, Problem Solving
Continuous Uniform distribution	2.4	2	1	Lecture, Problem Solving
Normal Distribution and applications	2.5	2	3	Lecture, Problem Solving
Gamma and Exponential Distribution	2.6	2	2	Lecture, Problem Solving
Lognormal Distribution	2.7	2	1	Lecture, Problem Solving
Module 3: Regression Analysis (14)				
Simple Linear regression	3.1	3	2	Lecture, Problem Solving
Method of least squares	3.2	3	3	Lecture, Problem Solving
A Measure of Quality of Fit: Coefficient of Determination	3.3	3	1	Lecture, Problem Solving
Multiple Linear Regression Model - Estimating Coefficient	3.4	3	2	Lecture, Problem Solving
Linear Regression Model Using Matrices	3.5	3	2	Lecture, Problem Solving
Model selection and diagnostics	3.6	3	2	Lecture, Problem Solving
Nonlinear regression models	3.7	3	2	Lecture, Problem Solving
Module 4: Introduction to Machine Learning (19)				
Introduction to Machine Learning and applications	4.1	4	2	Lecture, Demonstration or Computer Simulation
Supervised learning vs Unsupervised	4.2	4	2	Lecture,

learning				Demonstration or Computer Simulation
Multiple Linear regression - model, Cost function- Gradient descent – Learning rate Practice: Train the model with gradient descent	4.3	4, 5	5	Lecture, Demonstration or Computer Simulation
K- Nearest Neighbours	4.4	4, 5	2	Lecture, Demonstration or Computer Simulation
Decision Trees	4.5	4, 5	2	Lecture, Demonstration or Computer Simulation
Logistic regression	4.6	4, 5	2	Lecture, Demonstration or Computer Simulation
Support Vector Machine (SVM)	4.7	4, 5	2	Lecture, Demonstration or Computer Simulation
K - Means Clustering	4.8	4, 5	2	Lecture, Demonstration or Computer Simulation
Module 5: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) **This content will be evaluated internally**				

Textbook

1. Ronald E. Walpole, Raymond H. Myers, Sharon L. Myers, Keying Ye, Probability & Statistics for Engineers & Scientists, 9th Edition, Prentice Hall, 2012.
2. Tom M. Mitchell, Machine Learning, McGraw-Hill Science/Engineering/Math, 1997
3. Christopher M. Bishop, Pattern Recognition and Machine Learning, Springer Science, 2006.

Reference

1. William Mendenhall, Robert J. Beaver, Barbara M. Beaver, Introduction to Probability and Statistics, Brooks/Cole, 2009.
2. Aurélien Géron, Hands-on Machine Learning with Scikit-Learn, Keras, and TensorFlow, 2nd Edition, O’Reilly Media, 2018.
3. https://www.coursera.org/learn/machine-learning-with-python

Course designed by: Benny Joseph T

SBU24PH6SEC300: INTRODUCTION TO DIGITAL DESIGN AND IOT

Type of Course	SEC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45		45
Pre-requisite (if any)	Students should have a foundational understanding of Digital Electronics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand the fundamental principles of digital design, including the historical evolution, applications, and significance in real-world scenarios.	U
CO2	Apply advanced digital design techniques, including the design and implementation of combinational circuits, adders, subtractors, registers, and counters, with a focus on practical applications.	A
CO3	Develop proficiency in IoT concepts, with an emphasis on the role of microcontrollers (Arduino and ESP32) in IoT systems, along with the understanding and application of communication protocols.	A
CO4	Apply digital design principles to analyze and solve real-world problems, demonstrating the ability to address challenges using acquired knowledge and critical thinking.	An
CO5	Demonstrate competence in the implementation of microcontroller-based IoT projects, showcasing the ability to plan, program, and execute practical applications using Arduino and ESP32 platforms.	C

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1					1				
CO2			1						1	
CO3	1					1				
CO4			1						1	
CO5					1					1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x	x		x		x
CO2		x		x	x	x
CO3		x	x		x	x
CO4		x	x		x	x
CO5					Mini Project	

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Digital Design - Basics to Flip Flops (15 Hrs)				
Introduction to Digital Design				
Definition and importance of digital design	1.1	1	0.5	Lecture, Class Discussions, presentation
Historical context and evolution of digital systems	1.2	2	0.5	Lecture, Class Discussions, presentation
Applications of digital design in real-world scenarios	1.3	1	1	Lectures, Demonstration
Combinational Circuits and Adders/Subtractors				
Designing combinational circuits using logic gates	1.4	1	2	Lecture, Class Discussions
Introduction to half and full adders	1.5	1	2	Lectures, Class Discussions
Implementing adders and subtractors in digital circuits	1.6	1	2	Lectures, Demonstration
Practical applications of adders and subtractors	1.7	2	2	Demonstrations and guided exercises.
Sequential Circuits and Flip Flops				
Introduction to sequential circuits	1.8	1	1	Lecture, presentation
Types of flip-flops (SR, JK, D, T)	1.9	1	2	Lecture, presentation
Designing and analyzing sequential circuits	1.10	2	1	Case studies, problem-solving sessions
Practical application of flip-flops in memory units	1.11	2	1	Demonstrations, and guided exercises.
Module 2 Advanced Digital Design and Applications (15 Hrs)				
Registers and Counters				
Design and implementation of registers	2.1	2	2	Case studies, problem-solving sessions
Types of counters and their applications	2.2	2	3	Case studies, problem-solving sessions
Digital Integrated Circuits (ICs) and Microcontrollers				
Overview of digital ICs	2.3	2	2	Lecture and presentation
Introduction to microcontrollers	2.4	2	2	Lecture and presentation
Application of microcontrollers in digital	2.5	2	3	Live

systems				demonstrations, and guided exercises.
Memory Systems				
Types of memory (RAM, ROM, Flash)	2.6	2	1	Lecture, presentation
Memory organization and addressing	2.7	2	2	Lecture, presentation
Module 3: IoT with Microcontrollers (15 Hrs)				
Introduction to IoT				
Definition and significance of the Internet of Things	3.1	3	2	Lecture, concept explanations, and interactive discussions.
IoT applications in various industries	3.2	3	1	Lecture, video presentation
Microcontrollers in IoT				
Role of microcontrollers in IoT systems	3.3	4	1	Lecture, presentation
Introduction to Arduino and ESP32	3.4	3	2	Peer collaboration, and troubleshooting exercises
Programming basics for Arduino and ESP32	3.5	5	3	Live demonstrations and problem-solving exercises
IoT Communication Protocols				
Understanding communication protocols (MQTT, HTTP)	3.6	4	1	Lecture, Live demonstrations
Hands-on experience with IoT communication	3.7	5	5	Mini project
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbooks

1. Ray C. Mullin and Phil Simmons, "Electrical Wiring: Residential," 18th Edition, Cengage Learning, 2021.
2. Paul Horowitz and Winfield Hill, "Art of Electronics," 3rd Edition, Cambridge University Press, 2015.
3. Albert Malvino and David J. Bates, "Electronic Principles," 8th Edition, McGraw-Hill Education, 2015.
4. Arsath Natheem S - Arduino Book for Beginners
5. Dogan Ibrahim - The Complete ESP 32 Projects Guide - Elektor

Reference

1. Paul Scherz, "Practical Electronics for Inventors," 4th Edition, McGraw-Hill Education, 2016.
2. Robert L. Boylestad and Louis Nashelsky, "Electronic Devices and Circuit Theory," 11th Edition, Pearson, 2012.

3. B.L. Theraja and A.K. Theraja, "A Textbook of Electrical Technology: Volume 3 - Electronic Devices and Circuits," S. Chand & Company Ltd., 3rd Edition, 2010.

Course designed by: Justin John

SBU24PH6VAC300: ENVIRONMENTAL STUDIES AND HUMAN RIGHTS

Type of Course	VAC		
Course Level	300-399		
Credit	3		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	0	45
Pre-requisite (if any)	Elementary level knowledge in Physics and mathematics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Acquire a comprehensive understanding of environmental concepts, including the components of the environment, sustainable development principles, waste management strategies, pollution prevention, and the impact of human activities on natural ecosystems	U
CO2	Develop proficiency in assessing and mitigating disaster risks through hazard mapping, vulnerability assessment, and the implementation of preventive measures, preparing them to effectively manage disasters and minimise their impact	U
CO3	Develop familiarity with national and international perspectives on human rights, including definitions, relevance in India, key provisions of the Universal Declaration of Human Rights, and core issues such as poverty, overpopulation, and discrimination	U
CO4	Cultivate awareness of pressing environmental challenges such as pollution, deforestation, climate change, and natural disasters, and explore potential solutions and policies aimed at promoting environmental sustainability and resilience	U
CO5	Equipped to promote human rights literacy and awareness through an understanding of the mechanisms for redressal against human rights violations, including the role of the judiciary, government systems, and statutory commissions such as the NHRC	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1					1				
CO2			1						1	
CO3	1					1				
CO4			1						1	
CO5					1					1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Exit slips	Quiz	Home assignments	Written test	Problem based assignments	
CO1	x	x		x		x
CO2		x		x	x	x
CO3		x	x		x	x
CO4		x	x		x	x
CO5	x	x		x		x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Environmental Science (15 Hrs)				
Meaning and importance of environment, Biotic and abiotic components	1.1	CO1	2	Lecture
Environment and development, Concept of sustainable development	1.2	CO1	2	Lecture
Solid waste management-causes, effects and control measures of urban and industrial waste, Biodegradable and non-degradable, 3R's in waste management	1.3	CO1	3	Lecture
Pollution: Air, Water, Soil, Marine and Noise, Role of an individual in prevention of pollution	1.4	CO4	2	Lecture
Nuclear accidents and nuclear holocaust	1.5	CO1	1	Lecture
Sand mining, wetland reclamation, landscape changes, soil erosion, Deforestation and desertification, flood and drought	1.6	CO1	3	Lecture
Overexploitation Treats to fresh water resources of Kerala	1.7	CO4	1	Lecture
Tourism and its impact on environment	1.8	CO4	1	Lecture
Module 2: Disaster management (15 Hrs)				
Definition and meaning of key terms in Disaster Risk Reduction and Management	2.1	CO2	2	Lecture
Hazard types and hazard mapping; Vulnerability types and their assessment- physical, social, economic and environmental vulnerability	2.2	CO2	3	Lecture
Disaster risk assessment –approaches, procedures	2.3	CO2	2	Lecture
Measures for Disaster Risk Reduction – prevention, mitigation, and preparedness	2.4	CO2	3	Lecture
Relief; international relief organizations.	2.5	CO2	2	Lecture
Common disaster types in India	2.6	CO2	2	Lecture
National disaster management policy	2.7	CO2	1	Lecture
Module 3: Human Right education (15 Hrs)				
National and International Perspectives: Definitions of Human Right	3.1	CO3	2	Lecture
Relevance of Human Rights in India-Social Aspects-Economic Aspects-Political Aspects	3.2	CO3	3	Lecture
UDHR-Civil and political rights-Economic, social and cultural rights, Rights against torture, Discrimination and forced labour-Rights of the child	3.3	CO3	2	Lecture
Preamble to the Indian constitution-Human Rights and Duties in Indian constitution	3.4	CO3	2	Lecture
Deprivation of Human Rights-The core issues: Poverty-Overpopulation-Illiteracy, Unsustainable Development, Disadvantageous Groups (Women, Children, SC/ST, Homeless and slum dwellers, physically and mentally handicapped, refugees and	3.5	CO3	2	Lecture

