SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS)
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DEPARTMENT OF PHYSICS

Syllabus of

Bachelor's Degree in

PHYSICS

CHOICE BASED CREDIT SYSTEM
SEMESTER SCHEME
UNDER NEW EDUCATION POLICY 2020
2021-22 ONWARDS
(EFFECTIVE FROM ACADEMIC YEAR 2023-24)

BOS meeting held on 10-02-2024
Academic Council meeting, held on 23-03-2024

SDM COLLEGE (AUTONOMOUS), UJIRE DEPARTMENT OF PHYSICS
SYLLABUS -FOUR YEARS UNDERGRADUATE PROGRAMME

PREAMBLE

This program is a fundamental transformation to the current undergraduate education which replaces the conventional undergraduate programmes of Universities in the State. Outcome Based Education (OBE) practices will be used to design curriculum. It is proposed to develop Graduate Attributes at appropriate level which will act as common denominator for curriculum across universities. Curriculum shall focus on critical thinking and problem solving. Conscious efforts to develop cognitive and non-cognitive problem-solving skills among the learners shall be part of the curriculum. The programmes designed shall empower graduates as expert problem solvers using their disciplinary knowledge and collaborating in multi- disciplinary teams

Programme objectives:

- To enhance Subject knowledge of all branches of Physics with exposure to new and recent developments in Physics
- To develop Experimental skills/Communication and Learning skills
- To enable ICT exposure through computer simulation experiments/presentations
- To have Research exposure through SRPs
- To develop Additional skills in the field of interest through CC
- To develop Scientific approach in attitude and reasoning, creativity and innovative ideas
- To create Awareness on energy conservation/environment/cleanliness
- To develop Motivation on Nation development

Programme outcomes:

- PO-1-Disciplinary knowledge
- PO-2-Communication Skills
- PO-3-Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
- PO-4-Problem solving
- PO-5-Research-related skills
- PO-6-Cooperation/ Teamwork/ Leadership readiness/Qualities
- PO-7-Information/ Digital literacy/Modern Tool Usage
- PO-8-Environment and Sustainability
- PO-9-Multicultural competence
- PO-10-Multi-Disciplinary
- PO-11-Moral and ethical awareness/Reasoning
- PO-12-Lifelong learning / Self Directed Learning

Bloom's Taxonomy of Learning	
Bloom's Level (BL)	
Level 6 (L6)	**Creating**
Level 5 (L5)	**Evaluating**
Level 4 (L4)	**Analyzing**
Level 3 (L3)	**Applying**
Level 2 (L2)	**Understanding**
Level 1 (L1)	**Remembering**

Curriculum Structure (Core and Electives)

Semesters- I to X

SEM	DSC	Core Papers
Sem-1	A1	Mechanics & Properties of Matter
Sem-2	A2	Electricity and Magnetism
Sem-3	A3	Wave Motion and Optics
Sem-4	A4	Thermal Physics & Electronics
Sem-5	A5 A6	1. Classical Mechanics and Quantum Mechanics 2. Atomic, Molecular Physics and Laser Physics
Sem-6	A7 A8	1. Electronic Instrumentation 2. Condensed Matter Physics and Nuclear Physics
Sem-7	A9 A10 A11	1. Mathematical Methods of Physics – I 2. Classical Electrodynamics. 3. Experimental methods of Physics 4. Research Methodology (Select Two DSE subjects from the Pool B-I shown below)
Sem-8	A12 A13 A14	1. Classical Mechanics and Quantum Mechanics-II 2. Statistical Mechanics 3. Astrophysics & Astronomy 4. Research Project* (Select Two DSE subjects from the Pool B-II shown below) *In lieu of the research Project, two additional elective papers/ Internship may be offered.
Sem-9	A15	1. Mathematical Methods of Physics – II (Select One DSE subjects from the Pool B-III shown below) 2. Research Project
Sem- 10	A17	1. Quantum Mechanics – III (Select One DSE subjects from the Pool B-IV shown below) 2. Research Project

Open Electives for 1st to 4th Semesters

Semester	Title of the courses	
	Science stream	**Non- Science stream**
First Semester	Energy Sources	Physics in time line
Second Semester	Astronomy	Space Mission
Third Semester	Electrical and Electronic Devices	Physics in Daily life
Fourth Semester	Climate Science	Physics of Sports
Fifth Semester		
Sixth Semester		

Discipline Specific Electives for 7th to 10th Semesters

	7th Sem Electives **Pool B-I (Select any two)**		**8th Sem Electives** **Pool B-II (Select any two)**
A.	Condensed Matter Physics-1	A.	Atomic & Molecular Physics-1
B.	Nuclear and Particle Physics	B.	Materials Physics & Nano materials
C.	Theoretical and Computational Physics-I	C.	Lasers and non-linear optics
D.	Biophysics	D.	Plasma Physics
E.	Astronomy and Astrophysics	E.	Physics of Semiconductor devices

	9th Sem Electives **(Specialization papers)** **Pool B-III**		**10th Sem Electives** **(Specialization papers)** **Pool B-IV**
A.	Condensed Matter Physics-2	A.	Condensed Matter Physics-3
B.	Nuclear and Particle Physics-2	B.	Nuclear and Particle Physics-3
C.	Atomic & Molecular spectroscopy-1	C.	Atomic & Molecular spectroscopy-2
D.	Materials Physics & Nanophysics –1	D.	Materials Physics & Nanophysics -2
E.	Theoretical and Computational Physics-I	E.	Theoretical and Computational Physics-2
F.	Astronomy and Astrophysics-1	F.	Astronomy and Astrophysics-2

COURSE PATTERN AND SCHEME

Core/ Elective	Paper Code	Title of the Paper	Instruction Hours	Duration of the Examination (Hrs)	Max. Marks			Credits
					Exam	IA	Total	
I Semester B.Sc.								
DSC1	Theory PHCT101	Mechanics and Properties of Matter	4	2	60	40	100	4
	Practical PHCP101	Physics Practical I	4	4	25	25	50	2
OE1	PHOE101 PHOE102	Physics in Time line Energy sources	3	2	60	40	100	3
							Total number of Credits in I Semester: 09	
II Semester B.Sc.								
DSC2	Theory PHCT151	Electricity and Magnetism	4	2	60	40	100	4
	Practical PHCP151	Physics Practical II	4	4	25	25	50	2
OE2	PHOE151 PHOE152	Space mission Astronomy	3	2	60	40	100	3
							Total number of Credits in II Semester: 09	
III Semester B.Sc.								
DSC3	Theory PHCT201	Wave Motion and Optics	4	2	60	40	100	4
	Practical PHCP201	Physics Practical III	4	4	25	25	50	2
OE3	Theory PHOE201/202	Physics in Daily Life Electric and electronic devices	3	2	60	40	100	3
							Total number of Credits in III Semester: 09	
IV Semester B.Sc.								
DSC4	Theory PHCT251	Thermal Physics and Electronics	4	2	60	40	100	4
	Practical PHCP251	Physics Practical IV	4	4	25	25	50	2
OE4	Theory PHOE251/252	Climate Science-SS Physics of Sports-NSS	3	2	60	40	100	3
							Total number of Credits in IV Semester: 09	

V th Semester B.Sc.								
DSC5	Theory PHCT301	Classical and Quantum Mechanics	4	2	60	40	100	4
	Practical PHCP301	Physics Practical V	4	4	25	25	50	2
DSC6	Theory PHCT302	Atomic, Molecular and Laser Physics	4	2	60	40	100	4
	Practical PHCP302	Physics Practical VI	4	4	25	25	50	2

Total number of Credits in V Semester: 12

VI th Semester B.Sc.								
DSC5	Theory PHCT351	Electronic Instrumentation	4	2	60	40	100	4
	Practical PHCP351	Physics Practical VII	4	4	25	25	50	2
DSC6	Theory PHCT352	Condensed Matter and Nuclear Physics	4	2	60	40	100	4
	Practical PHCP352	Physics Practical VIII	4	4	25	25	50	2

Total number of Credits in VI Semester: 12

Outline for Internal assessment (Theory)

Activity	1	2	Total marks
Internals	10	10	20
Assignments/Projects	10	10	20
Total	20	20	40

Allotment of Marks for Practicals for I-VI Semesters

Internal Assessment

Lab performance based on Continuous assessment 10
Model practical examination after completing the minimum 15
Number of experiments 08
Total 25 Marks

Scheme of Practical Examination

Formula : 03
Diagram/circuit/setup : 03
Observations and no. of trials : 06
Knowledge about the Expt/Viva : 03
Result and accuracy with units : 02
Class Record : 08
Total Marks -Practical Exam 25 (Minimum marks for pass =9/25)
Class records shall be valued at the time of Practical Exam by the External Examiner in consultation with Internal Examiner.
Record marks:
Regularity and completing the minimum number = 05marks Neatness / General impression = 03 marks Total = 08 marks
Total Marks = Internal Assessment marks +Practical Exam
= Max.25 + Max. 25 = 50

1. Question once given to the candidate during the practical examination should not be changed under any circumstances.
2. Practical record shall be valued by the external examiner in consultation with the internal examiner.
3. Practical examination answer scripts should be valued jointly by the external and internal examiners.
4. The candidates shall produce a certified practical record book while appearing for the practical examination.
5. Scientific calculators without programming facility are only allowed.
6. Each candidate has to use his/her own calculator at the time of practical examination.

Semester – I Mechanics and Properties of Matter CODE NUMBER-PHCT101	
Course Title: Mechanics and Properties of Matter	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Objectives

- To get the idea of possible errors in measurements
- To get the knowledge of basics of mechanics
- To get fundamental idea about properties of matter
- To study about gravitation laws
- To get the knowledge about relativistic mechanics
- To study conservation laws in Physics

Course Learning Outcomes (CO)

At the end of the course students will be able to:

CO-1 Estimate the possible error in measurement of a physical quantity, using its dimensional equation, the least counts of instruments used and by actual measurements in the appropriate system of units.
CO-2 Apply laws of conservation of momentum and associated energy along with laws to motion to the systems of linear/rotational motion to determine different parameters associated with physically rigid bodies.
CO-3 Apply the concept of the relative frame of reference with appropriate postulates of the theory of relative motion to the measurement of length, time and velocity.
CO-4 Apply the laws of Gravitation and Kepler laws to describe the working of satellites and other applications.
CO-5 Determine theoretically and experimentally the relation between three elastic constants
CO-6 Apply the concept of surface tension and viscosity of fluids.

Course Articulation Matrix

Mapping of Course Outcomes (CO) Program Outcomes												
Course Outcomes / Program Outcomes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
i	Estimate the possible error in measurement of a physical quantity, using its dimensional equation, the least counts of instruments used and by actual measurements in the appropriate system of units.	X	X	X	X	X	X					X	X
ii	Apply laws of conservation of momentum and associated energy along with laws to motion to the systems of linear/rotational motion to determine different parameters associated with physically rigid bodies.	X	X	X	X	X	X					X	X
iii	Apply the concept of the relative frame of reference with appropriate postulates of the theory of relative motion to the measurement of length, time and velocity.	X	X	X	X	X	X					X	X
iv	Apply the laws of Gravitation and Kepler laws to describe the working of satellites and other applications.	X	X	X	X	X	X					X	X
v	Determine theoretically and experimentally the relation between three elastic constants.	X	X	X	X	X	X					X	X
vi	Apply the concept of surface tension and viscosity of fluids.	X	X	X	X	X	X					X	X

PHCT 101 -Mechanics & Properties of Matter

Credits : 4+2 **Theory : 4 hours /Week**

Unit – 1

Chapter 1

Units and measurements: System of units (CGS and SI), dimensions of physical quantities, dimensional formulae. Minimum deviation, errors and error analysis **Vectors**: Instantaneous velocity and acceleration, Derivative of planar vector of constant magnitude but changing direction. Arbitrary planar motion, radial and transverse component of velocity and acceleration, deduction of the results of uniform circular motion**.** ***Problems***

Chapter 2

Momentum and Energy: Work and energy, Conservation of linear and angular momentum. Conservation of energy with examples. Work energy theorem, Motion of rockets. ***Problems***

Chapter 3

Special Theory of Relativity: Inertial and no-inertial frames of reference, Galilean transformation equation, Galilean principle of relativity. Search for absolute frame of reference, Ether concept, Null result of Michelson Morley experiment, Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Twin paradox, Doppler effect and applications Relativistic addition of velocities, Einstein's mass energy relation-photon box experiment. ***Problems*** **13 Hrs**

Topics for self -study

Units and measurements: Measurement of length, mass and time. Laws of Motion: Newton's Laws of motion. Dynamics of single and a system of particles. Centre of mass.

Activities

i). Students can measure diameters of small balls of different size and estimate their volumes.

ii). Students can measure lengths of nails of different size.

iii). Students can measure volume of a liquid.

iv). Students can measure distances and put the result both in CGS and SI units in 2, 3 and 4 significant figures. Ask them to mention the precession of the measurement.

v). students can estimate standard deviations wherever possible

Students can try and understand conservation of energy in every day examples. For example:

i) What happens in solar conservation panels

ii) Pushing an object on the table it moves

iii) Moving car hits a parked car causes parked car to move. In these cases, energy is conserved. How? Understand and verify if possible. Students can try and understand conservation of momentum with help of coins and balls by referring to websites.

iv) Students can demonstrate law of conservation of momentum

Unit 2

Chapter 4

Laws of Motion: Conservative and non-conservative forces. Deduction of conservation of energy in conservative force field. Centre of mass. Simple harmonic motion – vertical oscillations of the light loaded spring, expression for force constant and determination of acceleration due to gravity, Damped oscillations (mention)-***Problems***

Chapter 5

Dynamics of Rigid bodies: Rotational motion about an axis, Relation between torque and angular momentum, Rotational energy. Moment of inertia: Theorem of perpendicular axis and Theorem of parallel axes, Moment of Inertia of a rectangular Lamina, Circular disc and ring and solid cylinders. Flywheel, its use, theory of compound pendulum and determination of 'g'. ***Problems***

Chapter 6

Gravitation: Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Dynamics of a Top ,Kepler's laws (statements)-Derivation of Kepler's Laws from Newtons law-. Satellite in a circular orbit. ***Problems***

Chapter 7

Escape velocity, Geosynchronous orbits. Basic idea of global positioning system (GPS). Basics of remote sensing and GIS and applications **13 Hrs**

Self-study

Calculation of MI of different objects, Kepler's laws

Activities

Moment of inertia is an abstract concept. It simply gives a measure of rotational inertia of a rigid body and it is proportional to the product of the square of radius, r of the body and its mass, m.

Students by Referring to websites, students can construct and perform simple experiments to verify that MI α mr2.

Students can try to understand law of inertial with the help of coins and balloons by referring to websites

Reference: www.khanacademy.org, www.pinterest.com, www.serc.cerleton.edn, https://www.youtube.com

Prepare suitable charts and give seminar talks related to moment of inertia, gravitation and planetary motion

(i) Rolling of different disc and cylinders on inclined plane to understand the moment of inertia. (ii) Listing and discussing the moment of inertia of bodies come across in daily life.

Unit 3

Chapter 8

Elasticity: Hooke's law - Stress-strain diagram, elastic moduli-relation between elastic constants, Necking and breaking strength. Elasticity and plasticity- graphical explanation. Creep, stress relaxation and fatigue. Thermal effect on stress and strain, practical applications Poisson's Ratio-expression for Poisson's ratio in terms of elastic constants. Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder. Torsional pendulum-Determination of rigidity modulus and moment of inertia - q, η and σ by Searle's method Bending moment of beams, Cantilever bending and uniform bending, I - section of girders. Application of elasticity (materials). Resistance of bent beams, columns pillars, struts, critical load-different cases**-** ***Problems*** **13 Hrs**

Activities

Arrange a steel spring with its top fixed with a rigid support on a wall and a meter scale alongside. Add 100 g load at a time on the bottom of the hanger in steps.

This means that while putting each 100g load, we are increasing the stretching force by 1N. Measure the extension for loads up to 500g. Plot a graph of extension versus load. Shape of the graph should be a straight line indicating that the ratio of load to extension is constant. Go for higher loads and find out elastic limit of the material.

