Bangalore University
Department of Physics

Jnanabharathi Campus
Bengaluru – 560 056

Syllabus for
1st & 2nd Semester Physics Papers
Under-Graduate(UG) Program

Framed according to the National Education Policy (NEP 2020)

(Effective from the Academic Year 2021-22)

Board of Studies in Physics (UG) Members

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Date: 18 September 2021
Place: Bengaluru

Names	Members	Signature
Dr. A R Ushadevi, Professor & Chairman Department of Physics, Bangalore University, Bengaluru-560056.	Chairperson	18/9/2024
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Dr. B N Meera, Associate Professor (Invited) Department of Physics, Bangalore University Jnanabharthi Campus, Bengaluru-560056.	Member	B. N. Meera
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Dr. Seeta Vasudevrao, Assistant Professor, (Invited) Government First Grade College, Kengeri, Bengalore-560002.	Member	Seeta V

Introduction

The NEP-2020 offers an opportunity to effect a paradigm shift from a teacher-centric to a student-centric higher education system in India. It is based on Outcome Based Education, where the Graduate Attributes are first kept in mind to reverse-design the Programs, Courses and Supplementary activities to attain the graduate attributes and learning outcomes. The learning outcomes-based curriculum framework for a degree in B.Sc. (Honours) Physics is intended to provide a comprehensive foundation to the subject and to help students develop the ability to successfully continue with further studies and research in the subject while they are equipped with required skills at various stages. The framework is designed to equip students with valuable cognitive abilities and skills so that they are successful in meeting diverse needs of professional careers in a developing and knowledge-based society. The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of the knowledge and skills in Physics, as well as to develop scientific orientation, spirit of enquiry problem solving skills and human and professional values which foster rational and critical thinking in students.

Graduate attributes in Physics

Some of the characteristic attributes a graduate in Physics should possess are:

- Disciplinary knowledge and skills:
- Skilled communication:
- Critical thinking and problem solving capacity:
- Sense of inquiry:
- Team player/worker:
- Project Management Skills:
- Digital and ICT efficiency:
- Ethical awareness / reasoning:
- National and international perspective:
- Lifelong learning

Flexibility

- The programmes are flexible enough to allow liberty to students in designing them according to their requirements. Students may choose a single Major, one Major with a Minor, and one Major with two Minors. Teacher Education or Vocational courses may be chosen in place of Minor/s. Below listed are the various options students may choose from.
- One Major subject/discipline, Two Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses including Extracurricular Activities.
- One Major and one Minor subject/discipline along with Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses including Extracurricular Activities
- Two Major subject/disciplines along with Languages, Generic Electives, Ability Enhancement, Skill Development and Vocational courses, including Extracurricular Activities (subject to fulfilling the requirements as stated in 3.i and 3.ii)
- One Major subject/discipline and one Vocational course along with Languages, Generic Electives, Ability Enhancement and Skill Development and courses including Extracurricular Activities.
- One Major Discipline and One Education Discipline along with Languages, Generic Electives, Ability Enhancement and Skill Development Courses including Extracurricular Activities.

Progressive Certificate, Diploma, Bachelor Degree or Bachelor Degree with Honours Provided at the End of Each Year of Exit of the Four-year Undergraduate Programme/ Five-year Integrated Master's Degree Programme

EXIT OPTIONS	Credits required
Certificate upon the Successful Completion of the First Year (Two Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	44 - 48
Diploma upon the Successful Completion of the Second Year (Four Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	88 - 96
Basic Bachelor Degree at the Successful Completion of the Third Year (Six Semesters) of the multidisciplinary Four- year Undergraduate Programme/Five-year Integrated Master's Degree Programme	132 - 144
Bachelor Degree with Honours in a Discipline at the Successful Completion of the Fourth Year (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	176 - 192
Master's Degree in a Discipline at the Successful Completion of the Fifth Year (Ten Semesters) of the Five- year Integrated Master's Degree Programme	224- 240

Aims of UG program in Physics

The aims and objectives of our UG educational programs in sciences in general and Physics in particular should be structured to

- Create the facilities and environment in all the educational institutions to consolidate the knowledge acquired at +2 level and to motivate and inspire the students to create deep interest in Physics, to develop broad and balanced knowledge and understanding of physical concepts, principles and theories of Physics.
- Learn, design and perform experiments in the labs to demonstrate the concepts, principles and theories learned in the classrooms.
- Develop the ability to apply the knowledge acquired in the classroom and laboratories to specific problems in theoretical and experimental Physics.
- Expose the student to the vast scope of Physics as a theoretical and experimental science with applications in solving most of the problems in nature spanning from 10^{-15} m to 10^{26}m in space and 10^{-10} eV to 10^{25}eV in energy dimensions.
- Emphasize the discipline of Physics to be the most important branch of science for pursuing the interdisciplinary and multidisciplinary higher education and/or research in interdisciplinary and multidisciplinary areas.
- To emphasize the importance of Physics as the most important discipline for sustaining the existing industries and establishing new ones to create job opportunities at all levels of employment.

The progressive curriculum shall position knowledge and skills required on the transformation of novice problem solvers (at entry level of the program) to expert problem solvers (by the time of graduation) as given below:

- At the end of first year – Ability to solve well defined problems
- At the end of second year – Ability to solve broadly defined problems
- At the end of third year – Ability to solve complex problems that are ill-structure that require multi-disciplinary skills to solve them
- During fourth year – Experience of workplace problem solving in the form of internship or Research Experience preparing for higher education or Entrepreneurship and employment.