internally displaced persons)				
Redressal Mechanisms against Human Rights Violation: Judiciary -Government systems for Redressal - NHRC and other Statutory Commissions	3.6	CO5	2	Lecture
Creation of Human Rights Literacy and Awareness	3.7	CO5	2	Lecture

Textbook

1. Mckinney, M.L. and School, R.M. 1996. Environmental Science systems & Solutions, Web enhanced edition. 639p
2. R. Subramanian, Disaster Management, Vikas Publishing House, 2018
3. UNDP, Disaster Risk Management Training Manual, 2016

Reference

3. Miller, G. Tyler, and Scott E. Spoolman. Environmental Science. 15th Edition. Cengage Learning, 2021.
4. Kapoor, A.C., Disaster Management. 5th Edition. New Delhi: Sultan Chand & Sons, 2019.
5. Sen, Shibashis. Human Rights Education. 2nd Edition. PHI Learning Pvt. Ltd., 2020.
6. Cunningham, William P., and Mary Ann Cunningham. Environmental Science: A Global Concern. 14th Edition. McGraw-Hill Education, 2022.
7. Gupta, Kailash C. Disaster Management. 7th Edition. Atlantic Publishers & Distributors Pvt Ltd, 2021.

Course designed by: Dr. Prijil Mathew

SEMESTER VII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24PH7DSC400	Major/ Minor	Mathematical Methods in Physics	4	60	4
SBU24PH7DSC401	Major/ Minor	Atomic and Molecular Physics	4	60	4
SBU24PH7DSC402	Major/ Minor	Classical Mechanics - II	4	60	4
SBU24PH7DSC403	Major/ Minor	Nuclear and Particle Physics	4	60	4
SBU24PH7DSC404	Major/ Minor	Computational Physics	5	75	4
SBU24PH7DSC405	Major/ Minor	Classical and Quantum Statistical Physics	4	60	4

SBU24PH7DSC400: MATHEMATICAL METHODS IN PHYSICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Competency in mathematics at Higher Secondary level		

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply matrix algebra techniques to solve systems of linear equations, diagonalize matrices, and analyse linear transformations relevant to physical problems.	An
CO2	Analyse group representations, character tables, and group actions to classify symmetries and study the behaviour of physical systems under symmetry transformations.	An
CO3	Apply techniques such as contour integration, residue theorem, and analytic continuation to evaluate complex integrals and study complex function behaviour relevant to physical phenomena.	A
CO4	Utilise transform properties, convolution theorem, and inversion techniques to analyse time-domain and frequency-domain representations of physical signals and systems.	An
CO5	Apply mathematical tools to analyse experimental data, simulate physical systems, and derive theoretical predictions for phenomena in classical and modern physics.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	-	3	3	-	3	2	-	3	-
CO2	3	3	-	3	-	3	2	-	3	-
CO3	3	3	3	-	-	3	2	-	3	-
CO4	3	-	3	3	-	3	2	-	3	-
CO5	3	3	3	3	-	3	2	-	3	1

Mapping of CO to Assessment Tools (Theory)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Problem Sheets	Home Assignment		Written Test		
CO1	x	x		x		x
CO2	x	x		x		x
CO3	x	x		x		x
CO4	x	x		x		x
CO5	x	x		x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Matrices (15 Hrs)				
Orthogonal and unitary matrices	1.1	1	2	Lecture and Problem solving
Linear and Similarity transformations	1.2	1	1	Lecture and Problem solving
Eigen value problem	1.3	1,5	1	Lecture and Problem solving
Cayley-Hamilton theorem and matrix inversion by Cayley-Hamilton theorem	1.4	1	2	Lecture and Problem solving
Diagonalisation using normalized eigenvectors	1.5	1	3	Lecture and Problem solving
Normal modes of vibrations as an example of eigen value problem	1.6	1,5	1	Lecture and Problem solving
Pauli spin matrices	1.7	1,5	1	Lecture and Problem solving
solution of a set of linear equations – matrix inversion method, Gauss elimination method, Gauss-Jordan method	1.8	1,5	3	Lecture and Problem solving
Iteration methods for the solution of a set of linear equations by Gauss-Seidel method and Jacobi method.	1.9	1	1	Lecture and Problem solving
Module 2: Group Theory (15 Hrs)				
Definition of Groups	2.1	2	1	Lecture and Problem solving
Group of transformations – multiplication table	2.2	2	2	Lecture and Problem solving
Conjugate elements and classes-subgroups	2.3	2	1	Lecture and Problem solving
Direct product groups – isomorphism and homomorphism	2.4	2	1	Lecture and Problem solving
Permutation groups	2.5	2	1	Lecture and Problem solving
Reducible and irreducible representation – Unitary representations	2.6	2	1	Lecture and Problem solving
Schur's lemmas –orthogonality theorem and interpretations	2.7	2	2	Lecture and Problem solving
Character of a representation Character tables and examples C2V, C3V, C4V	2.8	2,5	2	Lecture and Problem solving
Continuous groups – full rotation groups – rotation of functions and angular momentum	2.9	2,5	1	Lecture and Problem solving
Lie groups and lie algebra – SU(2)-SO(3) homomorphism	2.10	2,5	1	Lecture and Problem solving
Irreducible representation of SU(2) group – SU(3) group	2.11	2,5	2	Lecture and Problem solving

Module 3: Complex Analysis (15 Hrs)				
Analytic function-Cauchy-Riemann conditions -C-R equation in polar form	3.1	3	2	Lecture and Problem solving
Harmonic function-Method to find conjugate function-Milne Thomson method to construct an analytic function	3.2	3,5	2	Lecture and Problem solving
Cauchy integral theorem-Cauchy integral formula- Cauchy integral formula for the derivative of an analytic function	3.3	3	3	Lecture and Problem solving
Taylor's and Laurent's series-poles and residues	3.4	3	4	Lecture and Problem solving
Method of finding residue- residue theorem	3.5	3,5	2	Lecture and Problem solving
Evaluation of complex and real integrals	3.6	3,5	2	Lecture and Problem solving
Module 4: Integral Transforms (15 Hrs)				
Fourier transform - integral form	4.1	4	2	Lecture and Problem solving
properties of Fourier transform – convolution - Parseval's identity	4.2	4	3	Lecture and Problem solving
Fourier transform of derivatives	4.3	4	1	Lecture and Problem solving
Momentum representation	4.4	4,5	1	Lecture and Problem solving
Laplace transform of harmonic oscillator	4.5	4,5	1	Lecture and Problem solving
Laplace transform– Properties of Laplace transform	4.6	4	2	Lecture and Problem solving
Laplace transformation of unit step function and Periodic functions	4.7	4	1	Lecture and Problem solving
Convolution theorem -Evaluation of integrals	4.8	4	1	Lecture and Problem solving
Inverse Laplace transform – properties and applications	4.9	4,5	1	Lecture and Problem solving
Solution of differential equations- LCR circuit	4.10	4,5	2	Lecture and Problem solving
Module 5: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) **This content will be evaluated internally**				

Textbooks

1. B. Arfken &H.J. Weber, Mathematical Methods for Physicists, 7th Edition, Academic Press, 2013.
2. A.W. Joshy, Elements of Group Theory for Physicists, 6th Edition, New Age India, 2023.