Repeat the above experiment with rubber and other materials and find out what happens after exceeding elastic limit. Plot and interpret.

Classifying different materials in to elastic and plastic materials. Studying the bending magnitudes of different shape and material rods

Unit 4

Chapter 9

Surface tension: Definition of surface tension. Surface energy, relation between surface tension and surface energy, pressure difference across curved surface example, excess pressure inside spherical liquid drop, angle of contact. Variation of surface tension with temperature and impurity and contamination, Effect of evaporation and condensation, Surface tension by drop weight method, Interfacial surface tension, ***Problems.***

Chapter 10

Viscosity: Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poiseuille's method, Stoke's method. Brownian motion. Super fluidity. Viscosity of gases , ***Problems.*** **13 Hrs**

Self-study

Variation of surface tension with temperature, Surface tension by Capillarity rise, Application of viscosity.

Activities

1. Measure surface tension of water and other common liquids and compare and learn

i) Why water has high ST? think of reasons.

ii)Check whether ST is a function of temperature? You can do it by heating the water to different temperatures and measure ST.

iii) Plot ST versus T and learn how it behaves. Mix some quantity of kerosene or any oil to water and measure ST. Check whether ST for the mixture is more or less than pure water. List the reasons.

2. Collect a set of different liquids and measure their viscosity.

i) Find out whether sticky or non-sticky liquids are most viscous. List the reasons.

ii) Mix non sticky liquid to the sticky liquid in defined quantities and measure viscosity. Find out viscosity is increasing or decreasing with increase of non sticky liquid concentration.

iii)Do the above experiment by mixing sticky liquid to the non sticky liquid. Find out change in viscosity with increase of concentration of sticky liquid. List the applications where concept of Viscosity plays a dominant role

Text Books:

1) Mechanics by, New edition D. S. Mathur S. Chand & Co. 2000

2) Mechanics and Relativity by 3rd Edition, Vidwan Singh Soni, PHI Learning Pvt. Ltd. 2013

3) Mechanics- Berkeley Physics Course, Vol.1: Charles Kittel, et.al. Tata McGraw-Hill 2007

4) Properties of Matter by Brijlal & Subramanyam. S.Chand & Co 2014

5) Physics for Degree Students CL Aurora S.Chand & Co 2010

6) Mechanics J C Upadhyaya Himalaya 2016

References Books

1) Principles of Physics, 9 th Edn, Resnick, Halliday & Walker, Wiley 2013

2) Conceptual Physics, 10th Edn Paul G Hewit Pearson 2012

3) Introduction to Special Theory of Relativity Robert Resnick Wiley Student Edition 2014

4) Physics for Scientists and Engineers Jewett & Serway Cengage learning India Pvt Ltd, Delhi 2012

5)The Feynman Lectures on Physics – Vol 1 Richard P Feynman, Robert B Leighton, Mathew Sands Narosa Publishing House 1986

6)Physics – (International Student Edition) Marcelo Alonso & Edward J Finn Addison – Wesley 1999

7) Concepts of Modern Physics Arthur Beiser Tata McGraw Hill 1998

8) Modern Physics Kenneth Krane Wiley 2012

9) Newtonian Mechanics AP French Viva Books 2017

10) Modern Physics G Aruldhas & P Rajgopal PHI Learning Pvt. Ltd. 2009

PHCP101: Practical 1 4 Hrs Per week

List of Experiments

(Minimum EIGHT experiments have to be carried out)

1. Determination of g using bar pendulum (two -hole method and L versus T graphs).
2. Determination of moment of inertia of a Fly Wheel.
3. Determination of rigidity modulus using torsional pendulum.
4. Modulus of rigidity of a rod – Static torsion method.
5. Determination of elastic constants of a wire by Searle's method.
6. Young's modulus by Koenig's method.
7. Viscosity by Stokes' method.
8. Verification of Hooke's law by stretching and determination of Young's Modulus.
9. Determination of surface tension of a liquid by drop weight method.
10 Study of motion of spring and to calculate the spring constant, g and unknown mass.
11. Determination of Young's modulus of a bar by the single cantilever method.
12. Determination of Young's modulus of a bar by uniform bending method.
13. Radius of capillary tube by mercury pellet method.
14 Verification of parallel and perpendicular axis theorems.
15 Determination of interfacial tension between two liquids using drop weight method.
16 Determination of viscosity of liquids by Poiseuille's method.
17.Computer simulation Experiment

Reference Book for Laboratory Experiments

1) Advanced Practical Physics for students B.L. Flint and H.T. Warson Asia Publishing House. 1971

2)A Text Book of Practical Physics I. Prakash & Ramakrishna Kitab Mahal, 11th Edition 2011

3) Advanced level Physics Practicals Michael Nelson and Jon M. Ogborn Heinemann Educational Publishers, 4th Edition 1985

4)A Laboratory Manual of Physics for undergraduate classes D.P. Khandelwal, Vani Publications. 1985

5) BSc Practical Physics Revised Ed CL Arora S. Chand & Co 2007

6) An advanced course in practical physics D. Chattopadhyay, PC Rakshit, B.Saha New Central Book Agency Pvt Ltd 2002

SEMESTER 1 **3Hrs per week**

OPEN ELECTIVE- FOR NON- SCIENCE STUDENTS

CODE NO: PHOE101: PHYSICS IN TIME LINE

Objectives

- To study about origin of universe
- To gain the knowledge on nuclear energy
- To study the basics of super conductivity
- To gain the knowledge about discoveries in Physics

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Program Outcomes (POs)

Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12
CO1-Will be able to understand the origin of universe and different constituents	**x**											x
CO2-Will gain the basic knowledge of Newtons laws	**x**											x
CO3-Can justify the importance of quantum theory	**x**		x									x
CO4-will acquire the knowledge on superconductivity	**x**							x				
CO5-will be able to explain about Nuclear energy	**x**	x	x					x				x
CO-6 will gain the basic knowledge of basic discoveries in Physics	**x**											
CO-7-will be able to explain the determination of crystal structure using X rays	**x**	**x**	x		**x**		**x**					**x**
CO-8 will learn the concept of Atom bomb	**x**		x		**x**		**x**					

SEMESTER 1 **3Hrs per week**

OPEN ELECTIVE- FOR NON -SCIENCE STUDENTS

CODE NO: PHOE101: PHYSICS IN TIME LINE

Unit I

EARLY MODERN WORLD: The ancient India describes the origin of the universe, Aristotle- geocentric Universe, Ptolemy - Geocentric model, Aryabhata ,Nicolaus Copernicus, Kepler Laws of Planetary Motion, Galileo Galilei Principle of Relativity, , Freely falling bodies, Isaac Newton Laws of motion , laws of gravitation John Dalton develops his atomic theory, Michael Faraday electromagnetism James Clerk Maxwell demonstrates that electric and magnetic field Henri Becquerel radioactivity. Thomson discovers the electron. **13 Hrs**

Unit II

MODERN WORLD: Quantum theory, photoelectric effect. $E=mc^2$ mass-energy relation, Special Theory of Relativity , General Theory of Relativity, discovery of the proton, Pauli exclusion principle, Uncertainty principle, Schrödinger Equation, - Hubble's Law, discovers the neutron, "Chandrasekhar limit" nuclear fission,
Integrated Circuit" Higgs Bosons, nuclear reactor, atom bomb, Blue LED,Laser, Optical fibre, MRI, CT scan, Ultrasound Super conductivity, Magnetic levitation-trains **13 Hrs**

Unit III

Discoveries and Inventions- (mention only):

X-rays ,Zeeman effect Radioactivity Work of Marie Curie, Rayleigh Scattering, Lenard - work on cathode rays, Thomson -conduction of electricity by gases" Michelson instruments and the spectroscopic, Colours photography, Wireless telegraphy, Equation of state for gases and liquids, Superconductivity Diffraction of X-rays by crystals Stark effect, Structure of atoms, Andrews Millikan- elementary charge ,Compton effect, Thermionic emission, - The wave nature of electrons, Raman -Effect, Diffraction of electrons by Crystals, Discovery of nuclear reactions, Cyclotron, Transistor, Quantum electro dynamics. **13 Hrs**

Suggested Activities:

1. Uses of LED, Transistor, diodes, and IC
2. Uses of LASER in Medicine, bar code reader, laser printer.
3. Uses of MRI, CT SCAN and X-RAYS.
4. Uses and applications of physics in daily life

References:

1. Concepts in physics by H C Verma
2. https://www.pdfdrive.com/halliday-resnick-fundamentals-of-physics-e175337758.html
3. https://openstax.org/details/books/college-physics
4. https://www.nobelprize.org/prizes/lists/all-nobel-prizes-in-physics/
   https://www.britannica.com

SEMESTER 1 **3Hrs per week**

OPEN ELECTIVE- FOR SCIENCE STUDENTS CODE NO:PHOE102: ENERGY SOURCES

Objectives

- To understand different types of energy sources
- To study the significance of solar energy
- To gain the knowledge on conventional and non -conventional energy sources
- To understand the problems of global warming

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Program Outcomes (POs)

Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12
CO - 1: Will be able to comprehend the varieties of energy sources and differentiate between the renewable and non-renewable sources of energy	**x**	**x**										
CO - 2: Will know the significance of solar energy and the different techniques to harness the solar energy	**x**	**x**					x					x
CO - 3: Will gain the idea of the formation of waves and standing wave pattern, analysis of longitudinal and transverse waves.	**x**	**x**			**x**		x	x				
CO - 4: Will acquire the knowledge of wind energy and the methods to tap the energy from the blowing wind to generate electrical power.	**x**	x		x			x					
CO - 5: Will come to know about the conventional energy sources and its impact on the climate	**x**	x			**x**			x				
CO - 6: Will acquire the skill to set up a model to show the production of energy from different energy sources	**x**				**x**	**x**						
CO - 7: Will be able to explain the different energy sources and how they are beneficial for the development of Technology.	**x**	**x**			**x**	**x**						**x**
CO - 8: Will be able to understand the problems of global warming and other climatic impact of the reckless usage of energy resources	**x**			**x**	**x**	**x**		**x**				**x**

SEMESTER 1 **3Hrs per week**

OPEN ELECTIVE- FOR SCIENCE STUDENTS

CODE NO:PHOE102: ENERGY SOURCES

Unit 1

Non -Renewable energy sources

Chapter 1: Introduction-Energy concept-sources in general, its significance & necessity. Classification of energy sources: Primary and Secondary energy, Commercial and Non-commercial energy, Renewable and Non-renewable energy, Conventional and Non-conventional energy, Based on Origin-Examples and limitations. Importance of Non-commercial energy resources. **4 Hrs**

Chapter-2: Conventional energy sources-Fossil fuels & Nuclear energy- production & extraction, usage rate and limitations. Impact on environment and their issues& challenges. Overview of Indian & world energy scenario with latest statistics- consumption & necessity. Need of eco-friendly & green energy & their related technology. **9 Hrs**

Unit 2

Renewable energy sources

Chapter-1: Introduction: Need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **5 Hrs**

Chapter 2 : Solar energy: Solar Energy-Key features, its importance, Merits & demerits of solar energy, Applications of solar energy. Solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell -brief discussion of each. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

8 Hrs

Unit 3

Chapter-3: Wind and Tidal Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies. Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy. **7 Hrs**

Chapter-4 : Geothermal and hydro energy: Geothermal Resources, Geothermal Technologies. Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Carbon captured technologies, cell, batteries, power consumption.

Energy storage techniques and devices, electrochemical energy storage, Magnetic and electrical energy storage **6Hrs**

Activity

1. Demonstration of on Solar energy and wind energy using training modules at Labs.

2. Conversion of vibration to voltage using piezoelectric materials.

3. Conversion of thermal energy into voltage using thermoelectric (using thermocouples or heat sensors) modules.

4. Project report on Solar energy scenario in India

5. Project report on Hydro energy scenario in India

6. Project report on wind energy scenario in India

7. Field trip to nearby Hydroelectric stations.

8. Videos on solar energy, hydro energy and wind energy.

Reference Books:

1). Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi

2). Solar energy - M P Agarwal - S Chand and Co. Ltd.

3). Solar energy - Suhas P Sukhadev Tata McGraw - Hill Publishing Company Ltd.

4). Godfrey Boyle, "Renewable Energy, Power for a sustainable future", 2004, Oxford University Press, in association with The Open University.

5). Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009

6). J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).

7). http://en.wikipedia.org/wiki/Renewable_energy

Semester – II

Electricity & Magnetism

CODE NO: PHCT151

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Objectives

- To study basics of electrostatics
- To understand the concepts of electric and magnetic fields
- To study AC and DC circuits
- To apply various network theorems

Program Outcomes (POs)

Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12
i. Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.	**x**	**x**										
ii. Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.	**x**	x					x	x				
iii. Apply Gauss's law of electrostatics to solve a variety of problems.	**x**	**x**			**x**			x				
iv. Describe the magnetic field produced by magnetic dipoles and electric currents.	**x**											
v. Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.	**x**											
vi. Describe how magnetism is produced and list examples where its effects are observed.	**x**				**x**	**x**						**x**
vii. Apply Kirchhoff's rules to analyse AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.	**x**	**x**		x	**x**	**x**		**x**				**x**

viii.	Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity, Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis, and electrical machines.	**x**	**x**			**x**	**x**		**x**				**x**

Electricity & Magnetism -PHCT 151

Credits: 4+2 **Theory: 4 hours /Week**

Unit I

Chapter 1

Electric charge and field Coulomb's law, electric field strength, electric field lines, point charge in an electric field and electric dipole, work done by a charge (derivation of the expression for potential energy), ***Problems***. **3 Hrs**

Chapter 2

Gauss's law and its applications (electric fields of a (i) spherical charge distribution, (ii) line charge and (iii) an infinite flat sheet of charge). **3 Hrs**

Chapter 3

Electric potential, line integral, gradient of a scalar function, relation between field and potential. Potential due to point charge and distribution of charges (Examples: potential associated with a spherical charge distribution, infinite line charge distribution, infinite plane sheet of charges). Constant potential surfaces, Potential due to a dipole and electric quadrupole. ***Problems*** **7 Hrs**

Self study topics

Electric charge and field Coulomb's law, electric field strength, electric field lines, point charge in an electric field and electric dipole . Constant potential surfaces - for self learning Work out problems listed in the reference

Activity

1. Learn the difference between and DC and AC electricity and their characteristics. Voltage and line frequency standards in different countries.

2. A small project report on production of electricity as a source of energy: Different methods
3. With the help of glass rod, plastic rod, silk, and fur demonstrate the generation of charge and electrostatic attraction and repulsion.

4. Learn to use a multimeter (analog and digital) to measure voltage, current and resistance. Continuity testing of a wire.

5. Learn about household electrical connection terminals: Live, neutral and ground and voltage between the terminals. Role of earthing and safety measures

6. Study the working principle of house hold electrical devices

Unit 2

Chapter 4

Conductors in electrostatic field Conductors and insulators, conductors in electric field. Capacitance and capacitors, calculating capacitance in a parallel plate capacitor, parallel plate capacitor with dielectric, dielectrics: an atomic view. Energy stored in a capacitor, Dielectric and Gauss's law, ***Problems.*** **6 Hrs**

Chapter 5

Electric currents and current density. Electrical conductivity and Ohm's law. Physics of electrical conduction, conduction in metals and semiconductors, circuits and circuit elements: Variable currents in capacitor circuits, Resistor, inductor and capacitor and their combination, charging and discharging of capacitor. Force on a moving charge. Smart electrical devices, ***Problems.*** **7 Hrs**

Self study

Currents and voltage in combination of R, L and C circuits, Kirchhoff's laws of voltage & Current

Activity

1. Learn about electrical appliances which work with AC and DC electricity

2. Learn about types of resistors and their colour codes and types of capacitors (electrolytic and non-electrolytic)

3. Learn about power transmission: 3-phase electricity, voltage and phase

4. Visit a nearby electrical power station. Interact with line men, Electrical engineers and managers. Discuss about power loss in transmission. How to reduce it?

