St Aloysius College (Autonomous)
Mangaluru

Re-accredited by NAAC "A++" Grade

Course structure and syllabus of

B.Sc.
PHYSICS

Under NEP Regulations, 2021

ಸಂತ ಅಲೋಶಿಯಸ್ ಕಾಲೇಜು (ಸ್ವಾಯತ್ತ)
ಮಂಗಳೂರು– 575 003, ಕರ್ನಾಟಕ
www.staloysius.edu.in

ESTD : 1880

ST ALOYSIUS COLLEGE (AUTONOMOUS)
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Re-accredited by NAAC with 'A++' Grade with CGPA 3.67/4 (Cycle 4)
Recognised as Centre for Research Capacity Building under UGC-STRIDE Scheme
Recognised under DBT – BUILDER Scheme, Government of India
College with "STAR STATUS" Conferred by DBT, Government of India
Recognised by UGC as "College with Potential for Excellence"

Date: 21-02-2022

NOTIFICATION

Sub: Syllabus of **B.Sc. PHYSICS** under NEP Regulations, 2021.
(As per Mangalore University guidelines)

Ref: 1. Decision of the Academic Council meeting held on 18-12-2021 vide Agenda No: 6
2. Decision of the Academic Council meeting held on 09-07-2022 vide Agenda No: 14
3. Decision of the Academic Council meeting held on 02-09-2023 vide Agenda No: 3
4. Office Notification dated 21-02-2022
5. Office Notification dated 17-08-2022
6. Office Notification dated 26-09-2023

Pursuant to the above, the Syllabus of **B.Sc. PHYSICS** under NEP Regulations, 2021 which was approved by the Academic Council at its meeting held on 18-12-2021, 09-07-2022 & 02-09-2023 is hereby notified for implementation with effect from the academic year **2021-22**.

PRINCIPAL

ST ALOYSIUS COLLEGE MANGALORE 575 003 AUTONOMOUS

REGISTRAR

To:
1. The Chairman/Dean/HOD.
2. The Registrar Office
3. Library

BOS meeting was held on 17.11.2021

Following members were present for the meeting

Subject Expert - Dr Rajesh Kumar
- Dr Sadanand Kumar

University Nominee - DR Y Narayana

Distinguished Alumni - Mr Clavin Miranda

Industry representative - Ms. Seema

Chairman - Mr Lawrence Pinto

Internal Members - Dr Praskash Kamath
Dr Narayana Bhat
Dr Ishwara Bhat
Mr Harshith B
Mr Shawn D'Souza
Ms Amruta
Dr Nirmala D'Souza

Student Representative - Mr Sarvin Chandan

B.O.S Meeting held on 29-06-2022

Sl No	Name	Designation	Mode of Participation
1.	Mr Lawrence Pinto	Chairman	offline
2.	Dr Prakash Kamath	Faculty Member	offline
3.	Dr Narayan Bhat	Faculty Member	offline
4.	Dr Ishwara Bhat	Faculty Member	offline
5.	Mr Harshith	Faculty Member	offline
6.	Mr Shawn Ajay D'Souza	Faculty Member	offline
7.	Ms Amrutha O	Faculty Member	offline
8.	Dr Nirmala D'Souza	Faculty Member	Offline
9.	Dr Sadananda Kumar N	Subject Expert	offline
10.	Dr Rajesh Kumar PC	Subject Expert	online
11.	Mr Clavian Larry Miranda	Distinguished Alumni	online
12.	Mr Sawin Deon Chandran	Student Representative	offline

BOS meeting was held in department of Physics on 13-06-2023

Following members were present

1. Dr Narayana Bhat (Director of Xavier Block and faculty member)
2. Dr Ishwara Bhat S (H.O.D and chairman)
3. Mr Harshith B. (Faculty member)
4. Mr Shawn Ajay D'Souza (Faculty member)
5. Dr Gopalakrishna Naik(University nominee)
6. Dr Vijaya kumari(Subject Expert)
7. Dr Felcy Jyothi Serrao (Subject Expert)
8. Mr Errol Joshua D'Souza (Industry Representative)
9. Mr Sarwin Chandran (Distinguished Alumni)
10. Ms Amritha Prabhu (Student Representative)

Course Structure – B.Sc. Physics
3 Years B.Sc. Course with Physics as one of the major subject and open Electives according to National education policy(2020)

Semester	Discipline core (DC) Subject	Subject code	Theory hours/ week	Practical hours/ week	Duration of exams (Hours)	Marks and Credits			
						Exam	IA	Total	Credits
I	Mechanics and Properties of Matter	G 501 DC1.1	4		2.5	60	40	100	4
I	Practical-Lab	G 501 DC2.1P		4	4	25	25	50	2
I	Electrical Circuits and Wiring	G 501 OE1.1	3		2.5	60	40	100	3
II	Electricity and Magnetism	G 501 DC1.2	4		2.5	60	40	100	4
II	Practical-Lab	G 501 DC2.2P		4	4	25	25	50	2
II	Renewable Energy and Energy Harvesting	G 501 OE1.2	3		2.5	60	40	100	3
III	Waves and Optics	G 501 DC1.3	4		2.5	60	40	100	4
III	Practical-Lab	G 501 DC2.3P		4	4	25	25	50	2
III	Fundamentals of Optics and Electricity	G 501 OE1.3	3		2.5	60	40	100	3
IV	Thermal Physics and Electronics	G 501 DC1.4	4		2.5	60	40	100	4
IV	Practical-Lab	G 501 DC2.4P		4	4	25	25	50	2
IV	Financial Education and Investment Awareness		3		2.5	30	20	50	

semester	Discipline core (DC) Subject	Subject code	Theory hours/ week	Practical hours/ week	Duration of exams (Hours)	Marks and Credits			
						Exam	IA	Total	Credits
V	Classical Mechanics and Quantum Mechanics	G501 DC1.5	4		2.5	60	40	100	4
V	Elements of Atomic,Molecular and Laser Physics	G501 DC2.5	4		2.5	60	40	100	4
V	Practical -Lab	G501 DC3.5P		4	4	25	25	50	2
V	Practical-Lab	G501 DC4.5P		4	4	25	25	50	2
VI	Elements of Condensed Matter and Nuclear Physics	G501 DC1.6	4		2.5	60	40	100	4
VI	Electronic Instrumentation and Sensors	G501 DC2.6	4		2.5	60	40	100	4
VI	Discipline specific Elective (Title yet to be given)	Yet to be given	3		2.5	60	40	100	3
VI	Practical -Lab	G501 DC3.6P		4	4	25	25	50	2
VI	Practical-Lab	G501 DC4.6P		4	4	25	25	50	2

Semester - I	
Course Title: **Mechanics and Properties of matter** Course Code: **G 501 DC1.1**	Course Credits: 4
Total Contact Hours: 52 (theory)	Duration of ESA: 2 Hrs.
Formative Assessment Marks: 60	Summative Assessment Marks: 40

Program 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)	**Program Outcomes (POs)**					
	1	**2**	**3**	**4**	**5**	**6**
Co-1: will learn to deduce the dimensions of a physical quantity, will learn about accuracy of measurement and sources of errors, importance of significant figures.	**x**	**x**				**x**
co-2: will perceive the nuances of motion in one dimension and the ideas connected with it and understand the invariance of physical laws under translations.	**x**	**x**			**x**	
co-3. understand the basic concepts of elasticity, gain the knowledge about the properties of materials	**x**		**x**	**x**		
co-4. study the motion of viscous fluids	x					**x**
co-5. effectively use measuring instruments to quantify observable phenomena	x	**x**				
co-6. understand the principles and methods used in analyzing motion of particle, verify conservation laws and gain knowledge about the rigid body mechanics.	x			**x**		
co-7. grasp the ideas of classical theory of relativity, special theory	x	**x**			**x**	**x**

Course articulation matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content

Chapter	Content	Hours
Unit 1		
Chapter 1 Physical World and Measurements	System of units, Dimensions of Physical Quantities. Dimensional formulae, significant figures, order of magnitude, error in measurements, combination of error, error analysis. Problems	2
	Textbook: Sears and Zemmansky's University Physics 14 th Edition by Hugh D Young and Roger A. Freedman	
Chapter 2 Fundamentals of motion in one and two dimensions	Motion in one-dimension, instantaneous velocity and acceleration, Motion in two- dimensions, derivative of a planar vector of constant magnitude but changing direction, arbitrary planar motion, radial and transverse components of velocity and acceleration, deduction of the results of uniform circular motion. Problems.	4
	Textbook: Sears and Zemmansky's University Physics 14 th Edition by Hugh D Young and Roger A. Freedman	
Chapter 3 Conservation Laws	Conservation of linear momentum, motion of a rocket, conservation of angular momentum, conservative and non-conservative forces. Work, Law of conservation of energy, conservation of energy in a central force field, illustrations. Vertical oscillations of a light-loaded spring, force constant. Determination of acceleration due to gravity. Problems	5
	Textbook: Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker	
Chapter 4 Gravitation	Newtonian Law of Universal Gravitation, (gravitational force is a central force), Motion of a particle in a central force field, Kepler's laws of planetary motion, dynamics of satellites in circular orbits. Problems:	2
	Textbook: Mechanics: Berkeley Physics Course Vol 1 by Charles Kittel, Walter Knight), Malvin Ruderman and Carl Helmholtz	
Topics for self study	Concept of gradient and curl. The relationship of space and time symmetry to conservation laws. The Universal and Fundamental nature of Conservation	