Reference

1. E. Kreyszig, Advanced Engineering Mathematics, 10th Edition, John Wiley, 2020

2. L.A. Pipes & L.R. Harvill, Advanced Mathematics for Engineering and Physics, 3rd Edition, Tata McGraw Hill, 2014

Course designed by: Benny Joseph T

SBU24PH7DSC401: ATOMIC AND MOLECULAR PHYSICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Graduate course in Quantum Mechanics, Electrodynamics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understands the nature and behaviour of interactions between matter and energy at the atomic and molecular level.	U
CO2	Describe the Atomic spectra and interpret the spectra.	A
CO3	Describe the Rotational and Vibrational spectrum of simple molecules and interpret the Microwave and Infra Red spectrum.	A
CO4	Describe the Raman and Electronic spectrum of simple molecules and interpret the spectrum.	A
CO5	Describe the spectroscopic techniques NMR, ESR and Mossbauer and interpret the spectrum.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	1	-	2	1	-	1	1
CO2	2	2	2	2	1	2	1	1	2	1
CO3	2	2	2	2	1	2	1	1	2	1
CO4	2	2	2	2	1	2	1	1	2	1
CO5	2	2	2	2	1	2	1	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz	Exit slip	Quiz	Written test	Assignment/ Problem based assignments	
CO1	x	x		x	x	x
CO2			x	x	x	x
CO3					x	x
CO4	x	x	x		x	x
CO5	x	x	x		x	x

Course Content & Transaction Mechanism
Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Atomic Spectra (15 Hrs)				
Vector Atom Model, Quantum numbers	1.1	1	2	Lecture
Coupling Schemes: LS Coupling Scheme and JJ Coupling Scheme	1.2	2	2	Lecture
Comparison of spectral terms in L-S and J-J coupling	1.3	2	1	Lecture

The Hydrogen atom	1.4	2	2	Lecture
Spectroscopic terms	1.5	2	1	Lecture
Spin-orbit interaction, derivation of spin-orbit interaction energy	1.6	2	1	Lecture
Fine structure in sodium atom, selection rules	1.7	2	1	Lecture
Lande g-factor	1.8	2	1	Lecture
Normal and Anomalous Zeeman effects	1.9	2	1	Lecture
Paschen–Back effect and Stark effect in one electron system	1.10	2	1	Lecture
Hund's rule, Lande interval rule	1.11	2	1	Lecture
Hyperfine structure and width of spectral lines. (qualitative ideas only).	1.12	2	1	Lecture
Module 2: Microwave and Infrared Spectroscopy (15 Hrs)				
Classification of molecules	2.1	1	1	Lecture, Assignment
Rotational spectra of rigid diatomic molecules	2.2	3	1	Lecture, Problem solving, Assignment
Intensity of spectral lines - effect of isotopic substitution	2.3	3	1	Lecture, Problem solving
Non–rigid rotor - rotational spectra of non-rigid rotator	2.4	3	1	Lecture
Rotational spectra of polyatomic linear and symmetric top molecules	2.5	3	2	Lecture
Applications of microwave spectroscopy	2.6	3	1	Lecture, Assignment
Born-Oppenheimer approximation.	2.7	3	1	Lecture
Vibrational energy of a diatomic molecule-harmonic oscillator model	2.8	3	1	Lecture
Anharmonic oscillator model	2.9	3	1	Lecture, Problem solving
Diatomic vibrating rotor	2.10	3	1	Lecture, Problem solving
Break down of Born-Oppenheimer approximation	2.11	3	1	Lecture
Vibrations of polyatomic molecules - overtone and combination frequencies	2.12	3	1	Lecture, Assignment
Influence of rotation on the spectra of polyatomic linear and symmetric top molecules	2.13	3	1	Lecture
Fourier transform IR spectroscopy	2.14	3	1	Lecture
Module 3: Raman and Electronic Spectroscopy (15 Hrs)				
Raman Spectroscopy: Classical and Quantum Mechanical description	3.1	1	2	Lecture, Problem solving, Assignment
Pure rotational Raman spectra of linear and	3.2	4	2	Lecture

symmetric top molecules				
Vibrational Raman spectra	3.3	4	1	Lecture
Raman activity of vibrations - mutual exclusion principle	3.4	4	1	Lecture
Rotational fine structure	3.5	4	1	Lecture
Structure determination from Raman and IR spectroscopy	3.6	4	2	Lecture, Assignment
Electronic spectra of diatomic molecules	3.7	4	1	Lecture
Intensity of spectral lines. Franck – Condon principle	3.8	4	1	Lecture
Rotational fine structure of electronic-vibrational transition	3.9	4	2	Lecture, Problem solving
Fortrat parabola	3.10	4	1	
Dissociation energy – Predissociation.	3.11	4	1	Lecture, Problem solving, Assignment
Module 4: Spin Resonance Spectroscopy (15 Hrs)				
NMR: Quantum mechanical and classical descriptions	4.1	1	1	Lecture
Bloch equations -Relaxation processes	4.2	5	3	Lecture
Chemical shift	4.3	5	1	Lecture, Problem solving
CW spectrometer	4.4	5	1	Lecture
ESR: Theory of ESR	4.5	5	1	Lecture
Thermal equilibrium and relaxation	4.6	5	1	Lecture, Assignment
g- factor - Hyperfine structure	4.7	5	2	Lecture, Assignment
Mossbauer spectroscopy: Mossbauer effect - recoilless emission and absorption	4.8	1	1	Lecture, Assignment
Experimental technique	4.9	5	1	Lecture, Assignment
Chemical isomer shift	4.10	5	1	Lecture, Assignment
Hyperfine interactions	4.11	5	1	Lecture, Assignment
Applications of NMR, ESR, Mossbauer	4.12	5	1	Lecture, Assignment
Module 5: Teacher Specific Content This content will be evaluated internally				

Textbook

1.H.E. White, Introduction of Atomic Spectra, Mc Graw Hill
2.C.N. Banwell, Fundamentals of Molecular Spectroscopy, TMH
3.Philip Gutlich, Mossbauer Spectroscopy

Reference

1.P. Straughan & S. Walker, Spectroscopy (Vol-1,2,3), John Wiley
2.G.M. Barrow, Introduction to Molecular Spectroscopy, TMH
3.G. Herzberg, Van Nostrand; Molecular Spectra and Molecular Structure (Vol-1,2,3)
4.G. Aruldhas, Molecular Structure and Spectroscopy; PHI
5.Gupta, Kumar and Sharma; Elements of Spectroscopy; Pragathi Prakashan

Course designed by: Ajai Jose

SBU24PH7DSC402: Classical Mechanics - II

Type of Course	Major/ Minor		
Course Level	400 - 499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Analyse the motion of rigid bodies using Newtonian mechanics, Euler's equations, and the equations of motion for rotational dynamics.	An
CO2	Study small oscillations around equilibrium positions, including the determination of normal modes, frequencies, and stability analysis of mechanical systems.	An
CO3	Understand the concept of canonical transformations and their significance in classical mechanics, including generating functions, Poisson brackets, and Hamiltonian mechanics.	A
CO4	Develop proficiency in tensor analysis techniques, including tensor algebra, tensor calculus, and the use of tensors in describing physical quantities and transformations.	A
CO5	Explore the principles of general relativity, including the equivalence principle, curvature of spacetime, and the Einstein field equations.	U

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	3	3	2	-	3	3	-	3	-
CO2	3	3	3	2	-	3	3	-	3	-
CO3	3	3	3	2	-	3	3	-	3	-
CO4	3	3	2	-	-	3	2	-	2	-
CO5	3	3	-	-	-	3	2	-	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Quiz	Problem Sheet		Written Test		
CO1	x	x		x		x
CO2	x	x		x		x
CO3	x	x		x		x
CO4	x	x		x		x
CO5	x	x		x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Rigid body Dynamics and Small Oscillations (15 Hrs)				
Motion of a rigid body, Euler angles, finite and infinitesimal rotations	1.1	1	2	Lecture, Problem solving

Angular momentum and Moment of inertia-principal axes-principal moments of inertia	1.2	1	2	Lecture, Problem solving
Euler's equations of motion for a rigid body	1.3	1	2	Lecture, Problem solving
Small oscillations: simple harmonic, forced, damped and anharmonic oscillations	1.4	2	2	Lecture, Problem solving
One dimensional oscillator-two coupled oscillators	1.5	2	2	Lecture, Problem solving
Normal co-ordinators and normal modes-general theory of small oscillations-secular equation and eigenvalue equation	1.6	2	3	Lecture, Problem solving
Eigenvalue calculations of a linear triatomic molecules	1.7	2	2	Lecture, Problem solving
Module 2: Canonical transformations (15Hrs)				
Canonical transformation (CT) – methods of constructing canonical transformations – different cases – generating function	2.1	3	3	Lecture, Problem solving
CT – harmonic oscillator– examples	2.2	3	1	Lecture, Problem solving
Conditions for canonical transformations	2.3	3	1	Lecture, Problem solving
Poisson Brackets – properties – equations of motion in Poisson bracket form – angular momentum Poisson brackets	2.4	3	2	Lecture, Problem solving
Hamilton-Jacobi (HJ) theory	2.5	3	1	Lecture
HJ – free fall under gravity – harmonic oscillator problem	2.6	3	2	Lecture, Problem solving
Hamilton's principal function and characteristic function - physical significance – harmonic oscillator as an example	2.7	3	2	Lecture
Action and Angle variables in systems of one degree of freedom-Harmonic oscillator	2.8	3	2	Lecture, Problem solving
Hamilton-Jacobi equation as the short wavelength limit of Schrodinger equation	2.9	3	1	Lecture
Module 3: Tensor Analysis (15 Hrs)				
Tensors: Contravarient and covariant tensors	3.1	4	1	Lecture
Direct product, contraction, inner product	3.2	4	1	Lecture
Quotient rule, tensor densities, dual tensors; Metric tensor	3.3	4	2	Lecture
Parallel transport	3.4	4	2	Lecture
Tensor analysis in Special Relativity	3.5	4	2	Lecture
Christoffel symbols	3.6	4	2	Lecture
Covariant derivative	3.7	4	2	Lecture
Riemanian geometry: Riemann curvature tensor, Ricci tensor, Ricci Scalar, Equation of geodesics	3.8	4	3	Lecture
Module 4: General Theory of Relativity (15 Hrs)				
Drawbacks of Newtonian theory of gravity	4.1	5	2	Lecture

Principle of equivalence: consequences of principle of equivalence (bending of light, gravitational redshift and time dilation)	4.2	5	3	Lecture
Gravity as curvature of space-time	4.3	5	2	Lecture
Einstein equation; Reduction to Newtonian form	4.4	5	3	Lecture
Schwarzchild solution: derivation, schwarzschild singularity, gravitational redshift	4.5	5	4	Lecture
An introduction to cosmology	4.6	5	1	Lecture
Module 5: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) **This content will be evaluated internally**				

Textbook

1. Herbert Goldstein, Charles Poole & John Safk, Classical Mechanics - 3 rd Edition, Pearson Education
2. Matrices and tensors in physics, A. W. Joshi, New York: Wiley (1975)
3. A First Course in General Relativity, B. Schutz, New York, NY: Cambridge University, Press, (1985)