5. Prepare a small project report on street lighting and types of electrical bulbs

Unit 3

Chapter 6

Magnetism Definition of magnetic field, Ampere's law and Biot-Savart law (magnetic force and magnetic flux), Magnetic force on a current carrying conductor, Hall effect. Electromagnetic induction, conducting rod moving in a magnetic field, law of induction and mutual inductance, self- inductance and energy stored in a magnetic field. ***Problems*** **5 Hrs**

Chapter 7

Alternating current circuits: Resonant circuit, alternating current, quality factor, RL, RC, LC, LCR circuits, admittance and impedance, power and energy in AC circuits. Filters – High and Low and band pass filters (qualitative) Applications, ***Problems.*** **8 Hrs**

Self study

Force acting on a moving charge in electric and magnetic fields – Lorentz force, Magnetic dipole moment – torque on a magnetic dipole.

Activity

1. Prepare a small project report on street lighting and types of electrical bulbs.

2. Learn the measurement of electric current using tangent galvanometer.

3. Build a small coil with insulated copper wire. Connect an ammeter micro/milli ammeter. Verify magnetic induction using a powerful bar magnet.

Unit 4

Chapter 8

Electromagnetic waves: Scalar and vector fields, operator grad, the gradient of a scalar function, integration theorems – line integral, surface integral, volume integral, divergence and curl of a vector, Gauss and Stokes theorems (qualitative), Equation of continuity, Maxwell's equations, displacement current, electromagnetic wave, energy transported by electromagnetic waves. Electromagnetic waves in different frames of reference, the field of a current loop, magnetic moment, Electric current in atoms, electron spin and magnetic moment, magnetization and magnetic susceptibility. ***Problems*** **10 Hrs**

Chapter 9

Types of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials. B-H hysteresis curves **3 Hrs**

Self study

B-H curves and its characteristics Ferrites

Activity

1. Prepare a small project report on production of magnetic field: Permanent magnets, electromagnets and superconducting magnets.

2. Learn the principle of working of a Gauss meter to measure magnetic field

3. Model the earth's magnetic field with a diagram. Explain the effect of tilt of the earth's axis and reasons for the change in the tilt of the earth's axis over thousands of years.

4. Identifying the magnetic meridian of the earth and measuring the magnetic dip at a place using the magnetic pointer. Discussion on magnetic equator

Text Books

1) Physics for Degree Students Volume 1 CL Aurora & PS Hemne S.Chand & Co 2010

2) Fundamentals of Magnetism and Electricity DN Vasudeva S Chand & Co 2011

3) Electricity and Magnetism R Murugesan S Chand & Co 2019

4) Electricity and Magnetism D C Tayal Himalaya 1989

Reference Books

1) Physics-Part-II, David Halliday and Robert Resnick Wiley Eastern Limited 2001

2) Berkeley Physics Course, Vol-2, Electricity and Magnetism, Special Edition Edward M Purcell Tata Mc Graw-Hill Publishing Company Ltd, New Delhi 2008

3) The Feynman Lectures on Physics – Vol II Richard P Feynman, Robert B Leighton, Mathew Sands Narosa Publishing House 1986

4) Physics for Scientists and Engineers Jewett & Serway Cengage learning India Pvt Ltd, Delhi 2012

5) Physics – (International Student Edition) Marcelo Alonso & Edward J Finn Addison – Wesley 1999

PHCP151: Practicals: *List of Experiments for Practicals* :4 Hrs Per week

(Minimum 8 to be performed)

1. Experiments on tracing of electric and magnetic flux lines for standard configuration.

2. Verification of Maximum Power Transfer Theorem.

3. Analysis of Phasor diagram.

4. Determination of capacitance of a condenser using B.G.

5. Determination of mutual inductance using BG.

6. Charging and discharging of a capacitor (energy dissipated during charging and time constant measurements.

7. Series and parallel resonance circuits (LCR circuits).

8. Impedance of series RC circuits- determination of frequency of AC.

9. Study the characteristics of a series RC and RL Circuit.

10. Determination of self- inductance of a coil.

11. Verification of laws of combination of capacitances and determination of unknown capacitance using de – Sauty's bridge.

12. Determination of BH using Helmholtz double coil galvanometer and potentiometer.

13. Low pass and high pass filters.

14. Charge sensitiveness of BG.

15. Field along the axis of a coil.

16. Low resistance by potentiometer

17.Computer simulation experiment

Reference Books for Practicals

1) Advanced Practical Physics for students B.L. Flint and H.T. Worsnop Asia Publishing House. 1971

2) A Text Book of Practical Physics I. Prakash & Ramakrishna Kitab Mahal, 11th Edition 2011

3) Advanced level Physics Practicals Michael Nelson and Jon M. Ogborn Heinemann Educational Publishers, 4th Edition 1985

4) A Laboratory Manual of Physics for undergraduate classes D.P.Khandelwal Vani Publications. 1985

5)BSc Practical Physics Revised Ed CL Arora S.Chand & Co 2007

6) An advanced course in practical physics D. Chattopadhyay, PC Rakshit, B.Saha New Central Book Agency Pvt Ltd 2002

OPEN ELECTIVES

Open Elective **SEMESTER 2** **3 Hrs Per week**

CODE NO: PHOE151
SPACE MISSION -FOR NON -SCIENCE STUDENTS

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Objectives

- To gain knowledge on space mission
- To study about different types of satellites
- To get the knowledge on uses of satellites
- To study the history of Indian space mission

Program Outcomes (POs)

Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12
CO-1 Will understand the basics of space mission	**x**				x					x		
CO-2-will gain the knowledge on space crafts	**x**									x		
CO-3-will be able to differentiate different types of satellites	**x**		x							x		
CO-5-will be able to explain the uses of satellites	**x**	x				x				x		x
CO-6-able to understand the techniques of launching	**x**			x	**x**					x		
CO-7-will acquire the knowledge on Indian space mission	**x**									**x**		**x**

OPEN ELECTIVES

Open Elective **SEMESTER 2** **3 Hrs Per week**

CODE NO: PHOE151
SPACE MISSION -FOR NON- SCIENCE STUDENTS

Unit I

Introduction to Space Missions:
Rockets, types and their applications, Different types of orbits, Artificial satellites – basic idea and their applications, Introduction to Space Missions, Beginning of Space Missions - World and India, Applications of Space Research, international space station, space telescopes - Hubble, Chandra and James web Telescopes **13 Hrs**

Unit II

Space crafts,
Launching Vehicles. Topics for Self-study: Major Space Centres in the World (at least 10) brief idea about their location, establishment, capabilities and achievements. People behind space programs – at least 2 from India. Successful Missions (Any Five). 6 Indian Space Research Organisation (ISRO):About ISRO and its Goals, History of Creation. General Satellite **13Hrs**

Unit III

Programmes:
The IRS series, The INSAT series. Gagan Satellite Navigation System, Navigation with Indian Constellation (NavIC), Other satellites. Launch vehicles: Satellite Launch Vehicle (SLV), Augmented Satellite Launch Vehicle (ASLV), Polar Satellite Launch Vehicle (PSLV), Geosynchronous Satellite Launch Vehicle (GSLV). Experimental Satellites: Details and applications (Any Five) Earth Observation Satellites: Details and applications (Any Five) Communication satellites: Details and applications **13 Hrs**

Suggested Activities:

1. Assignments on rockets.
2. Project work Indian space programme.
3. Brief report ISRO AND NASA.
4. Telescopes and space station.
5. SLV.PSLV and GSLV.
6. Launching pad in India, master control facility and ISRO headquarters.
7. Father of Indian space program.

References:

1. *India in Space Paper back by HarperCollins Publishers India.*
2. international space station by Michel D Cole.
3. *Developing space by John K.*
4. Deep space craft's by Dave Doode.
5. Mission exploration space encyclopaedia.

OPEN ELECTIVES

Open Elective 2 P1 **SEMESTER 2** **3 Hrs Per week**

CODE NO: PHOE152
ASTRONOMY -FOR SCIENCE STUDENTS

.**Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)**

Objectives

- To study the Historical growth of Astronomy
- To understand Basic principles of Optical instruments
- To gain the knowledge on stellar evolution
- To study the principles of rocket launching

Program Outcomes (POs)

Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12
CO – 1: Will come to know the historical growth of Astronomy and the accumulation of knowledge.	**x**	**x**										
CO – 2 : Will be able to understand the basic principle of optical instruments such as telescope, binoculars.	**x**	**x**										x
CO – 3: Will acquire the skills to set up the telescope and recognize the star clusters and also the planets and satellites.	**x**	**x**			**x**				x			x
CO- 4: Will acquire the knowledge of wind energy and the methods to tap the energy from the blowing wind to generate electrical power.	**x**	x	x					x				x
CO – 5: Will come to know about the conventional energy sources and its impact on the climate	**x**	x			**x**			x				
CO-6: Will be able to explain the stellar evolution and evolution of the universe.	**x**	x			**x**	**x**						
CO- 7: Will be able to explain the principle of Rocket launching and other space machines.	**x**	**x**			**x**	**x**						

OPEN ELECTIVES

Open Elective **SEMESTER 2** **3 Hrs Per week**

CODE NO: PHOE152
ASTRONOMY -FOR SCIENCE STUDENTS

Unit 1

Ancient Astronomy Vedic Astronomy, Ancient Astronomy – Aryabhata, Varahamihira, Bhaskara Greek, Sumerian, Mayan, Egyptian, Arabic and Chinese Observations. Medieval Astronomy: Geocentric Model, Heliocentric Model Observations by Tycho Brahe, Kepler, Galileo, Herschel and others. 3 Tools for Astronomy: Invention of Telescopes Pin Hole, Binoculars, Telescopes & Imaging. Modern Astronomy Hubble's discovery, Stellar Evolution (Brief), Microwave, Radio Telescopes, Observational Terminologies Cardinal Directions, Azimuth, Altitude, Measurements using Compass and Hand. Equatorial Co-ordinates, Light years, Magnitude, Colors**.** **13 Hrs**

Unit II

The Sun Ecliptic and the Orientation of the Earth, Seasons - Solstices and Equinox, Observations of the Sun from Earth during seasons. Zero-shadow day Sunspots. 2 The Moon Earth-Moon system – Phases, Lunar Eclipses, Ecliptic and Lunar Orbital Plane – Nodes, Lunar Month, Full Moon Names. Inner Planets: Mercury & Venus Observational History, Observational Windows, Appearance, Apparitions, Elongations, Superior Conjunctions, Inferior Conjunctions, Transits. Outer Planets: Mars, Jupiter & Saturn **13 Hrs**

Unit III

Observational History, Observational Windows, Appearance, Frequency of Oppositions, Oppositions, Conjunctions, Galilean Moons, Saturn's Rings Distant or Minute Objects: Uranus, Neptune & Asteroids Observational History, Observational Windows, Asteroid Belt, Prominent Asteroids. 5 Comets & Meteors Origin, Orbital Nature, Historical Observations, Prominent Comets and Asteroids., Meteors, Origins and Showers 2 Occultations, Transits and Eclipses Definitions, Prominent Occultations and Transits, Eclipses – Types and prominent occurrences. Famous Eclipses inthe past. **13 Hrs**

Suggested Activities:

1. Assignments on Planets and Sun.
2. Project work on Comets.
3. Assignments of Bing Bang Theory.
4. Assignments of Types of Galaxies.
5. Assignments of Eclipses -Solar and Lunar.
6. Use of telescope to view sun spots.

7. Visiting Regional Science Centre.

Reference:

1 The Amateur Astronomer Sir Patrick Moore Springer 2006.

2 Handbook of Practical Astronomy Gunter D. Routh Springer 2009.

3 3 Fundamental Astronomy Hannu Karttunen Springer 2007.

4 Guide to Night Sky P. Shankar KRVP 2007.

5 The Complete Idiot's Guide to Astronomy Christopher De Pree andAlan Axelrod Pearson 2001.

6 The story of Astronomy In India Chander mohan Research Gate 20157 Trigonometry - Inc. Bar Charts.

8. Stargazing for Dummies Steve Owens John Wiley & Sons 2013.

9. A Sky watcher's Year Jeff Kanipe Cambridge University Press 1999.

10. The Casual Sky Observer's Guie Rony De Laet Springer 2012.

Semester – III Wave Motion and Optics	
Course Title: Wave Motion and Optics-**PHCT201**	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Objectives

- To understand the formation of waves and propagation
- To study the formation of standing waves
- To study the concept of resonance
- To gain the knowledge about diffraction of light
- To study the concept of polarization of light

Course Learning Outcomes	
At the end of the course students will be able to:	
i.	Identify different types of waves by looking into their characteristics.
ii.	Formulate a wave equation and obtain the expression for different parameters associated with waves.
iii.	Explain and give a mathematical treatment of the superposition of waves under different conditions, such as, when they overlap linearly and perpendicularly with equal or different frequencies and equal or different phases.
iv.	Describe the formation of standing waves and how the energy is transferred along the standing wave in different applications, and mathematically model in the case of stretched string and vibration of a rod.
v.	Give an analytical treatment of resonance in the case of open and closed pipes in general and Helmholtz resonators in particular.
vi.	Describe the different parameters that affect the acoustics in a building, measure it and control it.
vii.	Give the different models of light propagation and phenomenon associated and measure the parameters like the wavelength of light using experiments like Michelson interferometer, interference and thin films.
viii.	Explain diffraction due to different objects like singles slit, two slits, diffraction of grating, oblique incidence, circular aperture and give the theory and experimental setup for the same.
ix.	Explain the polarization of light and obtain how the polarization occurs due to quarter wave plates, half wave plates, and through the optical activity of a medium.

Course Articulation Matrix

Mapping of Course Outcomes (CO) Program Outcomes

Course Outcomes / Program Outcomes		1	2	3	4	5	6	7	8	9	10	11	12
i.	Identify different types of waves by looking into their characteristics.	X	X	X	X	X	X					X	X
ii.	Formulate a wave equation and obtainthe expression for different parameters associated with waves.	X	X	X	X	X	X					X	X
iii.	Explain and give a mathematical treatment of the superposition of waves under different conditions such as when they overlap linearly and perpendicularly	X	X	X	X	X	X					X	X
	with equal or different frequencies and equal or different phases.												
iv.	Describe the formation of standing waves and how the energy is transferred along the standing wave in different applications, and mathematically model in the case of stretched string and vibration of a rod.	X	X	X	X	X	X					X	X
v.	Give an analytical treatment of resonance in the case of open and closed pipes in general and Helmholtz resonators in particular.	X	X	X	X	X	X					X	X
vi.	Describe the different parameters that affect the acoustics in a building, measure it and control it.	X	X	X	X	X	X					X	X
vii.	Give the different models of light propagation and phenomenon associated and measure the parameters like the wavelength of light using experiments like Michelson interferometer interference and thin films.	X	X	X	X	X	X					X	X
viii.	Explain diffraction due to different objects like singles slit, two slits, diffraction grating, oblique incidence, circular aperture and give the theory and experimental setup for the same.	X	X	X	X	X	X					X	X
ix.	Explain the polarization of light and obtain how the polarization occurs due to quarter wave plates, half wave plates, and through the optical activity of a medium.	X	X	X	X	X	X					X	X

WAVE MOTION AND OPTICS -PHCT201

Unit – 1 - Waves and Superposition of Harmonic Waves

Waves: Plane and Spherical Waves. Longitudinal and Transverse Waves. Characteristics of wave motion, Plane Progressive (Travelling) Wave and its equation, Wave Equation – Differential form (derivation). Particle and Wave Velocities: Relation between them, Energy Transport – Expression for intensity of progressive wave, Newton's Formula for Velocity of Sound. Laplace's Correction (Derivation). Brief account of Ripple and Gravity Waves. **(TextBook:1-4)*Problems*** **(5 Hours)**

Superposition of Harmonic Waves: Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats) – Analytical treatment. Superposition of two perpendicular Harmonic Oscillations: Lissajous Figures with equal and unequal frequency- Analytical treatment. Uses of Lissajous' figures. **(Text Book: 1-4)** ***Problems*** **(6 Hours)**

Activities **-2 Hrs**

Activity No. 1	We know that sound is produced because of vibration. Look into at least 10 musical instruments and identify the regions of vibrations that produces the sound and those parts which enhances the sound because of reverberation. 1. Identify one common element in all of these. 2. Identify equipment which creates beats and try to explain the underlying basic principles. Demonstrate the examples of beats using two tuning forks. 3. Identify what will happen when you drop a stone in a standing water, and when your drop two stones side by side. 4. Make your observations sketch them and comment on it in a report.
Activity No. 2	Draw two sine waves (Amplitude vs time) one shifted with other in phase. Identity where the resonation occurs for each phase shift. Plot phase vs time taken for resonance.
Activity No. 3	Take smooth sand, place a pointed edged pen vertically on the sand. To the mid of the pen, connect two perpendicular threads. Pull these perpendicular threads by varying the forces and timings. Note down the different shapes produced on the sand. Try to interpret the shapes. Make a report of it
Activity No. 4	Hang a pot with sand, which has a hole in the bottom. Gently pull the pot on one side and observe the pattern formed by the sand on the floor. Report the observations.
Activity No. 5	Design a coupled pendulum. Study the impact of the motion of one pendulum over the other pendulum by varying the length, direction of the motion of one pendulum and mass of pendulum and observe the resultant changes. Trace the path of the bobs and make a report.