	Laws. The practical value of Conservation laws. Energy transformation in the pole- vault. Uses of springs in vehicles. Internal forces and momentum conservation, Collision. General elastic collision of particle of different mass. Ultracentrifuge. Kepler's 2nd law : the Law of conservation of the Angular momentum of a planet. Ventures into space and the use of satellites.	
Suggested Activities		
Activity 1	Design innovative experiments to determine the density of liquids using a limited number of items provided and determine the possible sources of error in the measurement.	
Activity 2	Design innovative experiments to determine the surface area of objects of irregular shape and determine the possible sources of error in the measurement	
Activity 3	Design a throwing weapon based on the conservation of angular momentum.	
Activity 4	Play a Hoop rolling game and compete with your peers.	
Unit - 2		
Chapter 5 Rigid Body mechanics	Rigid Body mechanics: Rotational motion, relation between torque and angular momentum, moment of inertia, radius of gyration, rotational kinetic energy. Theorem of perpendicular axes, Theorem of parallel axes. Moment of Inertia of : a) rectangular lamina b) circular disc c) ring d) solid cylinder Flywheel, Compound pendulum, Centre of mass, reduced mass. Problems:	5
	Textbook: Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker	
Chapter 6 Motion in an Inertial frame	Newton's Concept of space, time, and matter. Inertial and non-inertial frames of reference. Galilean transformation equations, Galilean principle of relativity, classical velocity addition theorem. Velocity of light and Galilean transformation, absolute frame of reference. Michelson-Morley experiment, consequences of Michelson-Morley experiment, Null result of Michelson-	3

	Morley experiment, Need for a new-theory of relativity.	
	Textbook: Mechanics: Berkeley Physics Course Vol 1 by Charles Kittel, Walter Knight), Malvin Ruderman and Carl Helmholz	
Chapter 7 Theory of Special relativity	Postulates of theory of special relativity, Lorentz transformation equations. Consequences of Lorentz transformation (a) Relativity of space: Length contraction (b) Relativity of time: Time-dilation Explanation of Null-result of Michelson-Morley experiment. Relativity and simultaneity, relativistic addition of velocities, Constancy of the speed of light, variation of mass with velocity, Mass Energy relation : $E = mc^2$, relation between energy and momentum. Photon-Box thought experiment. Problems.	5
	Textbook :Introduction to Special Relativity by Robert Resnick	
Topics for self study	Practical uses of Fly wheel and Compound pendulum. Gyroscope. Rolling without slipping. Moments and products of inertia: Principle axes and Euler's equation. Tyrannosaurus Rex and the Physical pendulum. Earth as reference frame, Fixed star as standard unaccelerated frame of reference, Derivation of Lorentz transform equations. Speed of light in inertial frames in relative motion. The recessional red shift. Life time of π^+ meson. Aberration of light. Doppler effect. Twin paradox Recoilless emission of gamma rays.	
	Suggested Activities	
Activity No. 1	Activity: Construct a compound pendulum using any stationary item and measure it's moment of inertia	
Activity No. 2	Activity: Design a simple radio telescope	
Activity No. 3	Activity: Find the centre of mass of everyday objects	
Activity No. 4	Activity: Launch a bottle rocket	
Unit - 3		

Chapter 8 Elasticity	Introduction. Hooke's law - Stress-strain diagram, I- section girders, elastic moduli, Poisson's Ratio, Elastic after effect, elastic fatigue. Relation between shear and longitudinal strains. Relation between elastic moduli. Bending moment, uniform and non-uniform bending, Cantilever bending. Torsion- Couple per unit twist. Torsional pendulum. Work done in stretching and work done in twisting a wire-twisting -couple on a cylinder. Searle's double bar - Determination of rigidity modulus and moment of inertia - q, η and σ. Advantages. Problems	13
	Text Book : Concepts of Physics by H. C. Verma	
Topics for self study	Factors affecting elasticity of various materials, strain hardening and strain softening.	
Suggested Activities		
Activity No. 1	Stretching of a sock when loaded.	
Activity No. 2	Interaction with a Non- Newtonian Fluid.	
Activity No. 3	Strength of paper and string.	
Activity No. 4	Design and test the limits of a spaghetti bridge.	
Unit - 4		
Chapter 9 Surface tension	Definition of surface tension. Molecular theory of surface tension. Surface energy, relation between surface tension and surface energy, pressure changes due to surface tension, pressure difference across curved liquid surface, excess pressure inside spherical liquid drop, angle of contact, capillarity, surface tension by drop weight method, Interfacial tension. Problems	7
	Text Book : Concepts of Physics by H. C. Verma	
Chapter 10. Viscosity	Streamline flow, turbulent flow, equation of continuity. Coefficient of viscosity, effect of temperature and pressure. Reynolds number. Poiseulle's formula, terminal velocity, Stoke's formula, determination of coefficient of viscosity by Poiseulle's method, Stoke's method. Problems.	6
	Text Book : Physics for Degree students B.Sc. by C L Arora	
Topics for self study	1) Testing the aerodynamics of vehicles using wind tunnel. 2) Role of viscosity in drawing of optical fibres. 3) Physics of Hydrophobic fluids.	

	Suggested Activities	
Activity No. 1	Determination of flow properties of oils of different viscosity using Poiseulle's and Stoke's method.	
Activity No. 2	Study of temperature dependence of viscosity of oils.	
Activity No. 3	Magnus effect	
Activity No. 4	Blowing soap bubbles, Floating needle	

Text Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Mechanics Berkeley Physics Course, Vol.1:	Charles Kittel, et.al.	Tata McGraw-Hill	2007
2	Mechanics	D S Mathur	S.Chand & Co.	2007
3	University Physics	Sears & Zemansky		
4	Principles of Physics 9th Edn,	Resnick, Halliday & Walker,	Wiley	2013
5	Introduction to Special Relativity	Robert Resnick	Wiley Student Edition	2014
6	Elements of Properties of matter	D S Mathur	S.Chand & Co.	2007
7	Properties of Matter	Brijlal & Subramanyam	S.Chand & Co.	2014
8	Physics for Degree students	C L Aurora & PS Hemne	S.Chand & Co.	2010

References Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Classical Mechanics	J C Upadhyaya	Himalaya	2016
2	Conceptual Physics, 10th Edn	Paul G Hewit	Pearson	2012
3	Physics for Scientists and Engineers	Jewett & Serway	Cengage learning India Pvt Ltd, Delhi	2012

4	The Feynman Lectures on Physics – Vol 1	Richard P Feynman, Robert B Leighton, Mathew Sands	Narosa Publishing House	1986
5	Physics – (International Student Edition)	Marcelo Alonso & Edward J Finn	Addison – Wesley	1999
6	Concepts of Modern Physics	Arthur Beiser	Tata Mcgraw Hill	1998
7	Modern Physics	Kenneth Krane	Wiley	2012
8	Newtonian Mechanics	AP French	Viva Books	2017
9	Modern Physics	G Aruldhas & P Rajgopal	PHI Learning Pvt. Ltd.	2009

List of Experiments to be performed in the Laboratory

Sl. No	**Experiment**
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.

(Minimum EIGHT experiments have to be carried out).

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
5	BSc Practical Physics Revised Ed	CL Arora	S.Chand & Co	2007
6	An advanced course in practical physics	D. Chatopadhyay, PC Rakshit, B.Saha	New Central Book Agency Pvt Ltd	2002

ELECTRICAL CIRCUITS AND WIRING (OPEN ELECTIVE)
SEMESTER -I

Open Elective Paper Course Title: Electrical Circuits And Wiring Course Code: **G 501 OE1.1**	Course Credits:3
Total Contact Hours: 40	Duration of ESA:
Formative Assessment Marks: 15	Summative Assessment Marks: 35

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 problemsrelated to respective discipline.

PO - 3 Modern tool usage: Use a modern scientific, engineering and IT tool or technique for solvingproblems 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 amultidisciplinary team.

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

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

Course Outcomes (COs)	1	2	3	4	5	6
CO - 1: Will learn the various terms needed to understand the basics of current electricity.	x	x				
CO - 2: Will acquire sufficient working knowledge to identify and appreciate the merit of various passive circuit elements.	x	x				x
CO - 3: Will get a foothold on the need and applications of electrical circuits.	x	x			x	
CO - 4: Will graduate into understanding different sources of EMF and working of motors.	x	x		x		
CO - 5: Will acquire skills in electrical protection systems.	x	x			x	
CO-6: Will gain an understanding of electrical cables used in both domestic and industrial situations.	x	x		x	x	
CO-7: Will learn to calculate the electrical energy consumed by various appliances	x	x		x		x

Course Content		Hrs
Unit - 1		
Chapter	**Basic Electricity Principles:**	3

No. 1	Basics of electricity - Voltage, Current, Resistance, Power, Ohm's law. Series, parallel, and series-parallel combinations of circuit elements. AC and DC Electricity.	
	Text Boks : A text book in Electrical Technology – B L Theraja- S Chand & Co. A text book of Electrical Technology – A K Theraja Electrical Circuits and Network Skills – Prof.R S Khadayate	
Chapter No. 2	**Electrical elements:** Basic circuit elements. Resistors - types, color coding, applications, wattage rating. Inductors - types, color coding, applications. Capacitors - types, color coding, applications. Diodes - working, types, applications. Rectifiers - half wave, full wave, bridge.	4
Text Books : • A text book in Electrical Technology – B L Theraja- S Chand & Co. • A text book of Electrical Technology – A K Theraja • Electrical Circuits and Network Skills – Prof.R S Khadayate		

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Chapter No. 3	**Electrical Circuits:** Rules to analyze DC electrical circuits. Current and voltage drop across DC circuit elements. Response of inductors and capacitors to DC and AC sources. Inductive and capacitive reactance. Resistive load circuits, Capacitive load circuits, inductive load circuits, Series and parallel RLC circuits. Impedance. Real, imaginary and complex power components of AC source. True power, apparent power, Power factor. Economic operation with power factor correction.	6
	Text Books : 1. A text book in Electrical Technology – B L Theraja- S Chand & Co. 2. A text book of Electrical Technology – A K Theraja 3. Electrical Circuits and Network Skills – Prof.R S Khadayate	
Topics for self study (If any)		
	Suggested Activities	
Activity No. 1	Activity: Demonstration power transmission systems	
	Reference : Weblink/Youtube/Book	
Activity No. 2	Activity: Fabrication of a parallel plate capacitor with dielectric medium	