Reference

1. Gravitation: Foundations and Frontiers, T. Padmanabhan, Cambridge University Press; 1st edition (2010)
2. Gravity, J. B. Hartle, Pearson Education. (2003)
3. Gravitation, C. W. Misner, K. S. Thorne, and J. A. Wheeler, (1973)

Course designed by: Benny Joseph T

SBU24PH7DSC403: NUCLEAR AND PARTICLE PHYSICS

Type of Course	Major/ Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Demonstrate a comprehensive understanding of the fundamental properties of atomic nuclei, nuclear models, and associated applications.	A
CO2	Develop proficiency in analysing various types of nuclear reactions, understanding radioactive decay laws, and applying radiation physics principles to practical scenarios	An
CO3	Develop familiarity with the principles and functioning of particle detectors and accelerators, enabling them to understand their roles in experimental nuclear physics research.	A
CO4	Acquire knowledge about elementary particles, conservation laws, and the theoretical frameworks governing particle interactions, providing a foundation for advanced studies in particle physics.	E
CO5	Apply their understanding of nuclear physics principles to real-world problems and applications, fostering critical thinking and problem-solving abilities in addressing challenges related to nuclear technology and its societal impact	E

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	1	-	2	1	-	1	1
CO2	2	2	2	2	1	2	1	1	2	1
CO3	2	2	2	2	1	2	1	1	2	1
CO4	2	2	2	2	1	2	1	1	2	1
CO5	2	2	2	2	1	2	1	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Spot quiz	Exit slip	Spot assignment	Written test	Assignment / Problem based assignments	
CO1	x	x		x	x	x
CO2	x		x	x	x	x
CO3			x		x	x
CO4	x				x	x
CO5	x	x		x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: General properties nucleus and nuclear models. (15Hrs)				
Nuclear radius, size, shape, mass and abundance of nuclides, binding energy, Semi-empirical mass formula,	1.1	1	3	Lecture, Problem solving
Nuclear angular momentum and parity	1.2	1	1	Lecture, Problem solving
nuclear electromagnetic moments, nuclear excited states, deuteron- ground state, excited state	1.3	1	3	Lecture, Problem solving
exchange interaction and saturation of nuclear force, properties of the nuclear force	1.4	1	3	Lecture, Problem solving
Fermi gas model and Liquid drop model	1.5	1	2	Lecture
Shell model and applications of shell model	1.6	1	3	Lecture
Module 2: Nuclear reactions and radioactivity (15Hrs)				
Review on Radioactive decay and law of radioactivity	2.1	2	1	Lecture, Problem solving
Alpha decay - Kinematics of alpha-decay, alpha decay theory, angular momentum and parity of alpha-transitions	2.2	2	2	Lecture, Problem solving
Beta decay - Energy release in beta decay, Fermi theory of beta decay, angular momentum and parity selection rules	2.3	2	2	Lecture, Problem solving
Gamma decay - Energetics of gamma decay, Theory of gamma radiation, angular momentum and parity selection rules, internal conversion	2.4	2	1.5	Lecture, Problem solving
Radioactive series-radioactive dating- carbon dating	2.5	2	1.5	Lecture, Problem solving
Types of nuclear reactions and conservation laws	2.6	2	1.5	Lecture, Problem solving
Compound-nucleus reactions, direct reactions and heavy ion reactions	2.7	2	1.5	Lecture
Fission and Fission reactors	2.8	2	2	Lecture
Fusion and Fusion reactors	2.9	2	1	Lecture
Applications of radiation physics	2.10	5	1	Lecture
Module 3: Particle Detectors and Accelerators (15 Hrs)				
Particle Detectors, Wilson Cloud Chamber, Ionization Chambers	3.1	3	2	Lecture
Proportional Counter, Geiger Muller Counter	3.2	3	2	Lecture
Scintillation Counters, Semiconductor Counters	3.3	3	3	Lecture
Linear Accelerator, Lawrence Cyclotron and Synchrocyclotron	3.4	3	3	Lecture
Electron Accelerating Machines: Betatron The Alternate-Gradient Synchrotron, Intersecting Beam Accelerators	3.5	3	3	Lecture
Basic idea about LHC and experiments, The Growth and Future of Large Accelerating	3.6	5	2	Lecture

Machines				
Module 4: Elementary Particles (15 Hrs)				
The four basic forces	3.1	4	2	Lecture
Particles and antiparticles Families of particles	3.2	4	2	Lecture, Problem solving
Conservation laws	3.3	4	2	Lecture, Problem solving
Particle interactions and decays Resonance particles	3.4	4	2	Lecture, Problem solving
Energetics of particle decays Energetics of particle reactions	3.5	4	2	Lecture, Problem solving
The Quark Model and the Standard Model	3.6	5	3	Lecture
Basic ideas of quantum chromodynamics and Higgs boson	3.7	5	2	Lecture
Module 5: Teacher Specific Content				
(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned) **This content will be evaluated internally**				

Textbooks

1. Introductory nuclear physics by Kenneth S. Krane. (John Wiley & Sons, 1988).
2. T. A. Littlefield and N. Thorley, Atomic and Nuclear Physics – An Introduction, 3rd Edn, Springer. (Chapter 17 &18)
3. Kenneth S Krane, Modern Physics, 4thEdn, Wiley. (Chapter 14)

Reference

1. Concepts of Modern Physics, Arthur Beiser, Shobhit Mahajan and S Rai Choudhury, McGraw-Hill Book Co., Inc., New York
2. Nuclear Physics, Principles and Applications-John Lilley, Wiley (2006)
3. Modern Physics – R Murugeshan, Er. Kiruthiga Sivaprasath S. Chand Publishing- 18th Edition
4. Modern Physics- Raymond S. Serway, Clement J Moser, Curt A Moyer- 3rd edition (Cengage Learning)
5. Introduction to modern Physics- H.S Mani & G.K Mehta (Affiliated East-West PVT. LTD)
6. Introduction to the physics of nuclei and particles by R.A. Dunlap. (Singapore: Thomson Asia, 2004)
7. Nuclear Physics – Irving Kaplan, Narosa Publishers (2018)
8. Nuclear Physics D C Tayal, Himalaya publishing House (2011)

Course designed by: Dr. Prijil Mathew

SBU24PH7DSC404: COMPUTATIONAL PHYSICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	45	30	75
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Apply interpolation techniques to estimate values between data points.	A
CO2	Analyze the accuracy and stability of numerical integration and differentiation algorithms.	An
CO3	Develop proficiency in solving ordinary differential equations numerically.	A
CO4	Evaluate the appropriateness and efficiency of different numerical methods for specific types of PDEs.	E
CO5	Apply numerical methods to model and simulate dynamic systems.	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	1	1	2	1		3	1		1	
CO2	1	1	2	1		3	1		1	
CO3	1	1	2	1		3	1		1	
CO4	1	1	2	1		3	1		1	
CO5	2	1	3	2	1	3	1		1	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Viva	Quiz	Home assignments	Written test	Problem based assignments	
CO1		x		x	x	x
CO2	x	x		x	x	x
CO3	x	x		x	x	x
CO4		x	x	x	x	x

Mapping of CO to Assessment Tools (Practical)

CO	Formative Assessment			Summative Assessment		ESE
	Viva voce	Observation of practical skills		Laboratory report	Practical Assignment	
CO5	x	x		x	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Interpolation (15 Hrs)				
Finite differences (Forward differences, Backward differences, Central differences)	1.1	1	3	Lecture and Problem Solving
Detection of errors by use of difference tables-Differences of a polynomial	1.2	1	1	Lecture and Problem Solving
Newton's formulae for interpolation - Central difference interpolation formulae (Gauss central difference formulae, Stirling's formulae) - Interpolation with unevenly spaced points (Lagrange's interpolation formulae)	1.3	1	6	Lecture and Problem Solving
Least squares curve fitting procedures (Fitting a straight line, parabola and exponential)	1.4	1	5	Lecture and Problem Solving
Module 2: Integration and differentiation (15 Hrs)				
Numerical differentiation, Errors in Numerical differentiation	2.1	2	3	Lecture and Problem Solving
Trapezoidal rule, Simpson's 1/3 rule	2.2	2	2	Lecture and Problem Solving
Simpson's 3/8 rule	2.3	2	2	Lecture and Problem Solving
Romberg Integration	2.4	2	3	Lecture and Problem Solving
Monte Carlo evaluation of integrals	2.5	2	3	Tutorial
Double Integration, Newton-cotes, integration formulae	2.6	2	2	Lecture and Problem Solving
Module 3: Ordinary and partial differential equations (15 Hrs)				
Numerical Solutions of partial differential equations, Finite difference approximations to derivatives	3.1	4	3	Lecture and Problem Solving
Solution of Laplace equation, Jacobi's method, Gauss Seidal method, Successive over relaxation.	3.2	4	1	Lecture and Problem Solving
Numerical Solution of Parabolic partial differential equations: Schmidt method, Crank-Nicholson Method, Wieghted average Method	3.3	4	4	Lecture and Problem Solving
Numerical solution of ordinary differential equations: Solution by Taylor's series, Picards method of successive approximations	3.4	3	2	Lecture and Problem Solving
Euler's method, Runge-Kutta methods	3.5	3	3	Lecture and Problem Solving
Predictor-Corrector methods; Adom Moulton method and Milne's method.	3.6	3	2	Lecture and Problem Solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by*				

the teacher concerned) **This content will be evaluated internally**

Textbook

1. Introductory Methods of Numerical Analysis-fifth edition, S.S. Sastry, PHI Learning private Limited
2. Numerical Methods for Scientists and Engineers-third edition, K. Sankara Rao, PHI Learning private Limited

Reference

1. Computer oriented numerical methods, V. Rajaraman, PHI Learning private Limited
2. An Introduction to Computational Physics, Tao Pang, CUP
3. Numerical Recipes in C++, W.H. Press, Saul A. Teukolsky, CUP
4. Numerical Methods, Balaguruswami, Tata McGraw Hill, 2009.