Activity No. 6	**Note for the teachers for the activity:** Make 3 groups among students and assign each group the activity of drawing one of the 3 graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take a stretched spring. Stretch it across two edges. Put a weight on the string, pluck it and measure the amplitude of the vibration. All group will measure the total damping time of oscillating spring. (Using mobile or scale) And plot a graph of the- 1. Varying load on the spring and amplitude at the centre. 2. Take another weight and put that in another place and measure the amplitude of vibration at the centre. Vary the load in the centre of the spring and measure the amplitude at the centre

Unit – 2 - Standing Waves and Acoustics

Standing Waves: Velocity of transverse waves along a stretched string (derivation), Standing (Stationary) Waves in a String - Fixed and Free Ends (qualitative). Theory of Normal modes of vibration in a stretched string, Energy density and energy transport of a transverse wave along a stretched string. Vibrations in rods – longitudinal and transverse modes (qualitative). Velocity of Longitudinal Waves in fluids and gases (derivation). Normal Modes of vibrations in Open and Closed Pipes – Analytical treatment. Concept of Resonance, Theory of Helmholtz resonator. **(Text Book: 1-4)** ***Problems*** **(8 Hours)**

Acoustics: Absorption coefficient, Reverberation and Reverberation time, Sabine's Reverberation formula (derivation), Factors affecting acoustics in buildings, Requisites for good acoustics. Acoustic
measurements – intensity and pressure levels. **(Text Book: 1-4)** **(3Hours)**

Activities 2 Hrs

Activity No. 7	List different phenomenon where standing waves are found in nature. Identify the phenomena and reason for standing waves. Also identify the standing waves in musical instruments. Make a report.
Activity No. 8	**1.** Go to 5 different newly constructed houses when they are not occupied and when they are occupied. Make your observations on sound profile on each room. Give the reasons. Make a report**.** **2.** Visit three very good auditoriums, list out different ways in which the acoustic arrangements have been done (as decoration and Civil works).Look for the reasons in Google and identify which is acoustically the best auditorium among the three you visited. Make a report.
Activity No. 9	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO4) solution. Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop a marble on the liquid at the centre of the bowl. Repeat the experiment by dropping the marble from the different heights. Plot a graph of- 1. Height v/s time of oscillation 2. Weight of the marble v/s time of oscillation
Activity No. 10	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take two marble of same weight. Drop both the marbles on the surface of the liquid from some height. With the help of the mobile take the picture and measure the position of interface of two wave fronts formed in the liquid. Plot graphs for different activities by doing the following activities.

	4. By dropping two marbles of same weight from different heights. 5. By dropping two marbles of different weight from the same height

Unit – 3 - Nature of light and Interference

Nature of light: To Determine wavelength of light, distances and shapes using Michelson interferometer. The corpuscular model of light-The wave model - Maxwell's electromagnetic waves- Wave Particle Duality **(Text Book No 5; Sections 2.1 to 2.4 and 2.8)**

(2 Hours)

Interference of light by division of wave front: Huygen's theory-Concept of wave-front- Interference pattern produced on the surface of water-Coherence-Interference of light waves by division of wave-front- Young's double slit experiment- derivation of expression for fringe width-Fresnel Biprism- Interference with white light (Text Book No 5; Sections 12.1 to 12.2, 14.1 to 14.5, 14.7 to 14.9) ***Problems*** **(4 Hours)**

Interference of light by division of amplitude: Interference by division of amplitude-Interference by a plane parallel film illuminated by a plane wave-Interference by a film with two non-parallel reflecting surfaces- color of thin films—Newton's rings-(Reflected light)-Michelson Interferometer-Determination of wavelength of light* (Text Book No 5; Sections 15.1 to 15.2, 15.8 to 15.11) ***Problems*** **(5 Hours)**

Activity **2 Hrs**

Activity No. 11

In the table given below explore which phenomenon can be explained by what and Make a report**.**

Sl no	Phenomenon	Particle nature	Wave nature	Dual nature
1.	Pin hole camera			
2.	Images in lenses			
3.	Images in mirrors			
4.	Interference			
5.	Polarisation			
6.	Diffraction			
7.	Black body radiation			
8.	Photo electric effect			
9.	Debroglie concept			
10.	Davission and Germer expt			

Activity No. 12	Why colour strips are seen in paddles on roads in rainy seasons try to simulate the same. Give the reasons. Make a report**.**

Activity No. 13	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO4) solution. Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop two marbles of same weight (mass) from the same height on to the surface of the water but at the different time intervals. Plot graph for the different observations. **For teachers:** Demonstrate the formation of Lissajous Figure using a CRO. Give different shapes of Lissajous Figure with varying frequency and amplitude. Ask the students to comment on the observations.

Unit – 4 - Diffraction and Polarisation

Fraunhofer diffraction: Introduction- Fraunhofer diffraction- Single slit diffraction pattern- position of Maxima and Minima (Qualitative arguments)- Two slit diffraction pattern- position of Maxima and minima- Theory of plane diffraction Grating-Grating spectrum- normal and oblique incidence-Resolving power and dispersive power of a grating Single slit; Double Slit. Multiple slits & Diffraction grating. (Text Book No 5; Sections 18.1 to18.2,18.6,18.8to18.9)**(qualitativ)** **(4 Hours)**

Fresnel Diffraction- Fresnel half period zones-Diffraction by a circular aperture-diffraction by an opaque disc-The zone plate - comparison between zone plate and convex lens. Polaroids (Text Book No 5; Sections 20.1 to 20.3) **(Qualitative)**

(3 Hours)

Polarisation: Introduction-Production of polarized light- The wire Grid polarizer and Polaroid- Superposition of two disturbances- Phenomenon of double refraction-Quarter wave plates and half wave plates- Analysis of polarized light-optical activity**.** (Text Book No 5; Sections 22.1, 22.3,22.4,22.6 to 22.8**)** **(4 Hours)**

Activities 2 Hrs

Activity No. 14	Explain polarization of light through a chart. List out the surfaces that reflect polarized light. Learn how polarization of light can be done by both transmission and reflection. Perform an experiment and make a report. USING CDs AND DVDs AS DIFFRACTION Gratings Ref:https://www.nnin.org/sites/default/files/files/Karen_Rama_USING_CDs_AND_DVDs_AS_DIFFRACTION_GRATINGS_0.pdf Obtain the diffraction spectra using a CD and design an experiment to find the distance between the tracks on it) (Ref: https://www.brighthubeducation.com/science-lessons-grades-9-12/39347-diffraction-experiment-measuring-groove-spacing-on-cds/, https://silo.tips/download/diffraction-from-a-compact-disk)
Activity No. 15	What is the physics behind making 3D movies? Group Discussion (https://www.slideserve.com/rae/physics-behind-3d-movies-powerpoint-ppt-presentation) Make a report.
Activity No. 16	List out different types of zone plates and look for their applications in day-to- day life. Make a report.
Activity No. 17	Collect information and study how optically polarizing lenses are made. Visit a nearby lens making facility. Learn the principle behind sunglasses. Make a report.
Activity No. 18	**Note for the teachers for the activity:** Make 3 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Identify any 3 sharp edges of varying thickness and assign them to 3 groups. Shine a laser light pointing towards the edge of the needle. Observe the patterns formed on the wall or screen and measure the distance between the bands. Correlate the distance between the bands formed with the thickness of the edge and the distance from the edge to the screen. By this, calculate the wavelength of the laser light used.

Textbooks				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1.	The Physics of Waves and Oscillations,	N K Bajaj	Tata McGraw-Hill Publishing Company Ltd., Second Edition,	1984
2.	Waves and Oscillations	N Subramanyam and Brij Lal	Vikas Publishing House Pvt. Ltd., Second Revised Edition	2010
3.	A Text Book of Sound	D R Khanna and R S Bedi	Atma Ram & Sons, Third Edition	1952
4.	Oscillations and Waves	Satya Prakash	Pragathi Prakashan, Meerut, Second Edition	2003
5.	Optics	Ajoy Ghatak	McGraw Hill Education (India) Pvt Ltd	2017
6.	A text Book of Optics	Brij Lal, M N Avadhanulu & N Subrahmanyam	S. Chand Publishing	2012

References Books				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1.	Berkeley Physics Course – Waves,	Frank S Crawford Jr.	Tata Mc Graw-Hill Publishing Company Ltd., Special Indian Edition	2011
2.	Optics	Eugene *Hecht*	Pearson Paperback	2019
3.	Introduction To Optics	Pedrotti and Frank L ,	Pearson India	3rd Edition
4.	Fundamentals of Optics	Francis Jenkins Harvey White	McGraw Hill Education	2017

Core Practicals -III-PHCP-201

List of Experiments to be performed in the Laboratory ***(Minimum 8 (Eight) experiments must be performed)**	
1.	Velocity of sound through a wire using Sonometer.
2.	Frequency of AC using Sonometer.
3.	Study of Lissajous' Figures: Phase analysis at different phases.
4.	To verify the laws of transverse vibration using Melde's apparatus.
5.	Helmholtz resonator using tuning fork.
6.	Helmholtz resonator using electrical signal generator.
7.	To determine refractive index of the Material of a prism using sodium source.
8.	To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
9.	To determine the wavelength of sodium source using Michelson's interferometer.
10.	To determine wavelength of sodium light using Fresnel Biprism.
11.	To determine wavelength of sodium light using Newton's Rings
12.	To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
13.	To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating. (Minimum deviation method)
14.	To determine resolving power of a plane diffraction grating.
15.	To determine dispersive power of a plane grating. (Normal incidence method)
16.	Determination of refractive index of a prism using Brewster's law.
17.	Determination of specific rotation of sugar solution using polarimeter.
18.	Diffraction at a straight wire in optic bench.
19	Speaker Characteristics
20	Computer simulation experiment

Reference Book for Laboratory Experiments				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1.	Advanced Practical Physics for students	B.L. Flint and H.T. Worsnop	Asia Publishing House.	1971
2.	A Text Book of Practical Physics	I. Prakash & Ramakrishna	Kitab Mahal, 11th Edition	2011

3.	Advanced level Physics Practicals	Michael Nelson and Jon M. Ogborn	Heinemann Educational Publishers, 4th Edition	1985
4.	A Laboratory Manual of Physics for undergraduate classes	D.P.Khandelwal	Vani Publications.	1985

Additional Books

- University Physics by Sears Zemansky
- Engineering Physics by Jewett and Servey
- Optics by Satyaprakash

OPEN ELECTIVES

Open Elective 3 **SEMESTER 3/4** **3 Hrs Per week**

CODE NO: PHOE201/251
PHYSICS IN DIALY LIFE-FOR NON -SCIENCE STUDENTS

Objectives

- To understand the nature by applying laws of Physics
- To study the Physics behind different appliances
- To gain the knowledge on super conductivity and radiation

Programme Outcomes:

PO - 1 Discipline Knowledge: Knowledge of science and ability to apply to relevant areas.

PO - 2 Problem solving: Execute a solution process using first principles of science to solve problems related to respective discipline.

PO - 3 Modern tool usage: Use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.

PO - 4 Ethics: Apply the professional ethics and norms in respective discipline.

PO - 5 Individual and teamwork: Work effectively as an individual as a team member in a multidisciplinary team.

PO - 6 Communication: Communicate effectively with the stake holders, and give and receive clear instructions.

Course Outcomes (COs)	1	2	3	4	5	6
CO-1: To understand the phenomenon taking place in natureand use physical reasoning to explain astronomical phenomena	x					
CO-2: understand Newton's laws of motion and the role they play in predicting motion.	x	x				
CO-3: To understand the concept and significance of physical phenomena in accoustics, optics ,heat and thermodynamics	x					x
CO-4: Will acquire the knowledge of regulator, chokes and electrical appliances	x	x	x			
CO-5: Will understand the working principle of lightning arrestor, mixer, grinder	x		x			
CO-6 Students shall be able to understand principles and applications associated with general physics as applied to a broad range of aspects of everyday life.	x		x			x
CO-7: To understand the concept of laser principles and applications	x		x			
CO-8: Students shall be able to understand biological effects of radiations	x					

Unit I

PHYSICS IN NATURE

Introduction to environmental Physics-Our Environment, Constituents of Environment-Planetary motion atmospheric pressure, eclipses, **4 hours**

Light-propagation-reflection-refraction-mirages-total internal reflection-optical fibres 2 hours

Newton's laws of motion: Illustrations for three laws, Inertia, gravity and conservation of angular momentum (Recoiling of gun, launching rockets), friction, working of lubricants, weightlessness, frame of reference: Relative motion **5 hours**

Surface tension, viscosity, consequences capillarity: Applications Energy: Kinetic and potential energy, conservation of energy examples

Sound: production and propagation, Resonance, Echo, ultrasonic, applications, basics of acoustics **4 hours**

UNIT-II PHYSICS IN APPLIANCES

Working of switches (1-way 2-way), Principle and working of regulator, principle and working of starter and chokes, Domestic wiring -Application of Fuses, ELCB (Earth Leakage Circuit Breaker) **4 hours**

Principle and working of lightning arrester-precautions during lightning-, Principle and working of Iron box, induction coil- Principle and working of filament bulb, tube light, fluorescent bulb and LED bulbs, **5 hours**

Working of ceiling & table fan, working of Mixer and Grinder, Working of Fridge/ AC/-washing machine. Smart electrical devices. Electricity saving technique **4 hours**

UNIT III
RECENT TRENDS IN PHYSICS

Types of Radiations: Ionising and Non ionising radiations, Thermal radiations, Usage and impact. Radiation Hazards, Radiation Safety measures, Applications of radioactive elements. Nuclear Reactors, applications **5 hours**

Heat and thermodynamics: conduction, convection, working principle of pressure cooker, microwave ovens, effects of heat absorption-examples **4 hours**

Superconductivity, Applications, Laser Principles and Applications, Nanotechnology: Medical and Military applications of Physics **4 hours**

Activity

- Hands on training of electrical Equipments by experts
- Opening some electrical devices and understanding the construction and working

- Visiting nearby workshops / laboratories

Reference Books

1. Fundamentals of Environmental Physics by N K Mahapathra
2. Fundamental concepts in environmental studies by DD Mishra
3. Astronomy- the Evolving Universe III Edition (Harper and Row) by Felik M
4. Heat and thermodynamics: Brijlal N Subramanyam,P S Hemne
5. A text book of optics: N Subramanyam, Brijlal
4. Dawn of Universe by BimaNath
5. Sky watching by David H. Levy
6. Modern Physics by R. Murugeshan
7. Nuclear Physics by S. N. Ghoshal

OPEN ELECTIVES

Open Elective 3 **SEMESTER 3/4** **3 Hrs Per week**

CODE NO: PHOE202/252

ELECTRICAL AND ELECTRONIC DEVICES -FOR SCIENCE STUDENTS

Objectives

- To study the working principle of electrical and electronics devices
- To gain the knowledge on basics of measuring techniques
- To study about CRO

Programme Outcomes

PO - 1 Discipline Knowledge: Knowledge of science and ability to apply to relevant areas.