	Reference : Weblink/Youtube/Book	
Unit - 2		
Chapter No. 4.	**Generators, Transformers, Motors :** DC Power sources. Electromagnetic induction, Self-induction and mutual induction. AC/DC generators - construction, working. Single-phase and three-phase alternating current sources. Transformers - Principle, construction, working, losses, types of transformers Electric Motors- Principle, Basic design, working.	4
	Text Books : 1. A text book in Electrical Technology – B L Theraja- S Chand & Co. 2. A text book of Electrical Technology – A K Theraja 3. Electrical Circuits and Network Skills – Prof.R S Khadayate	
Chapter No. 5.	**Electrical Protection :** Notices and warning labels for electrical appliances. Importance of earthing and bonding - Electric shock, Earthing and earth fault loop impedance. Features of protective devices. Protective relays - definition, types, working. Fuses - importance, operation, types, ratings. Switches – ratings, types. Disconnect switches. Circuit breakers- Basic definition, working, types. Overload protection devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection.	7
	Text Books : 1. Electrical Circuits and Network Skills – Prof.R S Khadayate 2. Electrical wiring: Domestic – Brian Scaddn- 17th Edn. 3. The Homeowner's DIY guide to Electrical wiring – David Herres	
Chapter No. 6.	**Electrical Drawing and Symbols:** Rules for electrical drawing. Drawing symbols. Blueprints. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop.	3
	Text Books : 1. Electrical Circuits and Network Skills – Prof.R S Khadayate 2. Electrical wiring: Domestic – Brian Scaddn- 17th Edn	
Topics for self study (If any)		
	Suggested Activities	

Activity No. 3	Activity: Familiarization of the working of a diesel generator	
	Reference : Weblink/Youtube/Book	
Activity No. 4	Activity: Designing of two way switch wiring	
	Reference : Weblink/Youtube/Book	
Unit - 3		
Chapter No.7	**Electrical cables:** Basic knowledge on color coding of wires; Phase, Neutral, Earth, grounding. Gauges of electrical wires. Different types of conductors and cables. Voltage drops and losses across cables and conductors. Electrical insulation. Solid and stranded cable - necessity, advantages.	4
	Text Books : 1. Electrical Circuits and Network Skills – Prof.R S Khadayate 2. Electrical wiring: Domestic – Brian Scaddn- 17th Edn. **3.** The Homeowner's DIY guide to Electrical wiring – David Herres	
Chapter No. 8	**Domestic electrical wiring :** Instruments to measure current , voltage, power in DC and AC circuits- analog & digital ammeters, voltage measuring devices, clamp meter, line tester, multimeter. Simple domestic electrical wiring – ring circuit, radial circuit, two-way circuits. Conduit wiring system. Cable trays. Splices, wirenuts, crimps, terminal blocks, solder and applications. Extension board – construction. Inverter wiring.	6
	Text Books : 1. Electrical Circuits and Network Skills – Prof.R S Khadayate 2. Electrical wiring: Domestic – Brian Scaddn- 17th Edn 3. The Homeowner's DIY guide to Electrical wiring – David Herres	
Chapter No . 9	**Electrical appliances and energy calculation** Electrical power meter. Electrical appliances – electric iron, fan, bulbs. Calculation of energy consumption. Comparison of various light sources and other appliances - filament bulb, fluorescent tube, LED bulbs, BLDC fan, electronic fan regulators.	3
	Text Books : 1. Electrical Circuits and Network Skills – Prof.R S Khadayate 2. Electrical wiring: Domestic – Brian Scaddn- 17th Edn	

	3. The Homeowner's DIY guide to Electrical wiring – David Herres	
Topics for self study (If any)		
	Suggested Activities	
Activity No. 5	Activity: Familirization of the different gauges of electrical wires	
	Reference : Weblink/Youtube/Book	
Activity No.6	Activity: Non inductive household wiring.	
	Reference : Weblink/Youtube/Book	
Chapter No. 10	Topics to be covered	
	Text Book : Units/sections to be Referred:	

Semester – II

Course Title: Electricity and Magnetism **Course Code: G 501 DC1.2**	**Course Credits: 4**
Total Contact Hours: 52 (theory)	**Duration of ESA: 2 Hrs.**
Formative Assessment Marks: 60	**Summative Assessment Marks: 40**

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 clearinstructions.

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

Course Outcomes (COs) / Program Outcomes (POs)	**1**	**2**	**3**	**4**	**5**	**6**
CO-1: Will learn the requires mathematical skills to understand concepts of electricity, magnetism and electromagnetism.	**x**	**x**		**x**	**x**	
CO-2: Will gain the needed knowledge of the fundamental laws of electrostatics and their application in electrostatics	**x**	**x**			**x**	
CO-3: Will acquire the ability to differentiate between the effect of steady and variable currents in electrical circuits.	**x**	**x**		**x**		**x**
CO-4: Will understand the intimate connection between electricity and magnetism	**x**	**x**	**x**		**x**	
CO-5: Using the ideas obtained from variable currents will comprehend the concepts of converting other forms of energy into electrical	**x**	**x**			**x**	

energy						
CO-6: Will realise that light waves are electromagnetic waves	**X**	**x**	**x**	**x**		**x**

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content

Content		**Hrs**
Unit - 1		
Chapter 1 Scalar and vector fields	Concept of scalar and vector fields, gradient of a scalar function, vector integration: a) Line integral, line integral independent of a path, conservative force. b) Surface integral c) Volume integral- Gauss theorem, Stoke's theorem, Dirac delta function, curvilinear co-ordinates. Divergence of a vector, expression for divergence in Cartesian co-ordinates, physical significance of divergence. The curl of a vector function, expression for curl in cartesian co-ordinates, Physical significance of curl. Problems	**6**
	Textbook: Introduction to Electrodynamics by David J Griffiths.	
Chapter 2 Electrostatics	Coulomb's law, electric field, charge distributions: discrete and continuous charge distributions, linear, surface and volume charge densities, field lines, flux, and Gauss's law. Applications of Gauss's law, Electric potential, the potential of a localized Charge distribution, potential of an electric monopole, potential of a collection of charges for a continuous charge distribution: linear, surface and volume charge, electric dipole, potential of an electric dipole and electric Quadrupole, the work done to move a charge, potential energy, expression for potential energy of a point charge. The divergence of E. Problems	**7**
	Textbook: Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker Electricity and Magnetism: Berkeley Physics Course - Vol.2 by Edward Purcell	

Topics for self-study	Understanding lightning: Faraday cage, Electrostatic shielding, Thunderstorm Electrification (Physics of lightning)	
	Suggested Activities	
Activity No. 1	Activity: Charge a metal sphere by conduction.	
Activity No. 2	Activity: Test Gauss law experimentally: Faraday's ice pail.	
Activity No. 3	Activity: Construct a lightning arrestor	
Activity No. 4	Activity: Design a torsion balance to measure electric force.	
Unit - 2		
Chapter 3. Conductors and dielectrics in electrostatic field	Basic properties of conductors. Conductors in an external electric field, electric field inside a conductor, net charge density: inside a conductor, surface of a conductor. A conductor as an equipotential surface, nature of the electric field just outside a (charged) conductor, induced charges, surface charge and the force on a conductor, di-electric and di-electric polarisation, Capacitors, Capacitance, Capacitance of a parallel plate capacitor- with and without a di-electric medium between the plates, Electric displacement, Gauss's law in the presence of di-electrics, Energy in di-electric systems, energy stored in a parallel plate capacitor. Problems	**7**
	Text Book : Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker Concepts of Physics by H. C. Verma	
Chapter 4. Electric current	Electric current in conductors. Ohm's law, current density, conductivity, drift of electrons and the origin of resistivity. Variable Currents: Transient response of a circuit containing: a resistor, a capacitor, an inductor, and their series combinations, charging and discharging of a capacitor.	**6**
	Text Book : Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker	
Topics for self study	Applications of capacitors as motor starters, as energy storing devices. Pulsed power and weapons.	

	Suggested Activities	
Activity No. 1	Activity: Construct a parallel plate capacitor and find its capacitance with different dielectric material	
Activity No. 2	Activity: Fabricate resistors and print their colour codes	
Activity No. 3	Activity: Water hydrolysis using a battery and pencil electrodes	
Activity No. 4	Activity: Construct an electric stud finder	
Unit - 3		
Chapter 5 Magnetostatics	Magnetic field, magnetic flux, magnetic forces: Lorentz force law, steady currents. The magnetic field of a steady line current : Biot-Savart law, Divergence of magnetic field, Ampere's circuital Law. Problems	**3**
	Text Book : Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker	
Chapter 6 Magnetism	Circular current loop as a magnetic dipole, magnetic moment of a circular current loop, the magnetic dipole moment of a revolving electron. Magnetic properties of materials: Magnetization and magnetic intensity, magnetic susceptibility. Magnetic permeability. Diamagnetism, Paramagnetism and ferromagnetism, ferromagnetic domains, B-H curves, hysteresis. Problems	**5**
	Text Book : Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker	
Chapter 7 Alternating Current	Alternating Voltage and Alternating current, sinusoidal AC. AC voltage applied to : a resistor, an inductor, a capacitor, RL, RC, LC and LCR circuits, impedance, admittance, sharpness of resonance, quality factor, power in AC circuits. Filters: Low pass, High pass, and Band pass filters. Problems.	**5**
	Text Book : Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker	
Topics for self	1) Absence of magnetic charge	

study	2) Force on a magnetic dipole in an external field. 3) Magnetic materials used as transformer cores. 4) Filter circuits in sound system.	
	Suggested Activities	
Activity No. 1	Activity: Design an electromagnet	
Activity No. 2	Activity: design a simple DC motor	
Activity No.3	Activity: visualising magnetic field lines	
Activity No. 4	Activity: generate waves on a string using an electromagnet	
	Unit - 4	
Chapter 8 Electromagnetic Induction	Faraday's Law. Lenz's Law, Motional emf, self-induction, back emf, forward emf, self-inductance, mutual induction, mutual inductance, eddy currents , energy (stored) in magnetic fields. Problems.	**5**
	Text Book : Fundamentals of Physics: 6th Edition by Halliday, Resnick and Walker	
Chapter No. 9 Electromagnetic theory	Equation of continuity, Maxwell's field equations in vacuum and matter, Poynting vector, displacement current, electromagnetic waves, wave equations, electromagnetic waves in vacuum and matter, radiation pressure, Poynting Vector, Electromagnetic waves in different frames of reference, Maxwell's equations are valid in all frames of reference.	**8**
	Text Book : Electricity and Magnetism: Berkeley Physics Course - Vol.2 by Edward Purcell	
Topics for self study	1) Working of AC and DC induction motors 2) BLDC Motors	
	Suggested Activities	
Activity No.	Demonstrating the phenomenon of induced current	
Activity No. 2	Charge a metal sphere by induction	
Activity No. 3	Measuring absorbance using colour filters, measuring the	

	speed of light in various optical media, determination of absorption co-efficient of materials at different optical frequencies.	
Activity No. 4	Design a volume gauge	

Text Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	University Physics	Sears & Zemansky	Pearson	2011
2	Principles of Physics 9th Edn,	Resnick, Halliday & Walker,	Wiley	2013
3	Introduction to Electrodynamics , 4th edn.	D J Griffiths	Cambridge University Press	2017
4	Electricity and Magnetism	R Murugeshan	S Chand & Co	2019
5	Electricity and Magnetism	D C Tayal	Himalaya	1989

References Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Berkeley Physics Course, Vol-2, Electricity and Magnetism, Special Edition	Edward M Purcell	Tata Mc Graw-Hill Publishing Company Ltd, New Delhi	2008
2	The Feynman Lectures on Physics – Vol II	Richard P Feynman, Robert B Leighton, Mathew Sands	Narosa Publishing House	1986
3	Physics for Scientists and Engineers	Jewett & Serway	Cengage learning India Pvt Ltd, Delhi	2012

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

List of Experiments to be performed in the Laboratory
(Minimum EIGHT experiments have to be carried out)

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 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.