Practical

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 5: Computational Physics Experiments (30 Hours)				
Fourier transforms-Retrieving an original signal from a corrupted signal	5.1	5	3	Lab Practical
Non-Linear pendulum-Plotting the Phase space	5.2	5	3	Lab Practical
solution of Laplace equation for finite sized capacitor using SOR method	5.3	5	3	Lab Practical
Quantum harmonic oscillator- Plotting probability density functions	5.4	5	3	Lab Practical
Random walk Simulation	5.5	5	3	Lab Practical
Simulation of Young's Double Slit experiment	5.6	5	3	Lab Practical
Planetary motion-Verification of Kepler's laws	5.7	5	3	Lab Practical
Monte Carlo Simulation-Finding the value of π	5.8	5	3	Lab Practical
Monte Carlo Multidimensional Integration-Volume of an Ellipsoid	5.9	5	3	Lab Practical
Chaos-Plotting Logistic Maps	5.10	5	3	Lab Practical

[Additional experiments of equivalent standard shall be incorporated]

Textbook

1. Nicholas Giordano, Hisao Nakanishi, Computational Physics, Second Edition, Pearson Addison-Wesley,2005
2. R.C Verma, P.K Ahluwalia, K.C Sharma, Computational Physics, An Introduction, New Age International Publishers

Reference

1. Tao Pang, An Introduction to computational physics, Cambridge University Press, (1997)

Course designed by: Dr. Sajith Mathews T

SBU24PH7DSC405: CLASSICAL AND QUANTUM STATISTICAL PHYSICS

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Basic knowledge of Thermodynamics and Mathematical Physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe statistical basis of thermodynamics and microcanonical ensemble	U
CO2	Describe canonical ensemble and apply it to classical ideal gas	A
CO3	Describe grand canonical ensemble and apply it to classical ideal gas	A
CO4	Describe quantum mechanical ensembles, ideal Bose gas, ideal Fermi gas and apply them to ideal gas, metals, condensate	A
CO5	Apply statistical theory to magnetism and cooperative phenomena	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	3	2				1	1			
CO2	3	2	1			1	1			
CO3	3	2	1			1	1			
CO4	3	2	1			1	1			
CO5		2	2			1	1			

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Problem sheets			class test		
CO1	x			x		x
CO2	x			x		x
CO3	x			x		x
CO4	x			x		x
CO5	x			x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Statistical basis and Ensemble Theory (15 Hrs)				
The statistical basis of thermodynamics, macroscopic and microscopic states, contact between statistics and thermodynamics, further contact between statistics and thermodynamics	1.1	1	2	Lecture, Assignment
The classical ideal gas, the entropy of mixing and Gibbs paradox	1.2	1	2	Lecture

Phase space of a classical system, Liouville's theorem and its consequences	1.3	1	2	Lecture
The microcanonical ensemble, quantum states and the phase space	1.4	1	1.5	Lecture
The canonical ensemble, equilibrium between a system and a heat reservoir, a system in the canonical ensemble	1.5	2	2	Lecture
Physical significance of the various statistical quantities in the canonical ensemble, alternate expression for the partition function	1.6	2	3	Lecture, Assignment
The classical systems- ideal gas in canonical ensemble	1.7	2	2.5	Lecture
Module 2: Canonical and Grand Canonical Ensemble (15 Hrs)				
Energy fluctuations in canonical ensemble- correspondence with microcanonical ensemble	2.1	2	2	Lecture
A system of harmonic oscillators (classical and quantum treatment)	2.2	2	3	Lecture
Grand canonical ensemble- Equilibrium between a system and a particle-energy reservoir	2.3	3	1	Lecture
A system in the grand canonical ensemble	2.4	3	1	Lecture
Physical significance of the statistical quantities in grand canonical ensemble, grand partition function and thermodynamic quantities	2.5	3	3	Lecture
Classical ideal gas in grand canonical ensemble	2.6	3	3	Lecture, Assignmen
Density and energy fluctuations in grand canonical ensemble	2.7	3	2	Lecture
Module 3: Quantum Statistics (15 Hrs)				
Density matrix in quantum mechanical ensemble theory and quantum analogue of classical Liouville theorem	3.1	4	2	Lecture
Ideal gas in quantum mechanical microcanonical and other ensembles	3.2	4	3	Lecture
Statistics of the occupation numbers	3.3	4	1	
Gaseous system composed of molecules with internal motion, monatomic and diatomic molecules	3.4	4	3	Lecture
Thermodynamic behaviour of ideal Bose gas, Bose-Einstein condensation	3.5	4	3	Lecture, Assignment
Thermodynamic behaviour of ideal Fermi gas, the electron gas in metals	3.6	4	3	Lecture
Module 4: Phase Transitions and Magnetism (15 Hrs)				
First and second order phase transitions, order parameter	4.1	5	2	Lecture, Assignment
Landau phenomenological theory	4.2	5	2	Lecture
Quantum theory of paramagnetism	4.3	5	2	Lecture
Quantum theory of ferromagnetism	4.4	5	3	Lecture
Ising model in one dimension- exact solution- Transfer matrix method	4.5	5	3	Lecture

Ising model in the zeroth approximation- Bragg Williams theory	4.6	5	3	Lecture
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. R K Pathria and Paul D Beale, Statistical Mechanics, Academic Press
2. Walter Greiner, Ludwig Neise, Horst Stöcker, Thermodynamics and Statistical Mechanics, Springer

Reference

1. Kerson Huang, Statistical Mechanics, Wiley
2. Landau and Lifshitz, Statistical Physics, Pergamon Press
3. E S R Gopal, Statistical mechanics and properties of matter, Ellis Horwood Ltd
4. F Reif, Fundamentals of Statistical and Thermal Physics, Waveland Press, Inc.
5. Mehran Kardar, Statistical physics of Particles, Cambridge
6. B K Agarwal and Melvin Eisner, Statistical Mechanics, New Age Publishers
7. B B Laud, Fundamentals of Statistical Mechanics, New Age
8. Robert Bowley, Introductory Statistical Mechanics, Oxford Science Publications

Course designed by: Dr. Loji K Thomas

SEMESTER VIII

Course Code	Type of Course	Course Title	Hours /Week	Total Hours	Credit
SBU24PH8DSC400	Major	Electrodynamics - II	4	60	4
SBU24PH8DSC401	Major	Advanced Quantum Mechanics	4	60	4
SBU24PH8DSC402	Major	Condensed Matter Physics	4	60	4
SBU24PH8PRJ400	Major	Project			12

SBU24PH8DSC400: ELECTRODYNAMICS - II

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	-	60
Pre-requisite (if any)	Basic course in Electrodynamics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understand and apply Maxwell's equations and conservation theorems to describe the behavior of electromagnetic waves in different media	A
CO2	Apply the four-vector formalism to describe electromagnetic phenomena in relativistic scenarios	A
CO3	Analyse the physical basis of radiation reactions and comprehend electromagnetic phenomena associated with retarded potentials.	An
CO4	Understand electromagnetic radiation principles and derive basic equations of electromagnetic radiation	U
CO5	Comprehend different antenna parameters and propagation characteristics of waves in waveguides and transmission lines and apply them to solve numerical problems	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	3	2	1		3	1		1	
CO2	2	3	2	1		3	1		1	
CO3	2	3	2	1		3	1		1	
CO4	2	3	2	1		3	1		1	
CO5	2	3	2	1		3	1		1	

Mapping of CO to Assessment Tools (Theory)

CO	**Formative Assessment**			**Summative Assessment**		**ESE**
	Home Assignment	Quiz	Exit slips	Problem based assignment		
CO1		x		x		x
CO2	x	x		x		x
CO3		x		x		x
CO4	x					x
CO5			x	x		x

Course Content & Transaction Mechanism

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Conservation Laws and Electromagnetic Waves (15 Hrs)				
Charge and Energy: The Continuity Equation, Poynting's Theorem	1.1	1	2	Lecture, problem solving
Conservation of Momentum Newton's Third Law in Electrodynamics, Maxwell's Stress Tensor, Conservation of Momentum	1.2	1	3	Lecture, problem solving
Electromagnetic Waves: review of basic concepts	1.3	1	1	Lecture, problem solving
Reflection and Transmission at Oblique Incidence	1.4	1	2	Lecture, problem solving
Absorption and Dispersion: Electromagnetic Waves in Conductors	1.5	1	2	Lecture, problem solving
Reflection at a Conducting Surface	1.6	1	1	Lecture, problem solving
The Frequency Dependence of Permittivity	1.7	1	2	Lecture, problem solving
The Potential Formulation: Gauge Transformations, Coulomb Gauge and Lorentz Gauge	1.8	1	2	Lecture, problem solving
Module 2: Electrodynamics and Relativity (15 Hrs)				
The Special Theory of Relativity: Review of basic concepts	2.1	2	2	Lecture, problem solving
The Structure of Spacetime	2.2	2	1	Lecture, problem solving
Proper Time and Proper Velocity	2.3	2	0.5	Lecture, problem solving
Relativistic Energy and Momentum	2.4	2	0.5	Lecture, problem solving
Relativistic Kinematics	2.5	2	1	Lecture, problem solving
Relativistic Dynamics	2.6	2	1	Lecture, problem solving
Magnetism as a Relativistic Phenomenon	2.7	2	1	Lecture, problem solving
How the Fields Transform	2.8	2	2	Lecture, problem solving
The Field Tensor	2.9	2	2	Lecture, problem solving
Electrodynamics in Tensor Notation	2.10	2	2	Lecture, problem solving
Relativistic Potentials	2.11	2	2	Lecture, problem solving
Module 3: Electromagnetic Radiation (15 Hrs)				
Retarded potentials	3.1	3	1	Lecture, problem solving