PO - 2 Problem solving: Execute a solution process using first principles of science to solve problems related to respective discipline.

PO - 3 Modern tool usage: Use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.

PO - 4 Ethics: Apply the professional ethics and norms in respective discipline.
PO - 5 Individual and teamwork: Work effectively as an individual as a team member in a multi-disciplinary team.

PO - 6 Communication: Communicate effectively with the stake holders, and give and receive clear instructions

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs)	1	2	3	4	5	6
CO-1: Will be able to understand working principle of electronic devices	**x**	**x**				
CO-2: Will be able to understand working principle of electrical devices	**x**	**x**				
CO-3: will understand mobile communication process	**x**	**x**	x			
CO-4: Will acquire the knowledge of digital cameras and digital storage techniques	**x**		x			x
CO-5: Will understand the working principle of lightning arrestor	**x**	x	x			
CO-6: Will acquire the knowledge on measuring instruments	**x**		x	x	**x**	**x**
CO-7: Will be able to explain the working principle of CRO	**x**	**x**		x		**x**
CO-8: Will be able to understand the use of CRO for measuring	**x**					**x**

Unit -I

Working Principle of electronic devices

Electric current, Ohms law, emf, Electric Power, KWh, generator, reactance, impedance, capacitor, inductor, choke & transformer. Introduction to Current and voltage measuring instruments: AC & DC Ammeter, AC & DC Voltmeter, watt hour meter, Potentiometer, Multi meter, Basic working principle of Radio/TV /-Mobile phones-Chargers-remote controllers- Blue tooth-2G/3G/5G Concepts-GPRS-Digital devices –digital measuring instruments-digital display-Digital camera-Resolution–Pixels-advantages and limitations-Digital Zoom-Optical Zoom. Digital storage devices-CD/DVD/Pen drive..BLEC **13hrs**

Unit II

Working Principle of Electrical devices

Working of switches (1-way 2-way), Principle and working of regulator, principle and working of starter and chokes, Domestic wiring -Application of Fuses, ELCB (Earth Leakage Circuit Breaker) Principle and working of lightning arrester-precautions during lightning-, Principle and working of Iron box, Mixer grinder-induction coil- Principle and working of filament bulb, tube light, fluorescent bulb and LED bulbs, Working of ceiling & table fan, working of Mixer and Grinder, Working of Fridge/ AC/-washing machine. Smart electrical devices. **13 Hrs**

Unit III

Basics of Measurements: Instrument accuracy, precision, sensitivity, resolution range etc. Errors in measurements and loading effects. Multimeter: Principles of measurement of dc voltage and dc current, ac voltage, ac current and resistance. Specifications of a multimeter and their significance. Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity

Cathode Ray Oscilloscope: Block diagram of basic CRO. Construction of CRT, Electron gun, electrostatic focusing and acceleration (Explanation only no mathematical treatment), Specifications of a CRO and their significance. Use of CRO for the measurement of voltage (dc and ac frequency, time period) e waste management, Laser applications **13hrs**

Activity:

- Opening some electronic devices and understanding the construction and working
- Opening electrical devices and understanding the construction and working
- Studying all functions of multimeter
- Using multimeter for measurement of different electrical parameters
- Opening an old CRO and studying its construction
- Visiting nearby work-shops /laboratories
- List out the least counts of different instruments

- Design a voltage regulator with out put 5 V
- List out different sensors used in electronic appliances

Reference Books:

1. A text book in Electrical Technology - B L Theraja - S Chand and Co.
2. Performance and design of AC machines - M G Say ELBS Edn.
3. Digital Circuits and systems, Venugopal, 2011, Tata McGraw Hill.
4. Logic circuit design, Shimon P. Vingron, 2012, Springer.
5. Digital Electronics, Subrata Ghoshal, 2012, Cengage Learning.
6. Electronic Devices and circuits, S. Salivahanan& N. S.Kumar, 3rd Ed., 2012, Tata Mc-GrawHill.
7. Electronic circuits: Handbook of design and applications, U.Tietze, Ch.Schenk, 2008,Springer 8. Electronic Devices, 7/e Thomas L. Floyd, 2008, Pearson
8. Electrical Engineering, MV Rao, Subhas Stores Books Corner, 2013
9. Electrical Wiring, SL Uppal, GC Gang, Khanna, 1986
10. Electrical Engineering, NL Anwani, Dhanpat Rai& Sos, 1978

Semester – IV Thermal Physics and Electronics	
Course Title: Thermal Physics and Electronics-PHCT-251	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Objectives

- To study the laws of Thermodynamics
- To study kinetic theory of gases
- To understand the working of different semiconductor devices
- To gain the knowledge on digital electronics

Course Learning Outcomes	
At the end of the course students will be able to:	
i.	Apply the laws of thermodynamics and analyze the thermal system.
ii.	Apply the laws of kinetic theory and radiation laws to the ideal and practical thermodynamics systems through derived thermodynamic relations.
iii.	Use the concepts of semiconductors to describe different Semiconductor devices such as diode transistors, BJT, FET etc. and explain their functioning.
iv.	Explain the functioning of OP-AMPS and use them as the building blocks of logic gates.
v.	Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits.

Course Articulation Matrix

Mapping of Course Outcomes (CO) Program Outcomes

Course Outcomes / Program Outcomes		1	2	3	4	5	6	7	8	9	10	11	12
i.	Apply the laws of thermodynamics and analyze the thermal system.	X	X	X	X	X	X					X	X
ii.	Apply the laws of kinetic theory and radiation laws to the ideal and practical thermodynamics systems through derived thermodynamic relations.	X	X	X	X	X	X					X	X
iii.	Use the concepts of semiconductors to describe different Semiconductor devices like diode transistors, BJT, FET	X	X	X	X	X	X					X	X

	etc. and explain their functioning.												
iv.	Explain the functioning of OP-AMPS and them as the building blocks of logic gates.	X	X	X	X	X	X					X	X
v.	Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits.	X	X	X	X	X	X					X	X

UNIT -1

Laws of Thermodynamics:

Review of the concepts of Heat and Temperature. **(1 Hour)**

First Law of Thermodynamics: Differential form, Internal Energy. Equation of state for an adiabatic process, Work Done during Isothermal and Adiabatic Processes. **(3Hours)**

Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Reversible and Irreversible processes with examples. Heat Engines: Carnot engine & efficiency (no derivation). Refrigeration & coefficient of performance, Applications of Carnot engine in locomotion, Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. Concept of Entropy, Second Law of Thermodynamics in terms of Entropy **(5 Hours)**

Third Law of Thermodynamics: Statement, Significance and Unattainability of Absolute Zero. ***Problems*** **(2Hours)**

Activity **2 Hours**

Activity No. 1	I feel cold because coldness enters my body. Discuss the statement in day-to-day life. Approximately give examples of **(i)** open system **(ii)** closed system and **(iii)** isolated system Discuss when the temperature of the body is locked until what time you hold the thermometer in contact with a body. Discuss it in contact with laws of thermodynamics. Discuss why when a person works or does exercise, he sweats. Reason it with the laws of thermodynamics.

Activity No. 2	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. **(i)** The first slide will explain the process of doing the experiment. **(ii)** In the second slide. Students will show the graph of measurement. **(iii)** In the third slide, they will list three observations from that study. **Activity:** Take four different sizes of same metal, preferable of same shape and give one piece to each group. Heat it uniformly on a hot plate. Keep a beaker of water with a thermometer immersed in it. Drop one hot metal into the water and record the temperature with time. Repeat the experiment for the other heated metal pieces of different sizes. **(i)** Plot a graph for the volume of the metal piece used v/s respective temperature change observed. **(ii)** Determine the heat capacity and specific heat of the metal used.
Activity No. 3	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. **(i)** The first slide will explain the process of doing the experiment. **(ii)** In the second slide. Students will show the graph of measurement. **(iii)** In the third slide, they will list three observations from that study. **Activity:** Take ice cubes of different size and immerse in water and measure the temperature change with time and repeat the experiment. Graph the observations.

UNIT II

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Properties and Applications. **(1 Hour)**

Maxwell's Thermodynamic Relations: Derivations and applications of Maxwell's Relations (1) First order Phase Transitions with examples, Clausius - Clapeyron Equation (2) Values of Cp-Cv (3) Joule-Thomson Effect and Joule-Thomson coefficient and Derive an equation for Vander Walls gas. Attainment of low temperature by liquefaction of gases and adiabatic demagnetization. **(3 Hours)**

Kinetic Theory of Gases: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas: Mean, RMS and Most Probable Speeds. Degrees of Freedom, Law of Equipartition of Energy. Specific heats of Gases. **(2 Hours)**

Radiation: Blackbody radiation, spectral distribution, the concept of energy density and pressure of radiation, Wien's law, Wien's displacement law, Stefan-Boltzmann law, Rayleigh-Jeans law, Ultraviolet Radiation catastrophe and Planck's law of radiation.

Problems **(5 Hours)**

Activities -2 Hrs

Activity No. 4	**(i)** Measuring the Solar Constant Materials: Simple flat sided Jar and Thermometer. Activity: Bottle containing water is exposed to solar radiation. The rise in temperature and time taken are noted. Calculate the heat absorbed by water and relate it to the output of the Sun. **(ii)** Thermo emf Materials: Suitable two dissimilar metal wires, voltage measuring device. Activity: In this experiment student will assemble the thermocouple and study the three effects namely, Seebeck, Peltier, and Thompson. **(iii)** Inverse square law of radiation Materials: A cardboard with a grid, cardboard with a hole, supporting clips, a ruler, candle. **(iv)** Activity: Students set the device. They count the lighted squares on the cardboard with the grid by varying the distance. And make necessary measurements and calculations to arrive at the inverse square law of radiation. Ref: Activity Based Physics Thinking Problems in Thermodynamics: Kinetic Theory http://www.physics.umd.edu/perg/abp/think/thermo/kt.htm
Activity No. 5	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. **(i)** The first slide will explain the process of doing the experiment. **(ii)** In the second slide. Students will show the graph of measurement. **(iii)** In the third slide, they will list three observations from that study. **Activity:** Take two dissimilar metal wires. Spot weld them forming two junctions. Dip one junction in ice and heat the other junction with a burner. Plot a graph of time of heating v/s Thermo EFM generated in the voltmeter.

Activity No. 6	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. **(i)** The first slide will explain the process of doing the experiment. **(ii)** In the second slide. Students will show the graph of measurement. **(iii)** In the third slide, they will list three observations from that study. **Activity:** Make 4 groups and give different-sized balloons to each group. Fit different-sized nozzles into the mouth of the large balloons. Measure the temperature or the EMF generated using a thermocouple placed at the mouth of the nozzle as the pressurised gas is released. Plot a graph of time v/s temperature. Vary the volume of the balloon and repeat the experiment. Plot the graph of volume v/s temperature difference created.

Unit III

Semiconductor devices: Review of Intrinsic and Extrinsic semiconductors, p-n junction and its Characteristics (p-n, zener, LED and tunnel diode characteristics comparison) and Parameters, Diode approximations (applications of above diodes as per the respective graphs), Half-wave rectifier, Full-wave rectifier, Zener diode voltage regulators: Regulator circuit with no load, Loaded Regulator. **(5 hours)**

Junction Transistors: Basics of Bipolar Junction Transistors (BJT), BJT operation, Common Emitter mode characteristics, [Common Base and Common Collector Characteristics (qualitative)]. Field Effect Transistor (FET) and MOSFET and its characteristics [J-FET only]. Transistor as an Amplifier [CE mode: voltage divider bias, DC load line, Q point, CE amplifier construction and frequency response]and Oscillator [RC phaseshift oscillator and wein bridge oscillator (CEmode)].**Problems**

6 Hrs

Activity No. 7	Wire a regulated DC power supply on a bread board or groove board to give a regulated output voltage of + 5 V; +15 V; Dual power output : ± 5 V; Dual power output : ± 15 V. Use: 3-pin voltage regulators. Components required: 1. Step down transformer- 1 No. (5 V tapping, 100 – 500 mA current rating), BY 127 semiconductor diodes – 4 Nos, Inductor -1, Capacitor - 1, 3 pin 5V regulator-1 Search for circuit diagram in books/net. **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. **(i)** The first slide will explain the process of doing the experiment. **(ii)** In the second slide. Students will show the graph of measurement. **(iii)** In the third slide, they will list three observations from that study. **Activity:** Form 3 groups and tell them to make a DC supply of low current of different voltages like 5V, 10V, and 15V on a breadboard
Activity No. 8	**(i)** Learn to identify the terminals of different types (packages) of BJTs. **(ii)** In the case of power transistors, learn how to fix a heat sink for the transistor. **(iii)** Learn the difference between BJT and FET in its operational characteristics.
Activity No. 9	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. **(i)** The first slide will explain the process of doing the experiment. **(ii)** In the second slide. Students will show the graph of measurement. **(iii)** In the third slide, they will list three observations from that study. **Activity:** Take any 3 diode and assign one to each group. Measure its resistance when dipped in ice and heating the ice till it boils. Using this data, plot calibration curve of temperature v/s resistance and also the cooling curve of temperature V/s time for the diode by each group.

UNIT IV

Electronics: Integrated Circuits (Analog and Digital), Operational Amplifier, Ideal characteristics of Op-Amp, Inverting and Non-Inverting Configurations. Applications-Voltage Follower, Addition and Subtraction. **(4 hours)**

Digital: Switching and Logic Levels, Digital Waveform. Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary. **(3 hours)**

Boolean Algebra Theorems: De Morgan's theorem. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate, NOR Gate, Algebraic Simplification, Implementation of NAND and NOR functions. ***Problems*** **(4 hours)**

Activity **2 Hrs**

Activity No. 10	Learn how to implement logic functions (AND, OR, NOT) using just diodes and resistors. With a circuit diagram show how different types of gates can be built by X-NOR gates.
Activity No. 11	**Operational Amplifiers** **(i)** Understand the concept of virtual ground of an OP-AMP. **(ii)** Learn the different types of op-amps used for different applications. **(iii)** What is a buffer? Prepare a report on buffers and its application in instrumentation electronics.
Activity No. 12	**(i)** A man has to take a wolf, a goat, and some cabbage across a river. His rowboat has enough room for the man plus either the wolf or the goat or the cabbage. If he takes the cabbage with him, the wolf will eat the goat. If he takes the wolf, the goat will eat the cabbage. Only when the man is present are the goat and the cabbage safe from their enemies. All the same, the man carries wolf, goat, and cabbage across the river. How? Write the truth table for the above story and implement using gates. **(ii)** A locker has been rented in the bank. Express the process of opening the locker in terms of digital operation. **(iii)** A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by and one of the switches irrespective of the state of the other switch. The logic of switching of the bulb resembles.