Reference Book for Laboratory Experiments

Sl	**Title of the Book**	**Authors Name**	**Publisher**	**Year of**

No				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
5	BSc Practical Physics Revised Ed	CL Arora	S.Chand & Co	2007
6	An advanced course in practical physics	D. Chatopadhyay, PC Rakshit, B.Saha	New Central Book Agency Pvt Ltd	2002

Weightage for the formative and summative components

	Summative	Formative
Theory	40 (TS)	60(TF)
Practical's	50(PS)	50(PF)

Outline for the summative component (Internal assessment) of theory paper

Activities	C1	C2	Total marks
Session test	10	10	20
Assignment	10		10
Project		10	10
Total	20	20	40

Outline of the formative component of theory paper

Duration	Type of Question	Total number of questions	Number of Questions to be answered	Marks for each Question	Marks
2 Hours	Short Answer type	6 (Minimum of one question from each unit)	4	2	8
	Long answer type	8 (Two questions from each unit)	4 (Answer one question from each unit)	10	40
	Numerical Problems	4	3	4	12
Total Marks					**60**

Scheme of Practical Examination

(Minimum 8 experiments are to be carried out)

Allotment of Marks	
Record Book	8
Formula	3
Diagram/Circuit, Experimental set up	3
Observations & Trials	6
Knowledge about the experiment	3
Result & Accuracy	2
Total	**25**

Regularity	15
Test	10
Total	**25**

Outline for the summative component of practical paper

Semester: II

RENEWABLE ENERGY AND ENERGY HARVESTING

Open Elective Paper Course Title: Renewable Energy and Energy harvesting Course Code: G 501 OE1. 2	Course Credits:3
Total Contact Hours: 40	Duration of ESA:
Formative Assessment Marks: 15	Summative Assessment Marks: 35

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

Course Outcomes (COs) / Program Outcomes (POs)	**1**	**2**	**3**	**4**	**5**	**6**
CO - 1: Will be able to learn about different energy sources and know the difference between renewable and non- renewable sources of energy.	X	X			X	
CO - 2: Will know the significance of solar energy and o f different techniques to harness solar energy.	X		X	X		
CO - 3: Will gain an idea about formation of waves and standingwave patterns and analysis of longitudinal and transverse waves.	X	X				X
CO - 4: Will acquire knowledge of wind energy and methods to tap energy from the blowing wind to generateelectrical power.	X		X		X	
CO - 5: Will gain familiarity about conventional energy sources and their impact on climate.	X			X		X

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content		Hrs
Unit - 1		
Chapter No. 1 **Introduction**	**Topics** to be covered/taught/learnt: Energy, Types of Energy, Renewable Energy, Advantages/Disadvantages, Economics, Global Warming, Use of Fossil Fuels :-Oil , Natural Gas, Coal, bio-mass, nuclear energy	2
	Text Book : 1 Units/sections to be Referred: Chapter 1, Page: 1-11	
Chapter No. 2 **Sun**	Topics to be Covered: Solar Power, Electromagnetic Spectrum (a)Visible (b)Blackbody Radiation, Energy Balance of the Earth, motion of the Earth, position of the Sun, Insolation, Solar Resource, Greenhouse Effect.	3
	Text Book : Book 1 Units/sections to be Referred: Chapter 3, Page: 35-50	
Chapter No. 3 Solar Heating and Cooling	Topics to be Covered: Buildings: Air Quality, Air and Vapor Barriers, Wind and Vegetation, Passive systems, Windows and Glazing, Solar Heating , Shading , Passive Heating and Cooling, Direct Gain, Indirect Gain , Active Heating, Flat-Plate Collectors , Domestic Hot Water, Swimming Pools, daylighting, Active Cooling, Agricultural Products, Solar Cookers, Water Purification.	4
	Text Book : Book 1 Units/sections to be Referred:Chapter 5, Page: 69-96)	
Topics for self study (If any)		
	Suggested Activities	
Activity No. 1	Activity: Construction of Solar motor	
	Reference : Weblink/Youtube/Book	
Activity No. 2	Activity: study of crookes radiometer	
	Reference : Weblink/Youtube/Book	
Unit - 2		
Chapter No. 4. Photovoltaic	Topics to be covered: Introduction, Physics Basics, Energy Bands, Photovoltaic Basics Performance, Design Considerations, Sizing, tracking, Estimation of Energy Production , Installed Capacity and Production, Applications Grid Connected, Village and Hybrid Power, Stand-Alone.	4

	Text Book : Book 1 Units/sections to be Referred: Chapter 6, Page: 99-123	
Chapter No. 5. Wind Energy	Topics to be covered: Introduction, Wind Resource, Wind Shear, Wind Maps, Wind Turbines, Wind Farms, Small Wind Turbines, Village Power, Wind Diesel	3
	Text Book : Book 1 Units/sections to be Referred: 9, Page: 169-192	
Chapter No. 6. Bio-energy	Topics to be covered: Introduction, Conversion, Heat and Power, Municipal Solid Waste, Landfill Gas, Biogas, Biofuels, Ethanol, Biodiesel, Biogas, Microalgae	3
	Text Book : Book 1 Units/sections to be Referred: Chapter 10, Page: 193-115	
Topics for self study (If any)		
	Suggested Activities	
Activity No. 3	Activity:Constuction of anemometer	
	Reference : Weblink/Youtube/Book	
Activity No. 4	Activity:A field visit to study the working of Biogas plant	
	Reference : Weblink/Youtube/Book	
Unit - 3		
Chapter No.7 Geothermal Energy	Topics to be covered: Introduction , Resource, Types of Geothermal Resources Direct Use, Springs, Space Heating, Geothermal Heat Pumps, Electricity , Dry Steam, Flash , Binary Plants ,Combined Heat and Power.	4
	Text Book : Book 1 Units/sections to be Referred: Chapter 11, Page: 217-240	
Chapter No. 8 Water	Topics to be covered: Introduction, World Resource, Hydroelectric, Large (≥30 MW) Small Hydro (100 kW to 30 MW, 10 MW in Europe), Microhydro (≤100 kW) , Water Flow, Tides Ocean Currents, Waves, Ocean Thermal Energy Conversion, Salinity Gradient.	5
	Text Book : Book 1 Units/sections to be Referred: Chapter 12, Page: 243-272	
Chapter No . 9 Storage	Topics to be covered: Introduction, Pumped Hydro, Compressed Air , Flywheels, Batteries, Lead Acid, Lithium Ion, Sodium Sulfur, Flow Batteries , Other Storage Systems: Magnetic Systems ,Capacitors , Phase Change Materials	

	Hydrogen, Transportation and Hybrid and Electric Vehicles.	
	Text Book : Book 1 Units/sections to be Referred: Chapter 13, Page: 275-290	
Topics for self study (If any)		
	Suggested Activities	
Activity No. 5	Activity: Upcycling the lithium ion batteries from the cell phones	
	Reference : Weblink/Youtube/Book	
Activity No.6	Activity: A field visit to battery fabrication industry	
	Reference : Weblink/Youtube/Book	
Unit - 4		
Chapter No. 10 Institutional Issues	Topics to be covered: Introduction, Avoided Cost, Utility Concerns, Regulations, Environmental Issues, Politics, Incentives, Wind, Photovoltaic Energy, Externalities (Social Costs/Benefits), Transmission	
	Text Book : Book 1 Units/sections to be Referred: Chapter 14, Page: 293-313	
Chapter No. 11 Economics	Topics to be covered: Introduction , Factors Affecting Economics ,Economic Analyses Simple Payback, Cost of Energy , Life-Cycle Costs , Present Worth and Levelized Costs, Externalities, Project Development , Landowner, Considerations, Cost (Value) of Energy, Different Sources , Passive Solar Active Solar Heat , Photovoltaic, Concentrating Solar Power, Wind Bio-energy , Geothermal Systems, Water, Village Power ,Wind Diesel, Summary ,The Future.	
	Text Book : Book 1 Units/sections to be Referred: Chapter 15, Page: 315-341	
Topics for self study (If any)		
	Suggested Activities	
Activity No.7	Activity: Designing and installation of a cost-effective solar power system	
	Reference : Weblink/Youtube/Book	
Activity No. 8	Activity: Assessing the environmental impact of wind turbines	
	Reference : Weblink/Youtube/Book	

Text Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Introduction to renewable Energy(energy and the environment series)	Vaughn Nelson	CRC Press Taylor & Francis Group	2011

References Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Alternative Energy Systems and Applications	B. K. Hodge	Hoboken, NJ: John Wiley & Sons	2017
2	Fundamentals and Applications of Renewable Energy	Mehmet Kanoglu, Yunus Cengel, John Cimbala	McGraw-Hill Education	2020
3	Renewable Energy Resources	John Twidell and Tony Weir	Taylor & Francis	2006
4	Understanding Renewable Energy Systems	Volker Quaschning	Earthscan (science publishers)	2005
5	Wind Energy Engineering, A Handbook for Onshore and Offshore Wind Turbines		Academic Press	2017
6	Solar energy: The physics and engineering of photovoltaic conversion, technologies and systems	Arno HM Smets, Klaus Jäger,Olindo Isabella, René ACMM van Swaaij Miro Zeman	UIT cambridge	2015
7	Fundamentals of Renewable Energy Processes	Aldo Vieira da Rosa, Juan Carlos Ordonez	Academic Press	2021
8	non-conventional energy resources	G. S. Sawhney	Phi learning private limited	2012
9	Non-conventional Energy Sources	G. D. Rai	Khanna Publishers	2001

Semester III

Course Title: Waves and Optics Course Code: G 501 DC1.3	Course Credits: 4
Total Contact Hours: 52 (theory)	Duration of ESA: 2 Hrs.
Formative Assessment Marks: 60	Summative Assessment Marks: 40

Program 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)	Program Outcomes (POs)					
	1	2	3	4	5	6
CO-1: Will learn the fundamentals of oscillations, periodic motion, simple harmonic motion and wave propagation	x	x				x
CO-2: will perceive the nuances of wave energy and its implications	x	x			x	
CO-3. Will understand the basic concepts of stationary waves and will be enabled to relate it to music.	x		x	x		
CO-4. Will study the fundamentals of optical phenomena: namely interference, diffraction and polarization.	x					x
CO-5. Will learn to setup experiments related to wave optics.	x	x				
CO-6. Will understand the principles and methods used in analyzing interference fringes.	x			x		
CO-7. Will be able to understand the concept of diffraction and use it to make precise measurements.	x	x			x	x

Course articulation matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content

	Content	Hrs
Unit – 1: Waves and Superposition of Waves		
Chapter1. Waves	Classification of waves, Longitudinal and Transverse Waves, Plane and Spherical Waves. Characteristics of wave motion, Plane Progressive Wave and its equation, Differential equation and solution for a plane progressive wave. Particle and Wave Velocities, Energy Transport – Expression for intensity of progressive wave, Pressure of a Longitudinal Wave. Newton's Formula for Velocity of Sound in a gas, Laplace's Correction. Numerical problems.	05
Chapter 2. Superposition of 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, Fourier theorem and its applications. Free, damped and forced vibrations. Numerical problems.	06
	Suggested Activities	
	Analyze the sound from a musical instrument using a cathode ray oscilloscope. Prepare study material on musical sound and noise. Measure frequencies from the environment using the Arduino science journal app.	02
	Unit – 2: Standing Waves and Acoustics	
Chapter 3. Standing Waves	Velocity of transverse waves along a stretched string, Standing Waves in a stretched string. Theory of transverse vibrations of a stretched string, Vibrations in rods – longitudinal and transverse modes. Vibrations in air columns, Modes of vibration in Open and Closed Pipes – Analytical treatment, End correction, Concept of Resonance, Theory of Helmholtz resonator. Numerical problems.	06
Chapter 4. Acoustics	Reflection, Transmission and Absorption coefficients, Reverberation and Reverberation time, Sabine's formula for Reverberation time, Acoustics of buildings, Requisites of good acoustics, Measurements in acoustics– intensity and pressure levels. Numerical problems.	03

	Suggested Activities	
	Study the absorption co-efficient of materials experimentally.	02
	Study the requisites of good acoustics and initiate a group discussion.	
	Unit – 3: Nature of light and Interference	
Chapter No. 5 Nature of light	The corpuscular theory of light, Huygen's theory of light, Concept of wavefront. Explanation of Reflection and Refraction using Huygen's theory.	2
Chapter No. 6 Interference of light by division of wavefront	Theory of Interference. Interference by division of wavefront- Young's double slit experiment- expression for fringe width, Fresnel's Biprism, Numerical Problems	3
Chapter No. 7 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, Michelson Interferometer-Determination of wavelength of light. Numerical problems.	5
	Suggested Activities	
	Using the idea of Young's double slit experiment prepare a report on teleportation.	01
	Investigate the exhibition of colors by soap bubbles and mention how they are used in the prediction of cyclones and hurricanes	
	Unit – 4: Diffraction and Polarisation	
Chapter 8 Fraunhofer diffraction	Introduction to diffraction- Fraunhofer diffraction- Single slit diffraction pattern-position of maxima and minima, Fraunhofer diffraction at double slit. Theory of plane diffraction grating-Grating spectrum- normal and oblique incidence- Resolving power and dispersive power of a grating.Numerical problems.	4
Chapter 9 Fresnel Diffraction	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.	3
Chapter 10 Polarisation	Introduction-Methods of producing polarized light, plane of vibration and plane of polarization, double refraction, optic axis, principle section of doubly refracting crystals, principal refractive indices, theory of retarding plates, Quarter wave plates and half wave plates, circular and elliptically polarized light-analytical treatment, Fresnel's theory of optical activity, The wire Grid polarizer.	7

Suggested Activities

Design a diffraction grating and use it to determine the radius of a thin wire using a laser source. 01

Initiate a group discussion on the uses of polaroids.

Text Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Vibrations and Waves	A. P. French	CRC Press	1971
2	University Physics	Hugh D. Young	Pearson	1952
3	Fundamentals of Physics	Robert Resnick, Jearl Walker, David Halliday	Wiley	2003
4	Optics	Ajoy Ghatak	McGraw Hill Education (India) Pvt Ltd	2017
5	Fundamentals of Optics	Francis Jenkins and Harvey Elliott White	McGraw Hill	1937
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	The Feynman Lectures on Physics Vol. 2	Feynman, Leighton and Sands	Pearson India	Millennium Edition
5	Fundamentals of Optics	Francis Jenkins Harvey White	McGraw Hill Education	2017

List of Experiments to be performed in the Laboratory

Sl No	Experiment
1	Determination of wavelength of light using prism spectrometer
2	Diffraction grating- Normal incidence method
3	Frequency of AC using Sonometer.
4	Study of Lissajous' Figures
5	Damped oscillations
6	Newton's rings
7	Helmholtz resonator using electrical signal generator.
8	Air wedge
9	Network theorems
10	Diffraction at a straight wire

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

Semester: III	
Course Title : FUNDAMENTALS OF OPTICS AND ELECTRICITY **Course Code: G 501 OE1.3**	Course Credits: 3
Total Contact Hours: 40	Duration of ESA: 2 Hrs.
Formative Assessment Marks: 15	Summative Assessment Marks: 35

Course Outcomes (COs):

At the end of the course the student should be able to:

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6
CO-1. Learn about the fundamental principles of propagation of light through various optical media.	x	x		x		
CO-2. Acquire necessary skills/hands on experience/working knowledge of mirrors, lenses, prisms and optical devices and instruments.	x				x	
CO-3. Acquire the basic knowledge of principles in electrostatics and electricity.	x	x		x	X	
CO-4. Gain a working knowledge on economics of energy consumption.	x	x	x			X

Content		Hrs
Unit - 1		
Chapter 1	**Light :** Introduction, Four important theories of light, sources of light, properties of light, reflection and refraction, dispersion, velocity of light, visible spectrum, refractive index Numerical problems	2
Chapter 2	**Reflection and Refraction:** Laws of reflection, mirrors – plane, convex, concave, parabolic mirrors and their applications. Laws of refraction, Snell's law, Refractive index, Lateral shift, Normal shift, critical angle, total internal reflection, Totally internally reflecting prisms and their applications.	5
Chapter 3	**Fibre optics :** Wave Guides, Optical fibre, Critical angle of propagation, Modes of propagation, Acceptance Angle, Numerical aperture, Attenuation, Types of optical fibres, Fibre optic communication	6

	systems and their advantages. Applications	
Topics for self study (If any)	Study the theory of elliptical mirror and its design. Medical applications of optical fibres. Photonic Crystal fibres	
	Suggested Activities	
Activity No. 1	Construct a periscope.	2
	Construct a kaleidoscope.	
Activity No. 2	Construct a pin hole camera	
	Construct octagonal rotating mirror	
Unit – 2		
Chapter 4.	**Lenses :** Lenses ,types of lenses, sign convention, thin lenses, lens formula, lens makers formula, magnification, power of a lens Numerical problems.	4
Chapter 5.	**Optical Instruments :** Microscopes-simple microscope, compound microscopes. Telescopes- types of telescopes. Prism binoculars, camera, camera lenses, Numerical problems	6
Topics for self study (If any)	Working of an astronomical telescope, Working of Electron microscopes.	
	Suggested Activities	
Activity No. 3	Construct Galilean telescope	2
Activity No. 4	Construct Reflecting telescope	
Unit – 3		
Chapter 6	**Electricity:** Electric charges, electric field, electric potential, potential difference. Capacitors- Parallel plate capacitors, energy stored in a capacitor, Numerical problems.	4
Chapter 7	**Electric current :** Inrtroduction, Conductors and insulators, Ohm's law and its applications, Variation of resistance of a conductor with temperature,Power, heat dissipation, fundamental concepts of AC and DC. Numerical problems	5

Chapter 8	**Electrical appliances:** Working of electric iron, electric water heater, bulbs, tube lights - power rating and power consumption. Numerical problems	3
Topics for self study (If any)	Concept of resistivity, Origin of resistance. Kirchoff's laws	
	Suggested Activities	
Activity No. 5	Construct a water heater using a DC source	2
Activity No.6	Construct a two-way switch	

Text Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Fundamentals of Optics	Francis Jenkins, Harvey White	Mc Graw Hill	1976
2	A Text Book of Optics	N. Subrahmanyam Brijlal, M N Avadhanulu	S Chand	2006
3	Basic Electronics	B L Theraja	S Chand	2007
4	University Physics	Hugh D Young, Roger A Freedman	Pearson	

References Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Handbook of Repair and Maintenance of Domestic Electronics Appliances	Shashibhushan Sinha	BPB Publications	2016
2	Principles of Physics	J Walker, David Halliday, Robert Resnick	Wiley	2015
3	DIY Guide to Appliances	Steve Wilson	Creative Publishing International	2008

Semester – IV

Course Title: Thermal Physics and Electronics Course Code: G 501 DC1.4	Course Credits: 4
Total Contact Hours: 52	Duration of ESA: 2 Hrs.
Formative Assessment Marks: 60	Summative Assessment Marks: 40

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 clearinstructions.