Electric dipole radiation,	3.2	4	2	Lecture, problem solving
Magnetic dipole radiation	3.3	4	2	Lecture, problem solving
Jefimenkos equations,	3.4	4	1	Lecture, presentation
Point charges, Lienard-Wiechert potential,	3.5	4	2	Lecture, presentation
Fields of a moving point charge	3.6	3	2	Lecture, presentation
Power radiated by point charge-Larmour formula.	3.7	4	2	Lecture, presentation
Bremsstrahlung. Radiation reaction and its physical basis	3.8	3	1	Lecture, presentation
The Abraham-Lorentz formula	3.9	4	2	Lecture, presentation
Module 4: Antenna, Wave Guides and Transmission Lines (15 Hrs)				
Antenna, Radiation resistance of a short dipole	4.1	5	1	Lecture, problem solving
Current distribution in a longer antenna	4.2	5	1	Lecture, presentation
Radiation from a half wave dipole and a quarter wave monopole	4.3	5	2	Lecture, presentation
Antenna parameters - Radiation pattern, beam width, power density, directivity	4.4	5	1	Lecture, presentation
Waves between Parallel Conducting Planes	4.5	5	2	Lecture, presentation
TE waves in Parallel Plane Wave Guide, cut off frequency	4.6	5	1	Lecture, problem solving
TM and TEM Waves in Parallel Plane Wave Guide, cut off frequency	4.7	5	1	Lecture, problem solving
Waves in rectangular waveguides	4.8	5	2	Lecture, presentation
TE waves in rectangular Wave Guide, cut off frequency	4.9	5	1	Lecture, problem solving
TM waves in rectangular Wave Guide, cut off frequency, impossibility of TEM waves in rectangular wave guide	4.10	5	1	Lecture, problem solving
Transmission lines, characteristic impedance	4.11	5	1	Lecture, problem solving
Standing waves and SWR	4.12	5	1	Lecture, problem solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1.Introduction to Electrodynamics-David J Griffiths, PHI

2.K. D Prasad, Antenna and wave guide propagation– Satyaprakashan, NewDelhi, 2009
3.Electronic Communication Systems (5th edition) – George Kendy et.al – TMH

Reference

1. Antennas, J.D Kraus, Tata Mc-Graw Hill
2. Antenna and wave guide propagation - K. D Prasad – Satyaprakashan
3. Electromagnetic waves and radiating systems, E.C. Jordan & K.G. Balmain PHI, 1968
4. Electronic Communication Systems (5th edition) – George Kendy et.al – TMH
5. Antennas, J.D Kraus, Tata Mc-Graw Hill.
6. Classical Electrodynamics, J. D. Jackson, Wiley Eastern Ltd.
7. Electromagnetic fields, S. Sivanagaraju, C. Srinivasa Rao, New Age International.
8. Introduction to Classical electrodynamics, Y. K. Lim, World Scientific, 1986.
9. Electromagnetic Waves and Fields, V.V. Sarwate, Wiley Eastern Ltd, New Age International
10. The Feymann Lectures in Physics, Vol. 2, R.P. Feymann, R.B.Leighton & M. Sands
11. Electronic Communication Systems, G. Kennedy & B. Davis, TMH.

Course designed by: Dr. Sajith Mathews T

SBU24PH8DSC401: ADVANCED QUANTUM MECHANICS

Type of Course	Major		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60	0	60
Pre-requisite (if any)	Graduate course in Quantum Mechanics, Mathematical Physics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Understanding of the mathematical foundations of quantum mechanics	U
CO2	Ability to solve the Schrodinger equation for simple configurations and apply the principles.	A
CO3	Ability to understand the different pictures describing the dynamics of quantum systems and apply them.	A
CO4	Understand the angular momentum states, angular momentum addition rules and apply them.	A
CO5	Apply approximation methods to solve the Schrodinger equation	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	2	1	1	-	2	1	-	1	1
CO2	2	2	2	2	1	2	1	1	2	1
CO3	2	2	2	2	1	2	1	1	2	1
CO4	2	2	2	2	1	2	1	1	2	1
CO5	2	2	2	2	1	2	1	1	2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Spot quiz/Quiz	Exit slip	Spot assignment	Written test	Assignment	
CO1	x	x		x	x	x
CO2	x		x	x	x	x
CO3			x		x	x
CO4	x	x		Quiz	x	x
CO5	x	x		Quiz	x	x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Fundamental Concepts (15 Hrs)				
Stern-Gerlach experiment and results	1.1	1	2	Lecture
Kets, Bras and Operators, Ket space, Bra space and inner products	1.2	1	2	Lecture, Problem solving
Operators, Base Kets and Matrix representation	1.3	1	2	Lecture, Problem solving

Measurements, Observables, Compatible observables. Incompatible observables	1.4	1	1	Lecture, Problem solving
The fundamental postulates	1.5	1	2	Lecture
The general uncertainty relationship	1.6	1	2	Lecture
Infinitesimal and finite unitary transformations	1.7	1	1	Lecture
Change of bases and unitary transformations	1.8	1	1	Lecture
Representation in continuous bases, position representation, momentum representation	1.9	1	1	Lecture, Assignment
Connecting the position and momentum representations	1.10	1	1	Lecture
Module 2: Quantum Dynamics (15 Hrs)				
Schrodinger picture, Heisenberg picture, interaction picture	2.1	3	1	Lecture
Time evolution operator, properties and Schrodinger equation	2.2	3	3	Lecture, Problem solving
Hydrogen atom –polynomial method	2.3	2	4	Lecture, Problem solving
Heisenberg equations of motion	2.4	3	2	Lecture
Simple harmonic oscillator – Heisenberg picture	2.5	2	3	Lecture, Problem solving
Interaction picture, Equations of time evolution	2.6	3	2	Lecture
Module 3: Angular Momentum (15 Hrs)				
Rotations and Angular momentum commutation relations	3.1	3	2	Lecture, Assignment
Infinitesimal rotations in quantum mechanics	3.2	3	1	Lecture
Fundamental commutation relations of angular momentum	3.3	4	1	Lecture, Problem solving
Rotation operator for spin ½ system - Pauli two component formalism - Pauli spin matrices - 2x2 matrix representation of rotation operator	3.4	4	2	Lecture, Assignment
Commutation relations for Angular Momentum Operators	3.5	4	2	Lecture
Eigenvalues of J2 and Jz	3.6	4	2	Lecture, Problem solving
Matrix elements of angular momentum operators	3.7	4	2	Lecture, Problem solving
Addition of angular momentum	3.8	4	1	Lecture
Addition of spin angular momenta and Clebsch-Gordon coefficients for two spin ½ particles.	3.9	4	2	Lecture, Problem solving
Module 4: Approximation Methods in QM (15 Hrs)				
Non degenerate Perturbation Theory- Correction in Energy and Eigenfunctions upto second order	4.1	5	2	Lecture, Problem solving
Example of anharmonic oscillator	4.2	5	2	Lecture, Problem solving
Degenerate Perturbation Theory	4.3	5	2	Lecture
Example of Stark effect	4.4	5	2	Lecture, Problem solving
Variational method- the variational equation	4.5	5	2	Lecture
Application to ground state of Hydrogen atom	4.6	5	1	Lecture

WKB approximation**-** Expression for the WKB wave function	4.7	5	2	Lecture
Validity of approximation, Connection formulae	4.8	5	1	Lecture
Applications - Barrier penetration	4.9	5	1	Lecture, Problem solving
Module 4: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1.J. J. Sakurai; Modern Quantum Mechanics; Pearson Education

Reference

1.John S. Townsend; A Modern Approach to Quantum Mechanics; Viva Books MGH
2.V. K. Thankappan; Quantum Mechanics; New Age International.
3.N. Zettily; Quantum Mechanics, Concepts and Applications; John Wiley & Sons.
4.G. Aruldhas; Quantum Mechanics; PHI
5.Shankar R; Principles of Quantum Mechanics; Springer Education

Course designed by: Ajai Jose

SBU24PH8DSC402: CONDENSED MATTER PHYSICS

Type of Course	Major/Minor		
Course Level	400-499		
Credit	4		
Course Delivery Duration	**Theory (Hrs)**	**Practical (Hrs)**	**Total (Hrs)**
	60		60
Pre-requisite (if any)	Condensed matter-I, Basic Quantum Mechanics and Electrodynamics		

Course Outcomes

No.	Description	Cognitive Level
CO1	Describe the electron in periodic lattice	A
CO2	Physics of sound propagation in various lattices	A
CO3	Describe phenomena of Superconductivity	U
CO4	Describe magnetic properties of of solids	U
CO5	Describe optical properties of of solids	A

Cognitive Levels: R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1	2	1		1		2	2		1	
CO2	2	2		1		2	2			1
CO3	2	2			1	2	2		1	1
CO4	2	2		1	1	2	2		2	1
CO5	2	2		1	1	2	2		2	1

Mapping of CO to Assessment Tools (Theory)

CO	Formative Assessment			Summative Assessment		ESE
	Problem Sheets			Class test		
CO1	x			x		x
CO2	x			x		x
CO3	x			x		x
CO4	x			x		x
CO5	x			x		x

Course Content & Transaction Mechanism

Theory

Course Content	Unit	CO	Hours	Transaction Mechanism
Module 1: Electron in Periodic Potential, lattice dynamics (20 Hrs)				
Electrons in a Periodic Potential-Bloch Theorem	1.1	1	2	Lecture
Kronig-Penney Model, Fermi Surfaces, Van Hove Singularities	1.2	1	2	Lecture
Energy bands in 1D, 2D, 3D	1.3	1	1	Lecture, assignment
Failures of the Band-Structure picture of metals and insulators, Optical Properties of Insulators and Semiconductors	1.4	1	2.5	Lecture, assignment