Textbooks	
Sl No	**Title of the Book**
1.	Electronic Devices and Circuits, David A. Bell, 2004, PHI, New Delhi
2.	Integrated Electronics, Jacob Millman and CC Halkias
3.	Digital Fundamentals, Floyd, 2001, PHI, New Delhi

References Books	
Sl No	**Title of the Book**
1.	Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2.	Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
3.	A Treatise on Heat, Meghnad Saha, and B.N.Srivastava, 1958, Indian Press
4.	Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.
5.	Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6.	An Introduction to Thermal Physics, Daniel V Schroeder, 2020, Oxford University Press

Physics Core Practical -IV-PHCP251

List of Experiments to be performed in the Laboratory ***(Minimum 8 (Eight) experiments must be performed)**	
1.	Mechanical Equivalent of Heat by Callender and Barne's method.
2.	Coefficient of thermal conductivity of Copper by Searle's apparatus.
3.	Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
4.	Determination of Stefan's constant/ Verification of Stefan's law.
5.	Variation of thermo-emf across two junctions of a thermocouple with temperature.
6.	Verification of Clausius –Clapeyron equation and determination of specific enthalpy.
7.	V-I Characteristics of Silicon / Germanium p-n Junction diodes (FB & RB of p-n diode, FB of LED).
8.	Characteristics of BJT in Common Emitter Configuration(Input and Output characteristics).
9.	Half wave rectifier without & with filter (no filter C- filter, LC- filter and - filter).
10.	Applications of Operational Amplifier [(Non-inverting, inverting and differential amplifier (DC)]
11.	Transfer characteristics of a TTL gate using CRO.
12.	V-I Characteristics of zener diode and zener voltage regulator (line & load regulation)
13.	Construction of CE amplifier and study the frequency response.
14.	Construction of CC amplifier and study the frequency response.
15.	Full wave rectifier without & with filter (no filter C- filter, LC- filter and - filter).
16.	OPAMP applications: Adder, subtractor and voltage follower/differentiator/integrator

17.	Construction and verification of truth tables of OR, AND, NOT, NOR & NAND gates using discrete components.
18.	Construction and verification of truth tables of OR, AND, NOT, NOR & NAND gates using IC 7400.
19.	Verification of truth tables of De Morgan's theorems (for two input variables).
20	TTL Gates
21	Wien Bridge oscillator
22	Computer simulation experiment

Reference Book for Laboratory Experiments	
Sl No	**Title of the Book**
1.	Basic Electronics Lab (P242) Manual 2015-16, National Institute of Science Education and Research, Bhubaneswar, 2015.
2.	**Suggested Readings:** 1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e. 2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e. 3 Electronics-by Boylsted 4 Basic Electronics-by V K Mehta

Semester – V Paper- V Classical and Quantum Mechanics	
Course Title: Thermal Physics and Electronics-PHCT-301	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course Outcomes (COs): **After the successful completion of the course, the student will be able to**

- Identify the failure of classical physics at the microscopic level.
- Find the relationship between the normalization of a wave function and the ability to correctly calculate expectation values or probability densities.
- Explain the minimum uncertainty of measuring both observables on any quantum state.
- Describe the time-dependent and time-independent Schrödinger equation for simple potentials like for instance one-dimensional potential well and Harmonic oscillator.
- Apply Hermitian operators, their eigenvalues and eigenvectors to find various commutation and uncertainty relations.

Topic Learning Outcomes At the end of the topic, students should be able to:

SL No	TLO's	BL	CO	PO
	What are inertial and non-inertial frames of references ?	L2	8	1-6, 11-12
	Is inertial mass same as gravitational mass ?	L2	8	1-6, 11-12
	Law of conservation of linear momentum is a consequence of Newton's first law ?	L2	8	1-6, 11-12
	When do you say force is conservative?	L2	8	1-6, 11-12
	Explain angular momentum conservation by taking earth satellite as an example.	L2	8	1-6, 11-12
	"Absolute value of potential and kinetic energies has no meaning" comment.	L2	8	1-6, 11-12
	How are refraction and reflection by the ionosphere possible?	L2	9	1-6, 11-12
	What is the centre of mass frame of reference?	L2	9	1-6, 11-12
	Is mass necessary at the centre of mass in case of a solid body?	L2	9	1-6, 11-12
	Explain the principle of a rocket.	L2	9	1-6, 11-12
	Explain holonomic and non-holonomic constraints.	L2	8	1-6, 11-12
	What is meant by degrees of freedom ?	L2	8	1-6, 11-12
	What are generalize coordinates?	L2	8	1-6, 11-12

	State and explain D'Alembert's principle	**L2**	**8**	**1-6, 11-12**
	What are the first integrals of motion?	**L2**	**8**	**1-6, 11-12**
	What are velocity dependent potentials?	**L2**	**8**	**1-6, 11-12**
	What is a dissipation function?	**L2**	**9**	**1-6, 11-12**
	State and explain Hamilton's principle	**L2**	**9**	**1-6, 11-12**
	Explain D'Alembert's principle in integral form	**L2**	**9**	**1-6, 11-12**
	Explain the significance of Lagrange's multiplier constant.	**L2**	**9**	**1-6, 11-12**
	Explain the Euler-Lagrange differential equation in the calculus of variation	**L2**	**8**	**1-6, 11-12**

Classical Mechanics

Unit-I

Introduction to Newtonian Mechanics: Frames of references (Definition), Newton's laws of motion (statement), inertial and non-inertial frames (Statement). Mechanics of a particle: Conservation of linear momentum (Derivation), Angular momentum and torque, (Relation) conservation of angular momentum,(Derivation) work done by a force, conservative force and conservative energy.(Statement with equation)

Lagrangian formulation: Constraints, Holonomic constraints, non-holonomic constraints, Scleronomic and Rheonomic constraints (Statement, Differences and examples).

Generalized coordinates (statement).Degrees of freedom (Statement).Principle of virtual work (Derivation).D'Alembert's principle,(Derivation). Lagrange equations (qualitative). Newton's equation of motion from Lagrange equations (Derivation). Examples i: simple pendulum (Derivation) ii: Atwood's machine (Derivation) and iii: linear harmonic oscillator (Derivation) problems (13 hours)

Unit-II

Variational principle: Hamilton's principle (Statement), Deduction of Hamilton's principle (Derivation), Lagrange's equation of motion from Hamilton's principle (Derivation), (Examples same as Lagrangian) Hamilton's principle for non-holonomic systems. (Qualitative).

Hamiltonian Mechanics: The Hamiltonian of a system (statement), Hamilton's equations of motion,(Derivation) Hamilton's equations from variational principle, (derivation) Integrals of Hamilton's equations, energy integrals (Expression), Canonical Transformations (quantitative),

Poison Brackets (Qualitative), fundamental properties and equations of motion in Poison Brackets (Derivation), Problems. (13 hours)

Reference Books:

- Classical Mechanics, H.Goldstein, C.P. Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
- Classical Mechanics: An introduction, Dieter Strauch, 2009, Springer
- Classical Mechanics, G. Aruldhas, 2008, Prentice-Hall of India Private limited, New Delhi.
- Classical Mechanics, Takwale and Puranik-1989, Tata Mcgraw Hill, new Delhi

Activities

Atwood's Machine

Everyone is fascinated by pulleys. In this Interactive, learners will attach two objects together by a string and stretch the string over a pulley. Both an Atwood's machine and a modified Atwood's machine can be created and studies. Change the amount of mass on either object, introduce friction forces, and measure distance and time in order to calculate the acceleration.

Newton's Laws of Motion

Force

When forces are unbalanced, objects accelerate. But what factors affect the amount of acceleration? This Interactive allows learners to investigate a variety of factors that affect the acceleration of a box pushed across a surface, The amount of applied force, the mass, and the friction can be altered. A plot of velocity as a function of time can be used to determine the acceleration.

In the Balloon Car Lesson Plan, students build and explore balloon-powered cars. This lesson focuses mostly on energy, but it also demonstrates Newton's laws of motion. Guidance is provided for talking specifically about the third law of motion. *Question*: how does the air escaping the balloon relate to Newton's third law of motion? Does the car continue to coast after the balloon is deflated? Why or why not?

Most of the activities and lessons below *focus* on one or two of the laws of motion. The Build a Balloon Car activity specifically **talks about all three of Newton's laws of motion** students can observe when building and experimenting with a simple balloon-powered car. This is an accessible hands-on activity that uses recycled materials and balloons for a fun combined engineering design project and physics experiment. The activity can be used with a wide range of grade levels to introduce and demonstrate the laws of motion. See the "Digging Deeper" section for a straightforward discussion of how each law of motion can be identified in the balloon car activity. (For a related lesson plan, see Balloon Car Lesson Plan, which is NGSS-aligned for middle school and focuses on the third law of motion.)

In the Push Harder — Newton's Second Law , students build their own cars using craft materials and get hands-on exploring Newton's second law of motion and the equation "force equals mass times acceleration" (F=ma). Options for gathering real-time data include using a

mobile phone and a sensor app or using a meter stick and a stopwatch. *Questions*: What is the relationship between force, mass, and acceleration? As force increases, what happens to acceleration?

In the Skydive, students make parachutes and then investigate how they work to slow down a falling object. As students investigate the forces that are involved, educators can introduce Newton's second law of motion and how different forces change the resulting speed of a falling object. Questions: What forces help slow down the speed of a falling object? How does a parachute help slow the fall?

UNIT 3

Introduction to Quantum Mechanics

Brief discussion about the failure of classical theory of physics in the experimental observations of black body radiation (Qualitative), Photoelectric effect (Quantitative), stability of atoms and spectra of atoms (quantitative),Compton Effect: Compton scattering: Expression for Compton shift (derivation).
Matter waves: de Broglie hypothesis of matter waves,(Definition, relation), Experimental evidence for matter waves: Davisson-Germer experiment, (Quantitative) and its significance.
Electron microscope(Qualitative), Wave description of particles by wave packets, Group velocity, Phase velocity, Particle velocity and relation between them(Definition, derivation),Heisenberg uncertainty principle: Elementary proof of Heisenberg's relation between momentum and position, energy and time, angular momentum and angular position. (Definition, relation, examples).Illustration of uncertainty principle by Gamma ray microscope thought experiment (Derivation), Consequences of the uncertainty relations: why electron cannot exist in nucleus? (Quantative). Diffraction of electrons at a single slit (Derivation), G.P Thomson's experiment Double slit experiment with photons and electrons,(Qualitative**).** **Linear superposition principle as a consequence.(Qualitative)**.Problems

(13 hours)

Activities:

1. Both standard cameras (DSLRs, phone cameras) and our scientific cameras work on the principle of photoelectric effect to produce an image from light, involving the use of photodetectors and sensor pixels. Prepare a report on the working of digital camera.

2. **Demonstration of Heisenberg uncertainty principle in the context of diffraction at a single slit**:

   The uncertainty in the momentum Δp_x correspond to the angular spread of principal maxima Θ.
   Then, $\Delta p_x = \sin\theta \,.\, p$ where $\boldsymbol{p}$ is the momentum of the incident photon.

   Conduct the diffraction at a slit experiment virtually using the following link

   https://www.walter-fendt.de/html5/phen/singleslit_en.htm

1. Measure the angular spread ($\boldsymbol{\theta}$) for different slit widths (Δx) for given wavelength of the incident photon.

2. Determine the momentum of the incident photon using

$$p=\frac{h}{\lambda}$$

3. Create a line of best fit through the points in the plot $\frac{1}{\Delta p_x}$ against Δx and find its slope. How this exercise is related to Heisenberg Uncertainty principle.

Make a report of the observations.

3. Virtual lab to demonstrate Photoelectric effect using *Value@Amritha*:

Conduct the virtual experiment using the following link
https://vlab.amrita.edu/?sub=1&brch=195&sim=840&cnt=1

1. Determine the minimum frequency required to have Photoelectric effect for an EM radiation, when incident on a zinc metal surface.
2. Determine the target material if the threshold frequency of EM radiation is $5.5x10^{15}$ Hz in a particular photoelectric experimental set up.
3. Determine the maximum kinetic energy of photo-electrons emitted from a Zinc metal surface, if the incident frequency is $3x10^{15}$Hz.
4. What should be the stopping potential for photoelectrons if the target Material used is Platinum and incident frequency is $2x10^{15}$Hz?

Make a report of the calculations.

4. Visualization of wave packets using Physlet@Quantum Physics:

The concept of group velocity and phase velocity of a wave packet can be studied using this link
https://www.compadre.org/PQP/quantum-need/section5_9.cfm

Students can take up the exercises using the link which is as follows
https://www.compadre.org/PQP/quantum-need/prob5_11.cfm
Six different classical wave packets are shown in the animations. Which of the wave packets have a phase velocity that is: greater than / less than / equal to the group velocity?

Make a report of the observations.

UNIT 4

Foundation of Quantum Mechanics

Schrödinger equation: time-dependent and time-independent wave equations, (Derivation). Schrodinger wave equation for a free particle in one and three-dimension, (Derivation, problems).Probabilistic interpretation of the wave function: normalization and orthogonality of wave functions(Qualitative). Probability current density, equation of continuity and its

physical significance(Definition, equation)
Postulates of Quantum mechanics: First Postulate representation of states. Second postulates representation of dynamical variable as linear operators (Qualitative). Third postulate as representation of expectation values of operators (Qualitative). Ehrenfest theorem. (Statement and Significance). Eigen values and Eigen functions. (Qualitative)
Particle in a one-dimensional infinite potential well (Derivation), degeneracy in three-dimensional, case (Qualitative). Particle in a finite potential well (Qualitative), Transmission across a potential barrier (Qualitative), the tunnel effect (Qualitative), scanning tunnelling microscope, One-dimensional simple harmonic oscillator (Qualitative) - concept of zero - point energy (Qualitative). Problems 13 Hours

Activities:

1. **Superposition of eigen states in an infinite one - dimensional potential well using QuVis (Quantum Mechanics Visualization Project):**

   Construct different possible states by considering the first three eigen states and study the variation of probability density with position. Take the challenges after understanding the simulation and submit the report**.** The link is as follows

   https://www.standrews.ac.uk/physics/quvis/simulations_html5/sims/SuperpositionStates/SuperpositionStates.html

2. **Determination of expectation values of position, momentum for a particle in a an infinite one - dimensional potential well using Physlet@Quantum Physics:**

   The link to the visualization tool for the calculation is as follows
   https://www.compadre.org/PQP/quantum-theory/prob10_3.cfm

   A particle is in a one-dimensional box of length $L = 1$. The states shown are normalized. The results of the integrals that give $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$. You may vary n from 1 to 10.
   a) What do you notice about the values of $\langle x \rangle$ and $\langle x^2 \rangle$ as you vary n?

   b) What do you think $\langle x^2 \rangle$ should become in the limit of $n \rightarrow \infty$? Why?

   c) What do you notice about the values of $\langle p \rangle$ and $\langle p^2 \rangle$ as you vary n?

   Make a report of the calculations.

3. **Determination of expectation values for a particle in a one-dimensional harmonic oscillator using Physlet@Quantum Physics:**

   The link to the visualization tool for the calculation is as follows
   https://www.compadre.org/PQP/quantum-theory/prob12_2.cfm
   A particle is in a one-dimensional harmonic oscillator potential ($\hbar = 2m = 1$; $\omega = k = 2$). The states shown are normalized. Shown are ψ and the results of the

integrals that give $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$. Vary n from 1 to 10.

a) What do you notice about how $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$ change?
b) Calculate $\Delta x \, . \Delta p$ for $n = 0$. What do you notice considering $\hbar = 1$?
c) What is E_n? How does this agree with or disagree with the standard case for the harmonic oscillator?
d) How much average kinetic and potential energies are in an arbitrary energy state?

Make a report of the calculations.

4. **Calculate uncertainties of position and momentum for a particle in a box using Physlet@Quantum Physics:**

The link to the visualization tool for the calculation is as follows
https://www.compadre.org/PQP/quantum-theory/prob6_3.cfm

A particle is in a one-dimensional box of length $L = 1$. The states shown are normalized. The results of the integrals that give $\langle x \rangle$ and $\langle x^2 \rangle$, and $\langle p \rangle$ and $\langle p^2 \rangle$. You may vary n from 1 to 10.

a. For $n = 1$, what are Δx and Δp?
b. For $n = 10$, what are Δx and Δp?

5. **Write expressions for the three wave functions using Physlet@Quantum Physics:**

The link to the visualization tool for the calculation is as follows
https://www.compadre.org/PQP/quantum-theory/prob8_1.cfm

These animations show the real (blue) and imaginary (pink) parts of three time-dependent energy eigenfunctions. **Assume *x* is measured in cm and time is measured in seconds.**

a. Write an expression for each of the three time-dependent energy eigenfunctions in the form: $e^{i(kx-\omega t)}$.
b. What is the mass of the particle?
c. What would the mass of the particle be if time was being shown in **ms**?

Make a report of the calculations.

6. **If you store a file on your computer today, you probably store it on a solid-state drive (SSD), Make a detailed report on the role of quantum tunnelling in these devices.**

Reference books:

1. Concepts of Modern Physics, Arthur Beiser, McGraw-Hill, 2009.
2. Physics for Scientists and Engineers with Modern Physics, Serway and Jewett, 9th edition, Cengage Learning, 2014.
3. Quantum Physics, Berkeley Physics Course Vol. 4. E.H. Wichman, Tata McGraw-Hill Co., 2008.
4. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, McGraw Hill, 2003.
5. P M Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill publication, ISBN: 9780070146174.