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

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6
CO-1: Will learn the mathematical skills to understand concepts of thermal physics and electronics.	x	x		x	x	
CO-2: Will gain the needed knowledge of the fundamental laws of thermal physics and their application	x	x			x	
CO-3: Will acquire the ability to differentiate between the effect of steady and variable currents in electrical circuits.	x	x		x		x
CO-4: Will understand the intricacies of thermal physics and electronics.	x	x	x		x	
CO-5: Using the ideas obtained from variable currents will comprehend the concepts of converting other forms of energy into electrical energy	x	x			x	
CO-6: Will understand the scope of heat and thermodynamics in further academic pursuits and also factor in the need of a functional as well as advanced knowledge of electronics.	X	x	x	x		x

Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content

Semester – IV

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

Unit – 1

Thermodynamics:

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

Zeroth Law of Thermodynamics : Statement, Definition of temperature.

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

Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Reversible and Irreversible process with examples. Heat Engines: Carnot engine & efficiency. Refrigeration & coefficient of performance, Applications of Carnot cycle, 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. **(2 Hours)**

Numerical Problems.

Suggested Activities

Activity No. 1

1. Study the working of the diesel engine
2. Study the working of the petrol engine. (1 **Hour)**

Activity No. 2

1. Discuss how geothermal energy can be used to extract work.
2. Study the design of a refrigerator without moving parts. **(1 Hour)**

Unit – 2

Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Properties and Applications. **(3 Hours)**

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 and Cv (3)Joule-Thomson Effect , Joule-Thomson coefficient and Vander Walls equation for a real gas. Attainment of low temperature by liquefaction of gases and adiabatic demagnetization. **(4 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. **(3 Hours)**

Radiation: Blackbody radiation, spectral distribution, 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. **(3 Hours)**

Suggested Activities

Activity No. 3

1. Design an experiment to measure Solar Constant.
2. Study the variation of thermo emf using a thermocouple.

Activity No. 4

1. Design an experiment to determine the specific heat of a liquid.
2. Experimentally verify the inverse square law of radiation.

Unit - 3

Semiconductor devices: Review of Intrinsic and Extrinsic semiconductors, p-n junction and its Characteristics and Parameters, Diode approximations, 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 Base, Common Emitter and Common Collector Characteristics. Transistor biasing circuits, DC load line. Field Effect Transistor (FET)- JFET and MOSFET **(6 hours)**

Suggested Activities (2 hours)

Activity No. 5

1. Wire a DC power supply on a bread board or groove board to give a regulated output voltage.
2. Study the design of 3-pin regulators
3. Build a Joule thief circuit.

Activity No. 6

1. In the case of power transistors, learn how to fix a heat sink for the transistor.
2. Bridge rectifier simulation using Tinkercad circuits
3. Design a transistor based switching circuit for various applications.

Unit - 4

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. **(4 hours)**

Boolean Algebra: Boolean postulates and theorems. POS and SOP forms, Algebraic Simplification. Digital Circuits: Logic gates - NOT, AND, OR, NAND, NOR, XOR, XNOR. NAND and NOR as universal gates. **(4 hours)**

Suggested Activities

Activity No. 7

1. Learn how to implement logic functions (AND, OR, NOT) using diodes, transistors and resistors
2. Design and construction of logic gates using switches.

(1 hours)

Activity No. 8

1. Fabrication of audio amplifiers using IC
2. Design of differential amplifier for desired gain.

Reference Books:

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Heat and Thermodynamics	M.W. Zemansky, Richard Dittman	McGraw-Hill.	1981
2	Thermal Physics (2nd edition)	S. Garg, R. Bansal and Ghosh	Tata McGraw-Hill	1993
3	A Treatise on Heat	Meghnad Saha, and .N.Srivastava	Indian Press	1958
4	Modern Thermodynamics with Statistical Mechanics	Carl S. Helrich	Springer.	2009
5	Thermodynamics, Kinetic Theory & Statistical Thermodynamics	Sears & Salinger	Narosa	1988
6	An Introduction to Thermal Physics	Daniel V Schroeder	Oxford University Press	2020
7	Electronic Devices and Circuit Theory	Louis Nashelsky and Robert Boylestad	Pearson	1972
8	Op-amps and linear integrated circuit	Ramakant A. Gayakwad	PHI	1983

	technology			
9	Electronic Devices and Circuits	David A. Bell	PHI, New Delhi	2004
10	Integrated Electronics	Jacob Millman and CC Halkias	McGraw-Hill	1967
11	Digital Fundamentals	Floyd	PHI, New Delhi	2001

Lab Experiments List

Sl No	Experiments on electronics
1.	Thermal conductivity by Forbes method
2.	Verification of Stefan's law.
3.	Specific heat of liquids by the method of cooling.
4.	V-I Characteristics of Silicon & Germanium PN Junction diodes (FB & RB)
5.	V-I Characteristics of Zener diode
6.	Voltage regulator using Zener diode.
7.	Characteristics of BJT in Common Emitter Configuration
8.	Half Wave and Full Wave
9.	Applications of Operational Amplifier – Inverting, Non-inverting and difference amplifiers.
10.	Voltage follower, Adder and Subtractor circuits using op-amp.
11.	Construction of Logic gates using diodes and transistors/ Construction of various gates using IC7400

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Basic Electronics Lab (P242) Manual 2015-16		National Institute of Science Education and Research Bhubaneswar	2015

Weightage for the formative and summative components

	Summative	Formative
Theory	40 (TS)	60(TF)
Practical's	50(PS)	50(PF)

Outline for the summative component (Internal assessment) of theory paper

Activities	C1	C2	Total marks
Session test	10	10	20
Assignment	10		10
Project		10	10
Total	20	20	40

Outline of the formative component of theory paper

Duration	Type of Question	Total number of questions	Number of Questions to be answered	Marks for each Question	Marks
2 Hours	Short Answer type	6 (Minimum of one question from each unit)	4	2	8
	Long answer type	8 (Two questions from each unit)	4 (Answer one question from each unit)	10	40
	Numerical Problems	4	3	4	12
Total Marks					60

Scheme of Practical Examination (Minimum 8 experiments are to be carried out)

Allotment of Marks	
Record Book	8
Formula	3
Diagram/Circuit, Experimental set up	3
Observations & Trials	6
Knowledge about the experiment	3
Result & Accuracy	2
Total	25

Regularity	15
Test	10
Total	25

Course Content
Open Elective

Semester: IV

Course Title : **FUNDAMENTALS OF ENERGY STORAGE DEVICES AND INVERTERS** **Course Code:** G 501 OE1.4	Course Credits: 3
Total Contact Hours: 40	Duration of ESA: 2 Hrs.
Formative Assessment Marks: 15	Summative Assessment Marks: 35

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6
CO-1. Learn about the fundamental principles of electricity and capacitors.	x	x		x		x
CO-2. Gain working knowledge on inverters in the field of energy storage.	x	x				
CO-3. Acquire the basic knowledge of principles of energy storage devices.	x	x		x		x
CO-4. Gain a working knowledge on the scale of domestic energy consumption.	x	x	x		x	

Course Content

Content		Hrs
Unit - 1		
Chapter 1	**Electric Current:** Introduction, Voltage, Electric Current, Resistance, Conductance, Electrical Energy, Power. Numerical problems.	2
Chapter 2	**Capacitors:** Capacitance of a spherical conductor, Parallel plate Capacitor, Spherical Capacitor, Cylindrical capacitor, Variable capacitor. Energy stored in capacitors. Applications. Numerical problems.	5

Chapter 3	**Batteries :** Cells, Types of cells, emf of a cell, internal resistance, terminal potential difference, relation between electric current and emf of a cell in a simple circuit. Combination of cells- cells in parallel, cells in series, series-parallel combination of cells. Numerical problems.	6
Topics for self study (If any)	Lithium titanate batteries, nickel-cadmium batteries, SHE	
	Suggested Activities	
Activity No. 1	Charging a lead acid battery with different battery chargers.	2
Activity No. 2	Charging and discharging of capacitor and calculation of energy stored with time**.**	
Unit – 2		
Chapter 4.	**Energy storage :** Purpose of batteries, Full charge, Appearance of normal cells, Chemical changes, Internal self-discharge and effect of impurities on floating voltage, Temperature characteristics, Proper amount of charge, High-rate overcharging Low-rate overcharging, Undercharging, over discharge, Sedimentation, Replacement water, Water replacement rate for lead-antimony cells, Water replacement rate for lead-calcium cells, Water replacement for lead-selenium cells, Adjusting specific gravity, Hydrometer readings, Constant voltage charging	7
Chapter 5.	**Maintenance of batteries:** Battery life for different types and services, Cleanliness, Internal shorts, Normal sulfate and over sulfation, Elimination of over sulfation, Water treatment for over sulfation. Normal sulfate and over sulfation, Elimination of over sulfation, Water treatment for over sulfation, Acceptance testing, Capacity tests to determine replacement, Flooded, wet cell. Lead-acid battery maintenance schedule.	4
Topics for self study (If any)	Thermal management system of a battery.	
	Suggested Activities	
Activity No. 3	Determination of specific gravity of a cell using hydrometer.	2
Activity No. 4	Preparation of battery electrolyte with pH meter.	

Unit – 3		
Chapter 6	**Inverters:** Planning & Design: Planning Procedure, System capacity and Energy Demand, System concept, Module selection and PV Generator, Selection and sizing of cables, Standalone System; Battery sizing, Charge Controller and Inverter,	5
Chapter 7	**Off-Grid connection:** Selection and inverter sizing, Generator Junction Box and DC Main Switch, Safety Measures, Mounting System, tender specification, Standards and certification .	5
Topics for self study (If any)	Working of FET and MOSFET in the functioning of an inverter.	
	Suggested Activities	
Activity No. 5	Construction of a Sine wave inverter using lead lag circuit.	2
Activity No.6	Calibration of thermostat with variation of temperature.	