Electrons and Holes, Effective mass, momentum and velocity, Equations of Motion	1.5	1	1.5	Lecture, assignment
Doping, impurity states,	1.6	1	1	Lecture,
Mechanics of Semiconductors, law of mass action-intrinsic, doped semiconductors	1.7	1	3	Lecture assignment
Compressibility, Sound, and Thermal Expansion	1.8	2	1	Lecture
Vibrations of a 1D Monatomic Chain, dispersion, normal modes	1.9	2	3	Lecture assignment
Phonons, Crystal momentum	1.10	2	1	Lecture
Vibrations of a One-Dimensional Diatomic Chain-dispersion-acoustic, optic modes,		2	2	Lecture assignment
Module 2: Superconductivity (12 Hrs)				
Superconductivity-introduction (discovery, materials, R vs T curve etc.)	2.1	3	1	Lecture
Perfect diamagnetism and the Meissner Effect, Type1, Type II SC	2.2	3	3	Lecture assignment
London equations, Coherence length, surface energy, heat capacity	2.3	3	2	Lecture, assignment
BCS theory	2.4	3	2	Lecture
The Josephson Effect	2.5	3	3	Lecture assignment
Flux Quantization, SQUID			1	Lecture
Module 3: Magnetism (13 Hrs)				
Magnetism- Basic Definitions of Types of Magnetism	3.1	4	1	Lecture
Hund's Rules, Why Moments Align, The O2 molecule	3.2	4	2.5	Lecture assignment
Langevin Theory of Paramagnetism	3.3	4	2	Lecture
Ideal magnetic gas-quantum model, Rare earth, transition metal ions,	3.4	4	2	Lecture
Spontaneous Magnetic Order- Ferromagnets, Curie temperature expression for Tc	3.5	4	1.5	Lecture, assignment
Ferromagnetism-atomic moments, Domain Wall Structure Bloch/Neel Wall	3.6	4	1	Lecture, assignment
Negative interactions-Anti ferro, ferrimagnetism, Heisenberg interaction (qualitative)	3.7	4	2	Lecture
Neutrons and magnetism, real magnetic specimen	3.8	4	1	Lecture
Module 4: Optical Properties (15 Hrs)				
Optical properties-Phenomenological Theory-optical response of metals, interaction of light with matter	3.1	5	2	Lecture
Maxwell's Equations, Mechanical Oscillators as Dielectric Function	3.2	5	2	Lecture assignment
Semiconductors-Cyclotron Resonance	3.3	5	1	Lecture
Direct, indirect band gap (qualitative), excitons basic theory	3.4	5	2	Lecture
Insulators-free atom polarizability, local electric field	3.5	5	2	Lecture, assignment
Clausius-Mossotti relation	3.6	5	1.5	Lecture, assignment

Electronic, ionic polarizability	3.7	5	1.5	Lecture
Optical Modes in Ionic Crystals-Polaritons, Polarons	3.8	5	2	Lecture assignment
Ferroelectrics basics, applications	3.9	5	1	Lecture
Module 5: Teacher Specific Content *(This can be either classroom teaching, practical session, field visit etc. as specified by the teacher concerned)* **This content will be evaluated internally**				

Textbook

1. Solid state basics, Steven H. Simon (The Oxford Solid State Basics)
2. Condensed Matter Physics, Michael P. Marder, John Wiley & Sons
3. Introductory Solid State Physics, H.P. Myers, Taylor and Francis

Reference

1. Solid State Physics by Ashcroft-Mermin
2. Solid State Physics, S.O. Pillai, New Age Int.
3. Introduction to Solid State Physics by Charles Kittel
4. Principles of Condensed Matter Physics. P. M. Chaikin and T. C. Lubensky. Cambridge University Press

SBU24PH8PRJ400: PROJECT

Type of Course	Major		
Course Level	400-499		
Credit	12		
Course Delivery Duration	Theory (Hrs)	Practical (Hrs)	Total (Hrs)
Pre-requisite (if any)			

Course Outcomes

No.	Description	Cognitive Level
CO1	Design a research project in physics or allied subjects.	E
CO2	Perform the feasibility analysis and do a literature review.	An
CO3	Design a suitable methodology and execute the required experiments.	E
CO4	Analyse data and synthesize research findings.	A
CO5	Report research findings in written and verbal forms.	E

Cognitive Levels
R – Remember; U – Understand; A – Apply; An – Analyse; E - Evaluate

Course Mapping Table

CO	PSO1	PSO2	PSO3	PSO4	PSO5	PO1	PO2	PO3	PO4	PO5
CO1			2		1	2				1
CO2	2			2						2
CO3			2							2
CO4				3						2
CO5					3			3		2

Rubrics for Assessment Tools

Each course contains specific assessment tools. However, the faculty teaching the course has the freedom to alter these tools according to the course requirements, with prior permission from the respective Board of Studies.

1. Exit Slip

Criteria	Excellent (4 points)	Good (3 points)	Fair (2 points)	Needs Improvement (1 point)
Understanding of Content	Demonstrates a deep understanding of the key concepts covered in the lesson.	Shows a good understanding of the main concepts but may have some minor misunderstandings.	Demonstrates a basic understanding of the content, but may have significant gaps in knowledge.	Displays a lack of understanding of the key concepts.

2. Quiz

Criteria	Excellent (4 points)	Good (3 points)	Fair (2 points)	Needs Improvement (1 point)	Inadequate (0 points)
Mastery and Accuracy	All answers are correct with no errors.	Most answers are correct with minor errors.	Several answers are incorrect, but major concepts are understood.	Many answers are incorrect, demonstrating a lack of understanding.	Most answers are incorrect, indicating a serious lack of understanding.

3. Home Assignment

Criteria	Excellent (4 points)	Good (3 points)	Fair (2 points)	Needs Improvement (1 point)
Content Mastery	Demonstrates a thorough understanding of the topic, with accurate and detailed information.	Shows a good understanding of the topic, with mostly accurate information.	Demonstrates a basic understanding of the topic, but with some inaccuracies or omissions.	Shows a lack of understanding of the topic, with significant inaccuracies or missing information.
Organization	Presents ideas in a clear, logical, and well-organized manner, with a strong introduction and conclusion.	Organizes ideas in a mostly clear and logical manner, with a satisfactory introduction and conclusion.	Organizes ideas in a way that is somewhat clear, but with some inconsistencies or lack of coherence.	Organization is confusing or lacking, making it difficult to follow the flow of ideas.
Critical Thinking	Demonstrates critical thinking	Shows evidence of critical	Demonstrates basic critical	Lacks critical thinking, providing

	skills by analyzing and evaluating information, providing well-supported arguments or solutions.	thinking by analyzing information and presenting reasonable arguments or solutions.	thinking, but with limited analysis or weak arguments.	minimal analysis and weak or unsupported arguments.
Presentation and Format	Presents the assignment in a professional and visually appealing manner, following all formatting guidelines.	Presents the assignment in a mostly professional manner, with minor formatting issues.	Presents the assignment with some formatting issues, affecting overall presentation.	Presents the assignment with major formatting issues, making it difficult to read or understand.
Timeliness	Submits the assignment on or before the deadline.	Submits the assignment slightly after the deadline but within an acceptable timeframe.	Submits the assignment significantly after the deadline.	Fails to submit the assignment within a reasonable timeframe.

4. Problem Based Assignment

Criteria	**Excellent (4 points)**	**Good (3 points)**	**Fair (2 points)**	**Needs Improvement (1 point)**
Problem Understanding	Demonstrates a deep understanding of the problem, identifying key elements and nuances.	Shows a good understanding of the problem, identifying most key elements.	Demonstrates a basic understanding of the problem but may overlook some key elements.	Shows a limited understanding of the problem, missing significant key elements.
Analysis and Synthesis	Analyzes information critically, synthesizing relevant details to form a comprehensive solution.	Analyzes information effectively, synthesizing most relevant details to form a sound solution.	Analyzes information but may struggle to synthesize all relevant details into a coherent solution.	Analysis is limited, and the synthesis of information is weak or missing.
Problem-Solving Approach	Develops a well-structured and innovative approach to solving the problem, considering multiple perspectives.	Develops a solid approach to solving the problem, considering various perspectives.	Develops a basic approach to solving the problem but may lack depth or creativity.	Develops a weak or ineffective approach to solving the problem
Timeliness	Submits the assignment on or before the deadline.	Submits the assignment slightly after the deadline but within an acceptable timeframe.	Submits the assignment significantly after the deadline.	Fails to submit the assignment within a reasonable timeframe.

5. Written Test

Criteria	4 (Excellent)	3 (Proficient)	2 (Basic)	1 (Below Basic)
Content Knowledge	Demonstrates thorough understanding of all key concepts, including advanced details.	Shows a good understanding of key concepts, with minor gaps or inaccuracies.	Demonstrates a basic understanding of some key concepts but lacks depth or contains significant errors.	Displays a lack of understanding of essential concepts, with numerous inaccuracies.
Critical Thinking	Analyzes information critically, drawing insightful conclusions and making connections.	Analyzes information effectively, drawing appropriate conclusions and making connections.	Demonstrates basic critical thinking but may have difficulty drawing clear conclusions.	Lacks critical thinking, with little analysis or unclear conclusions.
Organization	Presents ideas in a clear and logical sequence, with a strong introduction and conclusion.	Organizes ideas effectively, with a mostly clear sequence and satisfactory introduction and conclusion.	Presents ideas with some organization but may lack clarity or coherence in sequence.	Organization is confusing, making it difficult to follow the flow of ideas.
Use of Examples/Evidence	Incorporates relevant and compelling examples or evidence to support arguments.	Uses appropriate examples or evidence to support arguments.	Includes some examples or evidence, but they may be irrelevant or insufficient.	Lacks meaningful examples or evidence to support arguments.
Adherence to Instructions	Follows all instructions precisely, including formatting and response length.	Follows most instructions, with minor deviations or oversights.	Follows some instructions but may have significant deviations or oversights.	Fails to follow essential instructions, affecting the overall quality of the response.