6. Ajoy Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer Publication,ISBN 978-1-4020-2130-5.
7. Modern Physics; R.Murugeshan & K.Sivaprasath; S. Chand Publishing.
8. G Aruldhas, Quantum Mechanics, Phi Learning Private Ltd., ISBN: 97881203363.
9. Gupta, Kumar & Sharma, Quantum Mechanics, Jai Prakash Nath Publications.
10. Physics for Degree Students B.Sc., Third Year, C.L.Arora and P.S.Hemne, 1st edition, S.Chand & Company Pvt. Ltd., 2014.

PRACTICAL V -PHCP 301

Lab experiments: (at least 4 experiments from 1-6 and 4 experiments from 7-16)

1) To determine 'g', the acceleration due to gravity, at a given place, from the L – T 2 graph, for a simple pendulum.
2) Studying the effect of mass of the bob on the time period of the simple pendulum.
3) Determine the acceleration of gravity is to use an Atwood's machine.
4) Study the conservation of energy and momentum using projectile motion.
5) Verification of the Principle of Conservation of Linear Momentum
6) Fine structure constant and dispersive power
7) Determination of Planck constant and work function of the material of the cathode using Photo-electric cell.
8) To study the spectral characteristics of a photo-voltaic cell (Solar cell).
9) Determination of electron charge 'e' by Millikan's Oil drop experiment.
10) To study the characteristics of solar cell.
11) To find the value of e/m for an electron by Thomson's method using bar magnets.
12) Wavelength of Laser by diffraction.
13) To study the tunnelling in Tunnel Diode using I-V characteristics.
14) Determination of quantum efficiency of Photodcell.
15) A code in C/C++/Scilab to find the first seven eigen states and eigen functions of Linear Harmonic Oscillator by solving the Schrödinger equation.
16) A code in C/C++/Scilab to plot and analyse the wavefunctions for particle in an infinite potential well.
17. G M Tube characteristics
18. Simulation Experiment

19) Damped oscillations
20) Monte-Carlo experiment
21) Study of tunnel diode as oscillator
22) FET Characteristics
23) FET CS amplifier
24) Fourier analysis of square wave.
25) IC 741 characteristics

Reference books:

1. B.Sc Practical Physics by C.L Arora.
2. B.Sc Practical Physics by Harnam Singh and P.S Hemne.
3. Practical Physics by G.S Squires.
4. Scilab Manual for CC-XI: Quantum Mechanics &Applications (32221501) by Dr Neetu Agrawal, Daulat Ram College, University of Delhi.
5. Scilab Textbook Companion for Quantum Mechanics by M. C. Jain.
6. Computational Quantum Mechanics using Scilab, BIT Mesra.
7. Advanced Practical Physics for Students by Worsnop B L and Flint H T.

Semester – V Paper- VI Atomic ,Molecular and Laser Physics	
Course Title: Atomic, Molecular and Laser Physics-PHCT-302	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course Outcomes (COs):

After the completion of the course, the student will be able to

CO1: Describe atomic properties using basic atomic models.

CO2: Interpret atomic spectra of elements using vector atom model.

CO3: Interpret molecular spectra of compounds using basics of molecular physics. CO4: Explain Laser systems and their applications in various fields.

Unit 1: Basic Atomic models:

Thomson's atomic model; Rutherford atomic model Theory of alpha particle scattering,(Idea of Distance of closest approach, impact parameter and scattering cross section), Rutherford scattering formula;(Mention) Bohr atomic model – postulates, Derivation of expression for radius, total energy of electron; Origin of the spectral lines; Spectral series of hydrogen atom; Effect of nuclear motion on atomic spectra - derivation; Ritz combination principle; Correspondence principle; Critical potentials-excitation potential and ionisation potential; Atomic excitation and its types, Franck-Hertz experiment; Sommerfeld's atomic model – model, Derivation of condition for allowed elliptical orbits.(Problems) **11Hours**

Activities: **02 Hours**

1. Students to estimate radii of orbits and energies of electron in case of hydrogen atom in different orbits and plot the graph of radii / energy versus principal quantum number 'n'. Analyse the nature of the graph and draw the inferences.

2. Students to search critical, excitation and ionisation potentials of different elements and plot the graph of critical /excitation / ionisation potentials versus atomic number/mass number/neutron number of element. Analyse the nature of the graph and draw the inferences.

Unit 2: Vector atomic model and optical spectra

Vector atom model – model fundamentals, spatial quantisation, spinning electron; Quantum numbers associated with vector atomic model; Coupling schemes – L-S and j-j schemes; Spin-orbit coupling/Spin-Orbit Interaction – qualitative; Pauli's exclusion principle; Magnetic dipole moment due to orbital motion of electron – derivation; Magnetic dipole moment due to spin motion of electron; Lande g-factor and its calculation for different states;(Singlet and Doublet) Stern-Gerlach experiment – Experimental arrangement and Principle; Fine structure of spectral lines with examples; Optical spectra – spectral terms, spectral notations, selection rules, intensity rules; Fine structure of the sodium D-line; Zeeman effect: Types, Experimental study and classical theory of normal Zeeman effect, Zeeman shift expression (no derivation),

examples; Stark effect: Experimental study, Types and examples.(Problems). **11 Hours**

Activities: 02 Hours

1. Students to couple a p-state and s-state electron via L-S and j-j coupling schemes for a system with two electrons and construct vector diagrams for each resultant. Analyse the coupling results and draw the inferences.

2. Students to estimate magnetic dipole moment due to orbital motion of electron for different states 2P1/2, 2P3/2, 2P5/2, 2P7/2, 2P9/2 and 2P11/2 and plot the graph of dipole moment versus total orbital angular momentum "J'. Analyse the nature of the graph and draw the inferences**.**

Unit 3: Molecular Physics;

Types of molecules based on their moment of inertia; Types of molecular motions and energies; Born-Oppenheimer approximation; Origin of molecular spectra; Nature of molecular spectra; Theory of rigid rotator – energy levels and spectrum, Qualitative discussion on Non- rigid rotator.Theory of vibrating molecule as a simple harmonic oscillator – energy levels and spectrum; Electronic spectra of molecules – fluorescence and phosphorescence; Raman effect – Stoke's and anti-Stoke's lines, characteristics of Raman spectra, classical and quantum approaches, Experimental study of Raman effect; Applications of Raman effect. Problems **11 Hours**

Activities: 02 Hours

1. Students to estimate energy of rigid diatomic molecules CO, HCl and plot the graph of rotational energy versus rotational quantum number 'J'. Analyse the nature of the graph and draw the inferences. Also students study the effect of isotopes on rotational energies.

2. Students to estimate energy of harmonic vibrating molecules CO, HCl and plot the graph of vibrational energy versus vibrational quantum number 'v'. Analyse the nature of the graph and draw the inferences.

Unit 4: Laser Physics:

Ordinary light versus laser light; Characteristics of laser light; Interaction of radiation with matter - Induced absorption, spontaneous emission and stimulated emission with mention of rate equations; Assuming the Einstein's A and B coefficients – Derivation of relation between Einstein's coefficients and radiation energy density; Possibility of amplification of light; Population inversion; Methods of pumping; Metastable states; Requisites of laser – energy source, active medium and laser cavity; Difference between Three level and four level lasers with examples; Types of lasers with examples; Construction and Working principle of Ruby Laser and He-Ne Laser; Application of lasers (qualitative) in science & research, isotope separation, communication, fusion, medicine, industry, and space**.** **Problems 11 Hours**

Activities: 02 Hours

1. Students to search different lasers used in medical field (ex: eye surgery, endoscopy, dentistry etc.), list their parameters and analyse the need of these parameters for specific application, and draw the inferences. Students also make the presentation of the study.

2. Students to search different lasers used in defence field (ex: range finding, laser weapon, etc.), list their parameters and analyse the need of these parameters for specific

application, and draw the inferences. Students also make the presentation of the study.

PRACTICAL VI PHCP 302 -LIST OF EXPERIMENTS

NOTE: Students have to perform at-least EIGHT Experiments from the above list.

1. To determine Planck's constant using Photocell.
2. To determine Planck's constant using LED.
3. Effect of amplitude of oscillation on the time period
4. To determine the value of Rydberg's constant using diffraction grating and hydrogen discharge tube.
5. Characteristics of Photo cell
6. Inverse square law using G M Tube
7. To determine the ionization potential of mercury.
8. To setup the Millikan oil drop apparatus and determine the charge of an electron.
9. To determine the absorption lines in the rotational spectrum of Iodine vapour.
10. To determine the force constant and vibrational constant for the iodine molecule from its absorption spectrum.
11. To determine the wavelength of laser source using diffraction by double slits.
12. To determine wavelength of He-Ne laser using plane diffraction grating.
13. To determine angular spread of He-Ne laser using plane diffraction grating.
14. Thevenin's and Norton's theorems
15. Superposition theorem
16. Low resistance by Carey-foster bridge.
17. M and C by Carey-Foster method
18. ECE of copper
19. Earth inductor
20. Intensity of spectral lines
21. L and C by Anderson's bridge.
22. Spectral response of LDR
23. Frequency response of IC 741
24. Q by stretching
25. Adder and subtrator using 741 IC
26. Simulation Experiment

Text Books:

1. Modern Physics, R. Murugeshan, Kiruthiga Sivaprakash, Revised Edition, 2009, S. Chand & Company Ltd.
2. Atomic & Molecular spectra: Laser, Raj Kumar, Revised Edition, 2008, Kedar Nath Ram Nath Publishers, Meerut.
3. Atomic Physics, S.N. Ghoshal, Revised Edition, 2013, S. Chand & Company Ltd.
4. Concepts of Atomic Physics, S.P. Kuila, First Edition, 2018, New Central Book Agency (P) Ltd.

Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, Seventh Edition, 2015, Shobhit Mahajan, S. Rai Choudhury, 2002, McGraw-Hill.
2. Introduction to Atomic Spectra, H.E. White, Fourth Edition, 2004, McGraw-Hill Publishers.
3. Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash, Fourth Edition, 2008, Tata McGraw-Hill Publishers.
1. University Practical Physics, D.C. Tayal, First Millennium Edition, 2000, Himalaya Publishing House.
2. B.Sc. Practical Physics, C.L. Arora, Revised Edition, 2007, S. Chand & Comp.Ltd.
3. An Advanced Course in Practical Physics, D. Chatopadhyaya, P.C. Rakshith, B. Saha, Revised Edition, 2002, New Central Book Agency Pvt. Ltd. Physics through experiments, B. Saraf, 2013, Vikas Publications.

Semester – VI Paper- VII Condensed Matter Physics and Nuclear Physics	
Course Title: Condensed Matter and Nuclear Physics- PHCT-351	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Programme Outcomes (POs)

PO-1: Discipline Knowledge: Knowledge of science and ability to apply to relevant areas.

PO-2: Problem solving: Execute a solution process using first principles of science to solve problems related to respective discipline.

PO-3: Modern tool usage: Use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.

PO-4: Ethics: Apply the professional ethics and norms in respective discipline.

PO-5: Individual and teamwork: Work effectively as an individual as a team member in a multidisciplinary team.

PO-6: Communication: Communicate effectively with the stake holders, and give and receive clear instructions.

Course Articulation Matrix:
Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) ***(UGC guidelines)***	**1**	**2**	**3**	**4**	**5**	**6**
CO-1: A brief idea about crystalline and amorphous substances, about lattice, unit cell, miller indices, reciprocal lattice, concept of Brillouin zones and diffraction of X-rays by crystalline materials	**X**	**x**				X
CO-2: Knowledge of lattice vibrations, phonons and in depth of knowledge of Einstein and Debye theory of specific heat of solids..	**X**	**x**				
CO-3: Knowledge of different types of magnetism from diamagnetism to ferromagnetism and hysteresis loops and energy loss.	**X**					
CO-4: Secured an understanding about the dielectric and ferroelectric properties of materials.	**X**			**x**	**x**	**X**
CO-5: Understand the basic idea about superconductors and their classifications.	**X**				x	**X**
CO-6: Students will study the basic properties of nucleus and get the idea of its inner information. Learn the concepts of binding energy and binding energy per nucleon v/s mass number graph.	**X**	**x**				
CO-7: Learn about the processes of alpha, beta and gamma						

decays based on well established theories.						
CO-8:Learn the basic aspects of interaction of gamma radiation with matter by photoelectric effect, Compton scattering and pair production.						
CO-9:Learn about nuclear radiation detectors such as ionization chamber, Geiger-Mueller counter etc.						
CO-10:Learn the basic concept of scintillation detectors, photo-multiplier tube and semiconductor detectors						
CO- 11: Will get hands on experience of different equipment.	**X**	**x**	**x**		**x**	**X**

Unit I

Crystal systems and X-rays: Crystal structure**:** Space Lattice, Lattice translational vectors, Basis of crystal structure, Types of unit cells, primitive, non-primitive cells. Wigner - Seitz cell. Seven crystal system, Coordination numbers, Bravais lattices Miller Indices, Expression for inter planner spacing, Crystal structure of NaCl. **X Rays**: Production and properties of X rays, Coolidge tube, Continuous and characteristic X-ray spectra; Moseley's law. **X-Ray diffraction**, Scattering of X-rays, Bragg's law. **Crystal diffraction:** Bragg's X-ray spectrometer- powder diffraction method, Intensity vs 2θ plot (qualitative).

Free electron theory of metals: Classical free electron model (Drude-Lorentz model), expression for electrical and thermal conductivity, Weidman-Franz law, Failure of classical free electron theory; Quantum free electron theory, Fermi level and Fermi energy, Fermi-Dirac distribution function (expression for probability distribution F(E), statement only); Fermi Dirac distribution at T=0 and $E<E_f$, at $T\neq 0$ and $E>E_f$, F(E) vs E plot at T = 0 and $T\neq 0$. Density of states for free electrons (no derivation). Qualitative discussion of lattice vibration and concept of Phonons.; Specific heats of solids: Classical theory, Einstein's and Debye's theory of specific heats. Hall Effect in metals. Problems 13 hrs

Activities

1. Students to construct seven crystal systems with bamboo sticks and rubber bands. Use foam ball as atoms and study the BCC and FCC systems.

2.Students to search the characteristic X ray wavelength of different atoms/elements and plot characteristic wavelength vs atomic number and analyse the result and draw the inference.

Unit II

Magnetic Properties of Matter, Dielectrics and Superconductivity
Magnetic Properties of Matter

Review of basic formulae: Magnetic intensity, magnetic induction, permeability, magnetic susceptibility, magnetization (M), Classification of Dia, Para, and ferro magnetic materials; Classical Langevin Theory of dia – and Paramagnetism. Curie's law, Ferromagnetism and Ferromagnetic Domains (qualitative). Discussion of B-H Curve. Hysteresis and Energy Loss, Hard and Soft magnetic materials

Dielectrics: Static dielectric constant, polarizability (electronic, ionic and orientation), calculation of Lorentz field (derivation), Clausius-Mosotti equation (derivation), dielectric loss. Piezo electric effect, cause, examples and applications.

Superconductivity: Definition, Experimental results – Zero resistivity – The critical magnetic field – Meissner effect, Type I and type II superconductors. Problems 13 hrs

Activities

1. Magnetic field lines are invisible. Students to trace the magnetic field lines using bar magnet and needle compass. https://nationalmaglab.org/magnet-academy/try-this-at-home/drawing-magnetic-field-lines/ ,

2.Using vegetable oil and iron fillings students to make ferrofluids and see how it behaves in the presence of magnetic field. https://nationalmaglab.org/magnet-academy/try-this-at-home/making-ferrofluids/

Unit III

General Properties of Nuclei: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, main features of binding energy versus mass number curve, angular momentum, parity, magnetic moment, electric moments

Radioactivity decay: (a) Alpha decay: basics of α-decay processes, theory of α emission (brief), Gamow factor, Geiger-Nuttall law. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion (Definition) Problems
13 hrs

Activities

1. Study the decay scheme of selected alpha, beta & gamma radioactive sources with the help of standard nuclear data book.
2. Calculate binding energy of some selected light, medium and heavy nuclei. Plot the graph of binding energy versus mass number A
3. Study the decay scheme of standard alpha, beta and gamma sources using nuclear data book.