Text Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Electronic Devices And Circuits Theory	Robert L. Boylestad, Louis Nashelsky	Pearson	2009
2	Basic Electronics	B L Theraja	S Chand	2007
3	Advanced DC/AC invertors : Applications in Renewable Energy	Fang Lin Luo, Hong Ye	CRC Press	2017
4	Electrical Engineer's Reference book	D F Warne, M A Laughton		2002

References Books

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Handbook of Repair and Maintenance of Domestic Electronics Appliances	Shashibhushan Sinha	BPB Publications	2016

2	Solar photovoltaic technology and systems	Chethan Singh Solanki	PHI	2015
3	DIY Guide to Appliances	Steve Wilson	Creative Publishing International	2008

Pedagogy:

Weightage for the formative and summative components

	Summative	**Formative**
Theory	40 (TS)	60(TF)
Practical's	50(PS)	50(PF)

Outline for the summative component (Internal assessment) of theory paper

Activities	**C1**	**C2**	**Total marks**
Session test	10	10	20
Assignment	10		10
Project		10	10
Total	20	20	40

Outline of the formative component of theory paper

Duration	**Type of Question**	**Total number of questions**	**Number of Questions to be answered**	**Marks for each Question**	**Marks**
2 Hours	Short Answer type	6 (Minimum of one question from each unit)	4	2	8
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	Numerical Problems	4	3	4	12

Scheme of Practical Examination
(Minimum 8 experiments are to be carried out)

Allotment of Marks	
Record Book	8
Formula	3
Diagram/Circuit, Experimental set up	3
Observations & Trials	6
Knowledge about the experiment	3
Result & Accuracy	2
Total	25

Regularity	15
Test	10
Total	25

Outline for the summative component of practical paper

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Course Content for Semester- V

Programme Name : B.Sc Semester: 5

Course Title: Classical mechanics and Quantum mechanics

Course code: G501 DC1.5 , Physics V(a) No. of credits:4

Contact Hours: 60 Hours, THEORY PER WEEK: 4 Hours.

Duration of SEA/ Exam : 2.30 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 realise

CO1) Failure of classical physics at the microscopic level. (BL-L2)

CO2) Relationship between the normalization of a wave function and the ability to correctly calculate expectation values or probability densities.
(BL-L3)

CO3) Minimum uncertainty of measuring both obsevables on any quantum state.
(BL-L2)

CO4) The time- dependent and time – independent Schrodinger equation for simple potentials like for instance one – dimensional potential well and Harmonic oscillator.(BL-L3)

CO5)Hermitian operators, their eigenvalues and eigenvectors.It teaches about various commutation and uncertainty relations.(BL-L2)

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.

CONTENTS

Unit I: Introduction to Newtonian Mechanics:

Frames of references, Newtonn's laws of motion, inertial and non-inertial frames.Mechanics of a particle, conservation of linear momentum,Angular momentum and Torque, conservation of angular momentum, work done by a force, conservative force and conservative energy.

Lagrangian formulation: Constraints,Halonomic constraints,non – halonomic constraints, Scleronomous and Rheonomous constraints. Generalized coordinates, degrees of freedom, Principle of virtual work, D'Alembert's principle, Lagranges

equations.Newton's equation of motion from Lagrange equations,simple pendulum, Atwood's machine and linear harmonic oscillator. Problems

15 Hours

Unit II: Variational principle:

Hamilton's principle, deduction of Hamilton's principle,Lagrange s equation of motion from Hamilton's principle, Hamilton's principle Non- holonomic systems.

Hamiltonian Machanics: The Hamiltonian of a system, Hamilton's equations of motion, Hamilton's equqtions from variational principle, integrals of Hamilton's equations,energy integrals, Canonical transformations, Poion Brackets,fundamental properties and equations of motion in Poison Brackets. Problems

15 Hours

Unit III : Introduction to Quantum Mechanics:

Brief discussion on failure of classical physics to explain black body radiation, Photoelectric effect, Compton effect, stability of atoms and spectra of atoms.

Compton scattering: Expression for Compton shift (with derivation).

Matter waves: de Broglie hypothesis of matter waves,Electron microscope, Wave description of particles by wave packets, Group and Phase velocities and relation between them,Experimental evidence for matter waves.Davisson – Germer experiment,G.p Thomson's experiment and its significance.Heisenberg's uncertainty principle: Elementary proof of Heisenberg's relation between momentum and position,energy and time,angular momentum and angular position, illustration of uncertainty principle by Gamma ray microscope thought experiment.Consequences of the uncertainty relations:Diffraction of electrons at a single slit, why electron cannot exist inside nucleus?

Two- slit experiment with photons and electrons. Linear superposition principle as a consequence. Problems 15 Hours

Unit IV: Foundation of Quantum mechanics:

Probabilistic interpretation of wave function-normalization and orthonality of wave functions, Admissibility conditions on a wave function, Schrodinger equation: Equation of motion of matter waves-Schrodinger wave equation for a free particle in one and three-dimension, time -dependent and time -independent wave equations, Probability current density, equation of continuity and its physical significance, Postulates of Quantum mechanics: States as normalized wavefunctions.Dynamical variables as linear Hermitian operators(position,momentum,angular momentum and energy as examples).Expectation values of operators and their time evolution.Ehrenfest theorem(no derivation), commutator brackets-Simultaneous Eigen functions,Commutator bracket using position, momentum and angular momentum operators.

Particle in a one-dimensional infinite potential well(derivation),degeneracy in three-dimensional case, particle in a finite potential well(qualitative),Transmission across a potential barrier, the tunnel effect(qualitative0,scanning tunneling microscope, One

dimensional simple harmonic oscillator(qualitative)-concept of zero-point energy .Problems 15 Hours

References:

1. Classical Mechanics, H. Goldstein, C.P .Poole, J.L. Safko, 3rd Edn. 2002, Pearson Education.
2. Classical Mechanics: An introduction, Dieter Strauch,2009, Springer
3. Classical Mechanics, G. Aruldhas,2008, Prentice-Hall of India Private limited, New Delhi.
4. Classical Mechanics, Takwale and Puranik-1989, Tata Mcgraw Hill, New Delhi.
5. Concept of Modern Physics, Arthur Beiser, McGraw-Hill, 2009.
6. Physics for Scientists and Engineers with Modern Physics, Serway and Jewett, 9th edition, engage Learning, 2014.
7. Quantum Physics, Berkely Physics Course Vol. 4. E. H. Wichman, Tata McGraw-Hill Co., 2008.
8. Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, McGraw Hill, 2003.
9. P M Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill publication, ISBN:9780070146174.
10. Ajoy Ghatak, S. Lokanathan, Quantum Mechanics: Theory and applications, Springer Publication, ISBN 978-1-4020-2130-5.
11. Modern Physics: R. Murugeshan and K. Sivaprarasath; S. Chand Publishing.
12. G Aruldhas, Quantum Mechanics, Phi Learning Private Ltd., ISBN:97881203363.
13. Gupta, Kumar and Sharma, Quantum Mechanics, Jai Prakash Nath Publications.
14. Physics for Degree Students B.Sc .,Third year, C.L. Arora and P.S. Hemme, 1stedition, S. Chand and Company Pvt. Ltd., 2014.

Activities:

1.Superposition of eigen states in an infinite one-dimensional potential well using QuVis(Quantum Mechanics Visualization Project).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 particle in an infinite one -dimensional potential well using Physlet@Quantum Physics:
The link is as follows
https://www.compadre.org/PQP/quantum-theory/prob10_3.cfm

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

4.Visulisation of wave packets using Phydlet@Quantum Physics:
Link is
https://www.compadre.org/PQP/quantum-need/section59.cfm

5.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.

6.Demonstrate of Heisenberg uncertainty principle in the context of diffraction at a single slit:

Use the following link

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

Lab Experiments:

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. Studying the effect of amplitude of oscillation on the time period of the simple pendulum.
4. Determination of acceleration due to gravity using an Atwood's machine.
5. Study the conservation of energy and momentum using projectile motion.
6. Verification of the Principle of Conservation of Linear Momentum.
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 Milikan'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. To determine the value of e/m for an electron by magnetron method.
13. To study the tunnelling in Tunnel diode using I-V characteristics.
14. Determination of quantum efficiency of Photodiode.
15. A code in C/C++/Scilab to find the first seven eigen states and eigen functions of Linear Harmonic Oscillator by solving the Schrodinger equation.
16. A code in C/C++/Scilab to plot and analyse the wavefunctions for particle in an infinite potential well.

    Note: (At least 4 experiments from 1-6 and 4 experiments from 7-16 in the above list are to be performed in lab)

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 and 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 BL and Flint H T.

Course Content for Semester- V

Programme Name : B.Sc Semester: 5

Course Title: Elements of Atomic ,Molecular and Laser Physics

Course code:G501 DC2.5, Physics V(b) No. of credits:4

Contact Hours: 60 Hours THEORY PER WEEK: 4 Hours.

Duration of SEA /Exam : 2.30 Hours

Formative Assessment marks:40 Summative Assessment marks: 60

Course Outcomes (COS):

After the completion of the course, the student will be able to realise the following.

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.

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.

CONTENTS

UNIT I: Basic Atomic models :

Thomson's atomic model, Rutherford atomic model, Theory of alpha particle scattring, Rutherford scattering formula, 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 ionization potential. Atomic excitation and its types, Franck -Hertz experiment. Sommerfeld's atomic model, derivation of condition for allowed elliptical orbits . Problems 15 Hours

Activities:

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 ionization potentials of different elements and plot the graph of critical/excitation/ionization potentials versus atomic

number/mass number/neutron number of element.Analyse the nature of the graph and draw the inferences.

UNIT II: 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, 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,Stern-Gerlach experiment-Experimental arrangement and principle,Fine structure of spectral lines with examples,Spin -orbit coupling/Spin -Orbit Interaction- (qualitative). Optical spectra-spectral terms,spectral notations, selection rules,intensity rules,fine structure of the sodium D-line, Zeeman effect and its types with examples,Stark effect and its types with examples. Problems 15 Hours

Activities:

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.

1. Students to estimate magnetic dipole moment due to orbital motion of electron for different states $^2P_{1/2}$, $^2P_{3/2}$, $^2P_{5/2}$, $^2P_{7/2}$,$^2P_{9/2}$, $^2P_{11/2}$ and plot the graph of dipole moment versus total orbital angular momentum "J". Analyse the nature of the graph and draw the inferences.