Criteria	Excellent (5)	Good (4)	Satisfactory (3)	Needs Improvement (2)	Unsatisfactory (1)
Knowledge and Understanding (CO1, CO2)	Demonstrates in-depth understanding of mathematical formulations, principles, and concepts related to mechanics. Applies knowledge accurately to solve complex problems.	Shows a strong understanding of key mechanics concepts and applies them effectively in problem-solving. Minor errors may be present.	Demonstrates a basic understanding of mechanics concepts and can apply them to straightforward problems. Some errors in application may be evident.	Shows limited understanding of fundamental mechanics concepts. Frequent errors in application and problem-solving.	Fails to demonstrate a basic understanding of key mechanics concepts. Significant errors in application and problem-solving.
Application of Concepts (CO3,	Effectively applies physical principles to analyze and solve problems	Applies physical principles to solve	Applies physical principles with limited	Demonstrates difficulty in applying physical	Fails to apply physical principles

CO4)	related to motion, forces, and dynamics. Demonstrates the ability to connect theoretical concepts with practical situations.	problems with proficiency. May exhibit some challenges in connecting theory to practice.	proficiency. Struggles to connect theoretical knowledge to practical scenarios.	principles to solve problems accurately. Limited connection between theory and practice.	effectively. Shows little to no connection between theory and practical application.
Critical Thinking and Analysis (CO2, CO4)	Analyzes and evaluates complex problems in Newtonian mechanics, rotational motion, and gravitation with depth and precision. Demonstrates insightful analysis and critical thinking.	Analyzes problems in Newtonian mechanics, rotational motion, and gravitation effectively. Provides clear and logical reasoning.	Analyzes problems in mechanics with basic proficiency. Some gaps in reasoning may be present.	Demonstrates limited ability to analyze problems in mechanics. Lacks coherent reasoning.	Fails to analyze problems effectively. Limited or no logical reasoning.

SHORT TERM COURSES

The main objective of the short term courses offered by the college is to supplement the students with various skills and technical know-how outside the structured academic curriculum, to produce quality citizens who are academically proficient, self-reliant and socially committed. The courses have compulsory components and optional components that equip the students to attain various programme objectives envisaged by the Vision and Mission statements of the college.

All Short-Term Courses (STCs) are coordinated by the Department of Short Term Courses, headed by a Director and is supervised by a Vice Principal nominated by the Principal. Each component of the STC is coordinated and managed by a Faculty Convener. The Advisory Board of the Department consists of the Vice-Principals, Director of the Short Term Courses and the various Conveners.

In case of any grievances, students can approach the Grievance Redressal Cell of the STC which consists of the Vice-Principal in Charge, Director and the concerned Convener. If the student feels that the issue was not adequately addressed, he/she can approach the Grievance Redressal Cell of the college. The grading pattern for all courses will be the same as in the UG regulations 2024. The courses offered by the department are given in the following table.

	Name	Semesters	Type	Credit
1	Value Education	I to VI	Compulsory	3
2	Basic Life Support System and Disaster Management (BLS & DM)	I	Compulsory	1
3	Social Awareness Course (SAC)	I and II	Compulsory	2
4	Skill Development Courses (SDC)	II and III	Optional	2
5	Finishing School	III and IV	Compulsory	1
6	Virtual Lab Experiments	V	Optional	1

REGULATIONS FOR SHORT TERM COURSES

VALUE EDUCATION

Value Education is a compulsory extra credit course with three (3) credits for all the students admitted to the undergraduate programmes.

Duration

The duration of the course shall be three academic years (six semesters). There shall be minimum 60 hours spread over three years with 20 hours every academic year.

Evaluation

The evaluation of each course shall contain two parts.

i. Continuous evaluation (every year)
ii. Final evaluation (every year)

There shall be a maximum of 50 marks comprising of forty (40) marks for final evaluation and ten (10) marks for continuous evaluation.

Continuous Evaluation

Component	Marks
Assignment	5
Attendance	5
Total	10

1. **Assignment**

   The students shall submit at least one assignment in every year. The marks for assignment is five (5).

2. **Attendance**

   The minimum requirement of aggregate attendance during a year for appearing the final examination shall be 75%.

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Final evaluation

Final evaluation shall be conducted by the course coordinator at the end of every year.

There shall be an annual written examination of one and a half hours (1½) duration with a maximum forty marks (40), every year.

The question paper shall be strictly on the basis of model question paper set by the Expert Committee.

A question paper consists of short answer type, short essay type and long essay type questions.

The total marks of the course (three years combined) shall be one hundred and fifty (150).

Award of certificate

A separate minimum 30% marks each for continuous evaluation and final evaluation and an aggregate minimum of 35% are required for a pass in the course.

If a student does not acquire minimum marks in first and second years, he/she can continue the course.

The student shall be eligible to get certificate only after completing the course with D Grade. On successful completion of the course, the grade awarded will be indicated in the Mark cum Grade Card.
The grading pattern will be the same as in UG Regulations 2024.
The course shall be completed during the tenure of the programme.

BASIC LIFE SUPPORT SYSTEM AND DISASTER MANAGEMENT (BLS & DM)

- The main objective of this course is to provide intensive training on Basic Life Support System and Disaster Management with the help of professional trainers and adequate numbers of mannequins and kits for imparting the training to students.
- This course is compulsory for all the undergraduate students of this college and has one (1) credit.
- The course on BLS & DM shall be conducted by a nodal centre created in the College.
- Each student shall undergo five (5) hours of hands-on training in BLS & DM organised by the Centre for BLS & DM.
- After the completion of the training, the skills acquired shall be evaluated using an offline/online test and grades shall be awarded.
- Nodal Centre for BLS & DM shall conduct an online test and publish the results.
- Students who could not complete the requirements of the BLS & DM training shall appear for the same along with the next batch.
- The grading of the course is as per the grading pattern in UG Regulations 2024.

SOCIAL AWARENESS COURSE (SAC)

- The aim of SAC is to make students aware of the problems that different societies and communities face on a day-to-day basis and to be conscious of the difficulties and hardships of society.
- This is a compulsory course with two (2) credits.
- Social Awareness Course shall be conducted by a nodal centre consisting of the convenor, other faculty members nominated by the Principal.
- The centre shall identify the areas where the students can serve the society through the course.
- During the first semester itself, the centre shall organise activities to sensitize the students about the significance and relevance of Social Awareness and publish a list of different areas where they can work as volunteers.
- The centre shall allot students to various areas based on their preference.
- Students shall carry out the voluntary work allotted to them after the regular class hours/weekends/holidays falling in the first and second semesters and the summer vacation following the second semester.
- Evaluation of the SAC activity shall be based on the hours of work put in by a student. A minimum of 50 hours of social work (corresponding to 50 marks) is required for the successful completion of the course. Every additional work beyond the minimum 50 hours shall fetch five (5) marks per hour. Maximum marks shall be 100.
- Students who donate blood during the first year shall be given 10 marks on production of the certificate from the medical officer. However, marks earned through blood donation shall not be counted for a pass in the course. Mark for blood donation shall be awarded only once during the SAC.
- Two credits shall be awarded to students who complete the requirements of SAC.
- The grading will be as per the grading pattern in the UG Regulations 2024.
- Students who could not complete the requirements of the SAC shall appear for the same with the next batch.
- The Director of Short-Term Courses and Convenor of SAC has the right to exclude students who are physically challenged from SAC, if requested.

SKILL DEVELOPMENT COURSES (SDC)

- This is a compulsory component of STC with two (2) credits.
- SDC's shall be completed within the first four semesters of the programme.
- Depending on the nature of the course, there will be a theory component and a skill development component.
- The credit will be awarded only if the student gets a D grade (35% marks) and above.
- A student can do a maximum of three skill Development Courses according to his/her choice, but pass in at least one course is compulsory.
- The Convenor of SDC will coordinate the course.
- The Head of the Department concerned in consultation with the faculty members may prepare a syllabus for the SDC, which will be approved by the Board of Studies concerned.

Evaluation of SDC

The evaluation the course shall be done internally and contain two parts.

i. Continuous evaluation
ii. Final evaluation

Both continuous evaluation and final evaluation shall be carried out using indirect grading. The marks for continuous evaluation is twenty (20) and that of the final evaluation is eighty (80).

Continuous evaluation

The components of the continuous evaluation and their marks are as below.

For all courses, without practical

There are two components for continuous evaluation, which include attendance and assignment. All the components of the continuous evaluation are mandatory.

Component	Marks
Attendance	5
Assignments	15
Total	**20**

Marks for attendance

Minimum 75% attendance is compulsory for attending the final examination.

% of Attendance	Marks
90 and above	5
85 - 89	4
80 – 84	3
76 – 79	2
75	1

(Decimals shall be rounded mathematically to the nearest whole number)

For all courses with practical

The components for continuous evaluation of courses with practical are given below.

Component	Marks
Attendance	5
Lab/skill work involvement	15
Total	**20**

Assignments

At least one assignment shall be submitted for the course.

Final evaluation

The final evaluation of theory and practical courses shall be conducted by the office of the Controller of Examinations. It can be in the form of 80 marks written examination or 80 marks project/practical examination or 80 marks written and project/practical examination combined, as decided by the Board of Studies concerned.

FINISHING SCHOOL

- It is a compulsory course with one (1) credit.
- The course provides compulsory training for all under graduate students of this college.
- The training is to help students develop their soft skills and interview skills.
- The training shall impart soft skills comprising of language skills, personal presentation and grooming, table manners, resume preparation, group discussion techniques, and interview skills among the undergraduate students.
- This course shall be conducted during the third and fourth semesters for all the undergraduate students.
- There will be a total of 20 contact hours which shall be handled by a team of professional members/faculty. In addition, a one-day outbound training session by a team of professional trainers that touches on the aspects of creativity, problem solving and team building shall also be organized.
- The students shall be assessed on the basis of the components given below.

Component	Marks
Attendance	5
Aptitude Test	10
Assignments	10
Group discussion	10
Interview	15
Total	**50**

Marks for attendance

Maximum of five (5) marks will be given for attendance as follows.

% of Attendance	Marks
90 and above	5
85-89	4
80-84	3
76-79	2
75	1

(Decimals shall be rounded off to the next higher whole number)

Grades will be awarded as per grading pattern in UG Regulations 2024.

VIRTUAL LAB EXPERIMENTS

- This is an optional course with one (1) credit.
- The main aim of the Virtual Lab Experiments is to provide remote-access to simulation-based Labs in various disciplines of Sciences which enthuse students to conduct experiments by arousing their curiosity.
- The Convenor will coordinate the Virtual Lab component and he may use the services available in different virtual lab platforms after the approval of the advisory body.
- Students have to do at least 36 hours of experiments and they get a maximum of one credit for this.
- Convenor and the mentor of the student shall oversee the progress and assign grades as per the grading pattern in UG Regulations 2024 after the completion of the programme.