Make the list of alpha emitters from Uranium series and Thorium series. Search the kinetic energy of alpha particle emitted by these alpha emitters. Collect the required data such as half-life or decay constant. Verify Geiger-Nuttal in each series.

Unit IV

Interaction of Nuclear Radiation with matter: Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production, Energy loss due to ionization (quantitative description of Bethe Block formula), energy loss of electrons, introduction of Cerenkov radiation.

Detector for Nuclear Radiations: Gas detectors: estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si and Ge) for charge particle and photon detection (concept of charge carrier and mobility) qualitative only. Accelerators : Cyclotrons and Synchrotrons Problems 13 hrs

Activities

1. Study the Z dependence of photoelectric effect cross section.
2. Study the Z dependence of common cross section for selected gamma energies and selected elements through theoretical calculation.
3. List the materials and their properties which are used for photocathode of PMT.
4. Study any two types of PMT and their advantages and disadvantages.

Prcticals VII-PHCP351

Min four from Condensed and Nuclear Physics each

CONDENSED MATTER PHYSICS

1. Hall Effect in semiconductor: determination of mobility, hall coefficient.
2. Eenergy gap of semiconductor (diode/transistor) by reverse saturation method
3. Thermistor energy gap
4. Fermi Energy of Copper
5. Analysis of X-ray diffraction spectra and calculation of lattice parameter.
6. Specific Heat of Solid by Electrical Method
7. Determination of Dielectric Constant of polar liquid.
8. Determination of dipole moment of organic liquid
9. B-H Curve Using CRO.
10. Spectral Response of Photo Diode and its I-V Characteristics.
11. Determination of particle size from XRD pattern using Debye-Scherrer formula.
12. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method).

15.Measurement of susceptibility of paramagnetic solid (Gouy's Method)

NUCLEAR PHYSICS

1. Study the absorption of beta particles in aluminium foils using GM counter. Determine mass attenuation coefficient of Aluminium foils.
2. Study the absorption of beta particles in thin copper foils using G M counter and determine mass attenuation coefficient.
3. Study the attenuation of gamma rays in lead foils using Cs-137 source and G M counter. Calculate mass attenuation coefficient of Lead for Gamma.
4. Determine the end point energy of Tl-204 source by studying the absorption of beta particles in aluminium foils.
5. Study the attenuation of absorption of gamma rays in polymeric materials using Cs-137 source and G M counter.
6. Half adder and full adder
7. Simulation experiment
8. Energy gap of photodiode
9. Simulation experiment
10. Refractive index of material of convex lens and focal length
11. Inverting and Non inverting amplifier

TEXT BOOKS

Textbooks.

1. Solid State Physics-R. K. Puri and V.K. Babber., S.Chand publications,1st Edition(2004).
2. Fundamentals of Solid State Physics-B.S.Saxena,P.N. Saxena,Pragati prakashan Meerut(2017).
3. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).

Reference Books

1) Introduction to solid State Physics, ***Charles Kittel***, VII edition, (**1996**)
2) Solid State Physics- **A J Dekker**, MacMillan India Ltd, (**2000**)
3) Essential of crystallography**, M A Wahab**, Narosa Publications (**2009)**
4) Solid State Physics-**S O Pillai**-New Age Int. Publishers (**2001**).
5) Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill, 1998).
6) Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
7) Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press

8) Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (Institute of Physics (IOP) Publishing, 2004).
9) Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
10) Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).

.1 *IGNOU : Practical Physics Manual*

2. Saraf : Experiment in Physics, Vikas Publications

3. S.P. Singh : Advanced Practical Physics

4. Melissons : Experiments in Modern Physics

*5. Misra and Misra, Physics Lab. Manual, South Asian publishers, (***2000***)*

*6. Gupta and Kumar, Practical physics, Pragati prakashan, (***1976***)*

Semester – VI Paper- VIII Electronic Instrumentation	
Electronic Instrumentation and sensors- PHCT-352	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 2 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course outcomes

At the end of the course, the students should be ensured to understand the following:

1. Identify different types of test and measuring instruments used in practice and understand their basic working principles.
2. Get hands on training in wiring a circuit, soldering, making a measurement using an electronic circuit used in instrumentation.
3. Have an understanding of the basic electronic components viz., resistors, capacitors, inductors, discrete and integrated circuits, colour codes, values and pin diagram, their practical use.
4. Understanding of the measurement of voltage, current, resistance value, identification of the terminals of a transistor and ICs.
5. Identify and understand the different types of transducers and sensors used in robust and hand held instruments.
6. Understand and give a mathematical treatment of the working of rectifiers, filter, data converters and different types of transducers.
7. Connect the concepts learnt in the course to their practical use in daily life.
8. Develop basic hands on skills in the usage of oscilloscopes, multimeters, rectifiers, amplifiers, oscillators and high voltage probes, generators and digital meters.
9. Servicing of simple faults of domestic appliances: Iron box, immersion heater, fan, hot plate, battery charger, emergency lamp and the like.

Unit 1:

General purpose electronic test instruments

Power supply

AC power and its characteristics, Single phase and three phase, Need for DC power supply and its characteristics, line voltage and frequency, Rectifier bridge, Filters: Capacitor and inductor filers, L-section and π-section filters, ripple factor, Electronic voltage regulators, stabilization factor, voltage regulation using ICs.

Basic electrical measuring instruments

Cathode ray oscilloscope- Block diagram, basic principle, electron beam, CRT features, signal display. Basic elements of digital storage oscilloscopes.

Basic DC voltmeter for measuring potential difference, Extending Voltmeter range, AC voltmeter using rectifiers

Basic DC ammeter, requirement of a shunt, Extending of ammeter ranges. Problems 13 hrs

Topics for self study:

Average value and RMS value of current, Ripple factor, Average AC input power and DC output power, efficiency of a DC power supply. Multirange voltmeter and ammeter.

Activities (3 hours)

1. Design and wire your own DC regulated power supply. Power output: 5 V, 10 V, ± 5 V. Components required: A step down transformer, semiconductor diodes (BY126/127), Inductor, Capacitor, Zener diode or 3-pin voltage regulator or IC. Measure the ripple factor and efficiency at each stage. Tabulate the result.
2. Extend the range of measurement of voltage of a voltmeter (analog or digital) using external component and circuitry. Design your own circuit and report.
3. Measure the characteristics of the signal waveform using a CRO and function generator. Tabulate the frequency and time period. Learn the function of Trigger input in an CRO.
4. Learn to use a Storage Oscilloscope for measuring the characteristics of a repetitive input signal. Convince yourself how signal averaging using Storage CRO improves S/N ratio.

Unit-II:

Wave form generators and Filters

Basic principle of standard AF signal generator: Fixed frequency and variable frequency, AF sine and square wave generator, basic Wein-bridge network and oscillator configuration, Triangular and saw tooth wave generators, circuitry and waveforms.

Passive and active filters. Fundamental theorem of filters, Proof of the theorem by considering a symmetrical T-network. Types of filters, Circuitry and Cut-off frequency and frequency response of Passive (RC) and Active (op-amp based) filters: Low pass, high pass and band pass.

Activities Problems (13 hours)

1. Measure the amplitude and frequency of the different waveforms and tabulate the results. Required instruments: A 10 MHz oscilloscope, Function generators (sine wave and square wave).
2. Explore where signal filtering network is used in real life. Visit a nearby telephone exchange and discuss with the Engineers and technicians. Prepare a report.
3. Explore op-amp which works from a single supply biasing voltage (+15V). Construct an inverting/non-inverting amplifier powered by a single supply voltage instead of dual or bipolar supply voltage.
4. Op-amp is a linear (analog) IC. Can it be used to function as logic gates? Explore, construct and implement AND, OR NAND and NOR gate functions using op-amps. Verify the truth table. Hint: LM3900 op-amp may be used. The status of the output may be checked by LED.

Unit-III:

Data Conversion and display

Digital to Analog (D/A) and Analog to Digital (A/D) converters – A/D converter with pre-amplification and filtering. D/A converter - Variable resistor network, Ladder type (R-2R) D/A converter, Op-amp based D/A converter.

Digital display systems and Indicators- Classification of displays, Light Emitting Diodes (LED)

and Liquid Crystal Display (LCD) – Structure and working.

Data Transmission systems – Advantages and disadvantages of digital transmission over analog transmission, Pulse amplitude modulation (PAM), Pulse time modulation (PTM) and Pulse width modulation(PWM)- General principles. Principle of Phase Sensitive Detection (PSD).

Problems 10 hours)

Topic for self study: Lock-in amplifier and its application, phase locked loop.

Activities (3 hours)

1. Explore where modulation and demodulation technique is employed in real life. Visit a Radio broadcasting station. (Aakashavani or Private). Prepare a report on different AM and FM stations.
2. Explore and find out the difference between a standard op-amp and an instrumentation op-amp. Compare the two and prepare a report.

Unit-IV:

Transducers and sensors

Definition and types of transducers. Basic characteristics of an electrical transducer, factors governing the selection of a transducer, Resistive transducer-potentiometer, Strain gauge and types (general description), Resistance thermometer-platinum resistance thermometer. Thermistor. Inductive Transducer-general principles, Linear Variable Differential Transducer (LDVT)- principle and construction, Capacitive Transducer, Piezo-electric transducer, Photoelectric transducer, Photovoltaic cell, photo diode and phototransistor – principle and working. Problems (10 hours)

Activities (3 hours)

1. Construct your own thermocouple for the measurement of temperature with copper and constantan wires. Use the thermocouple and a Digital multimeter (DMM). Record the emf (voltage induced) by maintaining one of the junctions at a constant temperature (say at 0^{o} C, melting ice) and another junction at variable temperature bath. Tabulate the voltages induced and temperatures read out using standard chart (Chart can be downloaded from the internet).
2. Observe a solar water heater. Some solar water heaters are fitted with an anode rod (alloy of aluminium). Study why it is required. Describe the principle behind solar water heater.

Reference texts

1. Physics for Degree students (Third Year) – C.L. Arora and P.S. Hemne, S, Chand and Co. Pvt. Ltd. 2014 (For Unit-1, Power supplies)
2. Electronic Instrumentation, 3rd Edition, H.S. Kalsi, McGraw Hill Education India Pvt. Ltd. 2011 (For rest of the syllabus)
3. Instrumentation – Devices and Systems (2nd Edition)– C.S. Rangan, G.R. Sarma, V.S.V. Mani,Tata McGraw Hill Education Pvt. Ltd. (Especially for circuitry and analysis of signal generators and filters)

PRACTICALS VIII-PHCP 352

List of experiments (At least 8 experiments to be performed)

1. Construct a DC power supply using a bridge rectifier and a capacitor filter. Use a Zener diode or a 3-pin voltage regulator and study the load and line regulation characteristics. Measure ripple factor with and without filter and compare with theoretical values.
2. Calibration of a low range voltmeter using a potentiometer
3. Calibration of an ammeter using a potentiometer
4. Design and construct a Wien bridge oscillator (sine wave oscillator) using µA 741 op-amp. Choose the values of R and C for a sine wave frequency of 1 KHz. Vary the value of R and C to change the oscillation frequency.
5. Design and construct a square wave generator using μA 741 op-amp. Determine its frequency and compare with the theoretical value. Also measure the slew rate of the op-amp. If the 741 is replace by LM318, study how does the waveform compare with the previous one.
6. Study the frequency response of a first order op-amp low pass filter
7. Study the frequency response of a first order op-amp low pass filter
8. Study the illumination intensity of a solar cell using a standard photo detector (e.g., lux meter).
9. Study the characteristics of a LED (variation of intensity of emitted light).
10. Study the characteristics of a photo-diode
11. Determine the coupling coefficient of a piezo-electric crystal.
12. Study the amplitude modulation using a transistor.
13. Performance analysis of A/D and D/A converter using resistor ladder network and op-amp.
14. Study of OPAMP as integrator
15. Study of OPAMP as differentiator
16. Measurement of frequency, voltage, types of waves and testing components using CRO
17. Photo Transistor
18. Sp Heat by cooling
19. CE amplifier
20. Attenuation of gamma rays in lead foils using Cs-137 source and G M counter.
21. Transistor as a switch
22. Simulation Experiment

Reference Texts

1. Advanced Practical Physics for students, B. L. Flint and H.T. Worsnop, 1971, Asia Publishing House.
2. B.Sc. Practical Physics, C.L. Arora (Revised Edition), S. Chand and Co. Ltd. 2007
3. University Practical Physics, D.C. Tayal, First Millennium Edition, Himalaya Publishing House, 2000

Employability and skill development

The whole syllabus is prepared with a focus on employability.
Skill development achieved: Fundamental understanding of the working of test and measuring instruments. Operating and using them for measurements. Servicing of laboratory equipment for simple cable faults, loose contacts and discontinuity.

Job opportunities: Lab Assistant/Scientific Assistant in hospitals, R and D institutions, educational institutions.

Question paper Pattern for I-VI Semester end examinations

SRI DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS),UJIRE

CORE SUBJECT-SEMESTER END EXAMINATIONS-NEP
B.Sc.-PHYSICS

PAPER-SEMESTER I/II/III/IV/V/VI

CODE NO: Reg No:

TOPIC-

TIME: 2HRS Max Marks 60

Note: Answer

all Parts

PART- A

I. **Answer any FOUR of the following** 2X4=8

1)
2)
3)
4)
5)
6)

PART B

Answer all

Units

7. a) 4 marks
b) 6 marks

UNIT-1

c) 4 marks
d) 6 marks

OR

8. a) 4 marks
b) 6 marks

UNIT-II

c) 4 marks
d) 6 marks

OR

UNIT III

9. a) 4 marks
b) 6 marks

OR

c) 4 marks
d) 6 marks

UNIT-IV

10 a) 4 marks
b) 6 marks

c) 4 marks
d) 6 marks

OR

Part C

Solve any **THREE** of the following (one PROBLEM from each unit).

3x4=12

11(a)

(b)

(c)

(d)

xxxxxxxxxx

QUESTION PAPER PATTERN –ELECTIVES-(TERM END EXAMINATION)

CODE NO: Reg No:

B.Sc.-PHYSICS

PAPER- SEMESTER I/II /III/IV/V/VI

TOPIC-

TIME: 2HRS MARKS:60

Answer all Parts

PART- A

I. **Answer any EIGHT of the following** **1X8=8**

1)
2)
3)
4)
5)
6)
7)
8)
9)
10)

PART-B

II. **Answer any FIVE of the following** 2X5=10

1)
2)
3)
4)
5)
6)

PART C

Answer any SIX of the following **4X6=24**

1)
2)
3)
4)
5)
6)
7)

PART D

Answer any THREE of the following **6X 3=18**

1)
2)
3)
4)

Xxxxxxxxxx

SHREE DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS), UJIRE

CORE SUBJECT-INTERNAL EXAMINATIONS-

PHYSICS

CODE NUMBER **PAPER -** **SEMESTER-1/II /III/IV/V/VI**

TOPIC-

Time::1 hr **Max marks: 25**

I Answer any Five of the following **1X5=5**

1.

2.
3.
4.
5.
6.

II Answer any TWO of the following

1

a) 2 Marks

b) 6Marks

2.

a) 2 Marks

b) 6 Marks

3

a) 2 Marks

b) 6Marks

III Solve any ONE of the following

4X1=4

1
2.

Xxxxxxxxx

SHREE DHARMASTHALA MANJUNATHESHWARA COLLEGE (AUTONOMOUS), UJIRE

OPEN ELECTIVES-INTERNAL EXAMINATIONS- PHYSICS

CODE NUMBER **PAPER -** **SEMESTER- I/II /III/IV**

TOPIC-

Time::1hr **Max marks: 25**

Answer any FIVE of the following **1X5=5**

1.
2.
3.
4.
5.
6.
7.

II. Answer any FOUR of the following **2X4=8**

1.
2.
3.
4.
5.

III. Answer any THREE of the following **4X3=12**

1.
2.
3.
4.

XXXXXXXXX