UNIT III: 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, 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 theories,Experimental study of Raman effect,Applications of Raman effect. Problems 15 Hours

Activities:

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 IV : Laser Physics :

Ordinary light versus laser light, Characteristics of laser light, Interaction of radiation with matter-Induced absorption,spontaneous emission and stimulated emission with rate equations,Einstein's A and B coefficients-Derivation of relation between Einstein's coefficents 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, three level lasers and four level lasers.Working principle of Ruby laser and He-Ne laser, Applications of Lasers(qualitative) in science and research, isotope separation,communication, fusion, medicine, industry, war and space. Problems 15 Hours

Activities:

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.

Text Books:

1. Modern Physics , R.Murugeshan, Kiruthiga Sivaprakash, Revised Edition,2009, S.Chand and Company Ltd.
2. Atomic and Molecular spectra: Laser, Raj Kumar, Revised Edition, 2008, Kedar Nath RamNath Publishers,Meerut.
3. Atomic Physics, S.N Ghoshal, Revised Edition, 2013,S.Chand and 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.

LIST OF Experiments:

1. To determine Planck's constant using Photocell.
2. To determine Planck's constant using LED.
3. To determine wavelength of spectral lines of mercury source using spectrometer.
4. To determine the value of Rydberg's constant using diffraction grating and hydrogen discharge tube.
5. To determine the wavelength of H-alpha emission line of Hydrogen atom.
6. To determine fine structure constant using fine structure separation of sodium D-lines using a plane diffraction grating.
7. To determine the value of e/m by Magnetic focusing or Bar magnet.
8. To determine the ionization potential of mercury.
9. To setup the Milikan oil drop apparatus and determine the charge of an electron.
10. To determine the absorption lines in the rotational spectrum of Iodine vapour.

11. To determine the force constant and vibrational constant for the iodine molecule from its absorption spectrum.
12. To determine the wavelength of laser source using diffraction by single/double slit.
13. To determine wavelength of He-Ne laser using plane diffraction grating.
14. To determine angular spread of He-Ne laser using plane diffraction grating.
15. Study of Raman scattering by CCl_4 using laser and spectrometer/CDS.

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

Reference Books:

1.University Practical Physics, D.C.Tayal, First Millenium Edition, 2000,Himalaya Publishing House.

2. B.Sc. Practical Physics, C.L. ARORA, Revised Edition, 2007, S.Chand and 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.

4.Physics through experiments, B. Saraf, 2013, Vikas Publications.

Course Content for Semester- VI

Programme Name : B.Sc Semester: 6

Course Title: Elements of Condensed Matter and Nuclear Physics

Course code: G501 DC1.6 , PhysicsVI(a) No. of credits:4

Contact Hours: 60 Hours, THEORY PER WEEK: 4 Hours.

Duration of SEA/ Exam : 2.30 Hours

Formative Assessment marks:40 Summative Assessment marka: 60

Course Outcomes(COS):

CO1: 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

CO2: Knowledge of lattice vibrations,phonons and in depth knowledge of Einstein and Debye theory of specific heat of solids.

CO3: Knowledge of different types of magnetism from diamagnetism to ferromagnetism and hysteresis loops and energy loss

CO4: Securing an understanding about the dielectric and ferroelectric properties of materia;s.

CO5: Understand the basic idea about superconductors and their classifications.

CO6: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 versus mass number graph.

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.

CONTENT

UNIT I: Condensed Matter Physics

Crystal systems and X-Rays: Crystal structure, lattice translational vectors,Basis of crystal structure,Types of unit cells, primitive, non primitive cells. Winger-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 coincept of phonons, Specific heats of solids:Classical theory, Einstein's and Debye's theory of specific heats.Hall effect in metals.

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. 15 Hours

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. Ferromagnetism and Ferromagnetic Domains(qualitative).Discussion of B-H Curve.Hysteresis and Energy loss, Haed and soft magnetic materials.

Dielectrics : Static dielectric constant, polarizability(electronic, ionic and orientation), calculation of Lorentz field(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.

Activities:

1. Magnetic field lines are invisible.Students to trace the magnetic field lines using bar magnet and needle compass.
2. Using vegetable oil and iron filings students to make ferrofluids and see how it behaves in the presence of magnetic field. 15 Hours

UNIT III: Nuclear Physics:

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

Radioactive decay: Alpha decay: basics of alpha decay process, theory of alpha emission(brief),Gamow factor, Geiger -Nuttal law. Beta Decay: Energy kinematics for beta decay, positron emission, electron capture, neutrino hypothesis.Gamma decay: Gamma rays emission and kinematics, internal conversion(Definition)

Activities:

1.Study the decay scheme of selected alpha,beta and 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 the mass number A

3.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 law in each series

15 Hours

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.

Activities:

1.Study the Z dependance of photoelectric effect cross section.

2.Study the Z dependance 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 disadvatages.

15 Hours

References:

Text Books:

1. Solid State Physics-R.K. Puri and V.K Babber.,S.Chand Publications, Ist 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-AJ Dekkar,MacMillan India Ltd,(2000).

3.Essential of crystallography, MA 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 McGrawHill,1998).

6.Introduction to the physics of nuclei and 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 measurements ,G.F.Knoll(John Wiley and sons, 2000).

10.Physics and engineering of Radiation Detection,Syed Naeem Ahmed(Academic Press,Elsevier,2007).

Lab Experiments:

Note: Minimum of 8 experiments are to be performed.

Condensed Matter Physics:

1. Determination of Planck's constant by Photo cell.
2. Hall effect in semiconductor: Determination of mobility, Hall coefficient.
3. Energy gap of semiconductor(diode/transistor) by reverse saturation method.
4. Thermistor Energy gap.
5. Fermi Energy of Copper.
6. Analysis of X-ray diffraction spectra and calculation of lattice parameter.
7. Planck's constant by LED.
8. Specific Heat of solid by electrical method.
9. Determination of Dielectric Constant of Polar liquid.
10. Determination of dipole moment of organic liquid.
11. B-H Curve using CRO.
12. Spectral Response of Photo Diode and its I-V characteristics.
13. Determination of particle size from XRD pattern using Debye-Scherrer formula.
14. 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 characteristics of Geiger-Muller Tube. Determine the threshold voltage, plateau region and operating voltage.
2. Study the absorption of beta particles in aluminium foils using GM counter. Determine mass attenuation coefficient of aluminium foils.
3. 3Study the absorption of beta particles in thin copper foils using GM counter and determine mass attenuation coefficient.
4. Study the attenuation of gamma rays in lead foils using Cs-137 source and GM counter. Calculate mass attenuation coefficient of lead for gamma.
5. Determine the end point energy of Tl-204 source by studying the absorption of beta particles in aluminium foils.
6. Study the attenuation of absorption of gamma rays in polymeric materials using Cs-137 source and GM counter.

Reference Books:

1. IGNOU: Practical physics manual.
2. Saraf: Experiments in Physics, Vokas 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)

Course Content for Semester- VI
Programme Name : B.Sc Semester: 6
Course Title: Electronic Instrumentation and Sensors
Course code: G 501 DC2.6, Physics VI(b) No. of credits:4
Contact Hours: 60 Hours, THEORY PER WEEK: 4 Hours.
Duration of SEA/ Exam : 2.30 Hours
Formative Assessment marks:40 Summative Assessment marks: 60
Course Outcomes: (COS)

CO1.Identify different types of test and measuring instruments used in practice and understand their basic working principles.

CO2.Get hands on training in wiring a circuit,soldering,making a measurement using an electronic circuit used in instrumentation.

CO3.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.

CO4.Understanding of the measurement of voltage,current,resistance value, identification of the terminals of a transistor and ICs.

CO5.Identify and understand the different types of transducers and sensors used in robust and hand held instruments.

CO6.Understand and give a mathematical treatment of the working of rectifiers, filter,data converters and different types of transducers.

CO7.Connect the concepts learnt in the course to their practical use in daily life.

CO8. Develop basic hands on skills in the usage of oscilloscopes, multimeters, rectifiers, amplifiers, oscillators and high voltage probes, generators and digital meters.

CO9. Servicing of simple faults of domestic appliances: Iron box,immersion heater, fan, hot plate, battery charger, emergency lamp and the like.

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.

UNIT I: 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 filters,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,single 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.

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:

1.Design and wire your own DC regulated power supply.Power output:5V,10V, $\pm$5V

2.Extend the range of measurement of voltage of a voltmeter (analog or digital) using external component and circuitry. Student has to design his own circuit and report.

3. Measure the characteristics of the signal waveformusing 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. 15 Hours

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(3 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(+15 V). 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 (analog0 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-ampmay be used.The status of the output may be checked by LED. 15 Hours

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 width modulation(PWM)-General principles. Principle of Phase Sensitive Detection (PSD).

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

Activities:

1. Explore where modulation and demodulation technique is employed in real life. Visit a radio broadcasting station.(Akashavani 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. 15 Hours

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.

Activities

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 0 degree celsius, melting ice0 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. 15 Hours

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.Sama, V.S.V Mani,Tata McGraw HillEducation Pvt.Ltd.(Especially for circuitry and analysis of signal generators and filters).

List of Experiments:

Note: Minimum of 8 experiments are 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 Wein bridge oscillator (sine wave oscillator) using μA 741 op-amp. Choose the values of R and C for a sine wave frequency of 1KHz. 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 741 is replaced 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 high pass filter.
8. Study the characteristics of pn – junction of a solar cell and determine its efficiency.
9. Study the illumination intensity of a solar cell using a photo detector(e.g., lux meter).
10. Study the characteristics of a LED(variation of intensity of emitted light).
11. Study the characteristics of a thermistor(temperature coefficient of resistance).
12. Study the characteristics of a photo diode.
13. Determine the coupling coefficient of a piezo-electric crystal.
14. Study the amplitude modulation using a transistor.
15. Performance analysis of A/D and D/A converter using resistor ladder network and op-amp.

Reference Texts:

1. Advanced Practical Physics for students, B.L. Flint and H.T., Worsnop,1971,Asia Publishing House.
2. B.Sc Practcal , 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.

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