Curriculum Framework for Multidisciplinary Four- year Undergraduate Programme/ Five-year Integrated Master's Degree Programme

Year	Objectives	Nature of Courses	Outcome	No. of courses
1st year – (1st & 2nd Semesters)	Understanding and Exploration	1. Discipline based Core Courses 2. Open Elective 3. Languages, 4. Ability Enhancement Compulsory Courses 5. Skill Enhancement/ Development Courses	Understanding of Disciplines Language Competency Gaining perspective of context/Generic skills Basic skills sets to pursue any vocation	2+2 1+1 2+2 1+1 1+1
Exit option with Certification				
2nd Year - (3rd & 4th Semesters)	Focus and Immersion	1. Discipline based Core Courses 2. Open Elective 3. Ability Enhancement 4. Skill based/Vocational 5. Extra Curricular Activities	Understanding of disciplines Gaining perspective of context Skill sets to pursue vocation Development of various domains of mind & Personality	2+2 1+1 1+1 1+1 1+1
Exit Option with Diploma				
3rd Year - (5th & 6th Semesters)	Real time Learning	1. Major Discipline Core and Elective Courses 2. Minor Discipline/ Generic or Vocational Electives/Field based Learning/ Research Project	In depth learning of major and minor disciplines, Skill sets for employability. Exposure to discipline beyond the chosen Subject Experiential learning/ Research.	2+2 1+1 1+1
Exit option with Bachelor Degree				
4th Year - (7th &8th Semesters)	Deeper Concentration	Major Discipline Core and Elective courses Research/ Project Work with Dissertation	Deeper and Advanced Learning of Major Discipline Foundation to pursue Doctoral Studies & Developing Research competencies	4+4
Bachelor Degree with Honours				
5th Year - (9th & 10th Semesters)	Master of the subject	Major Discipline Core and Elective courses/ Research/ Project Work with Dissertation	Deeper and Advanced Learning of the Major Discipline towards gaining proficiency	4+4/6+6

			over the subject	
Master's Degree				

Course Structure
(Major Discipline: Physics)
Semester 1 - 10

SEMESTER	Discipline Core Theory (DSCT)	Core Papers
SEMESTER -1	Phy.DSCT1	Mechanics & Properties of Matter
SEMESTER -2	Phy.DSCT2	Electricity and Magnetism
SEMESTER -3	Phy.DSCT3	Wave motion and optics
SEMESTER -4	Phy.DSCT4	Thermal Physics & Electronics
SEMESTER -5	Phy.DSCT5 Phy.DSCT6	1. Classical Mechanics and Quantum Mechanics- I 2. Elements of Atomic, Molecular Physics
SEMESTER -6	Phy.DSCT7 Phy.DSCT8	1. Elements of Nuclear Physics and Nuclear Instruments 2. Elements of Condensed Matter Physics
SEMESTER -7	Phy.DSCT9 Phy.DSCT10 Phy.DSCT11	1. Mathematical Methods of Physics – I 2. Classical Electrodynamics. 3. Experimental methods of Physics 4. Research Methodology
SEMESTER -8	Phy.DSCT12 Phy.DSCT13 Phy.DSCT14	1. Classical Mechanics and Quantum Mechanics-II 2. Statistical Mechanics 3. Astrophysics & Astronomy 4. Research Project* (Select Two DSE subjects from the Pool B-II shown below) *In lieu of the research Project, two additional elective papers/ Internship may be offered.
SEMESTER -9	Phy.DSCT15	1. Mathematical Methods of Physics – II (Select One DSE subjects from the Pool B-III shown below) 2. Research Project
SEMESTER -10	Phy.DSCT17	1. Quantum Mechanics – III (Select One DSE subjects from the Pool B-IV shown below) 2. Research Project

Open Electives

1st Semester	
1.	Phy-OE1: Energy Sources
2.	*Phy-OE2: Physics for All.
2nd Semester	
3.	Phy-OE3: Atmospheric Science
4.	Phy-OE4: Sports Science
3rd Semester	
5.	Phy-OE5: Optical Instruments
6.	Phy-OE6: Elements of Astronomy and Astrophysics
4th Semester	
7.	Phy-OE7: Medical Physics
8.	Phy-OE8: Nanotechnology
9.	Phy-OE9: Electrical Instruments

***Students who have chosen Phy-DST1 are not eligible to take Open Elective paper Phy-OE2.**

Discipline Specific Electives for 7 to 10 Semesters

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

9th Sem Electives (Specialization papers) Pool B-III		**10th Sem Electives (Specialization papers)** Pool B-IV	
A.	Condensed Matter Physics-2	A.	Condensed Matter Physics-3
B.	Nuclear and Particle Physics-2	B.	Nuclear and Particle Physics-3
C.	Atomic & Molecular spectroscopy-1	C.	Atomic & Molecular spectroscopy-2

D.	Materials Physics & Nanophysics –1	D.	Materials Physics & Nanophysics -2
E.	Theoretical and Computational Physics-I	E.	Theoretical and Computational Physics-2
F.	Astronomy and Astrophysics-1	F.	Astronomy and Astrophysics-2

Detailed Syllabus for 1st & 2nd Semesters

1st Semester

Phy-DSCT1: Mechanics and Properties of Matter	Course Credits (L+T+P) : 4+0+0
Total Contact Hours: 52	Duration of ESA: 3 hours

Course Outcomes (COs):

1. Fixing units, tabulation of observations, analysis of data (graphical/analytical).
2. Accuracy of measurement and sources of errors, importance of significant figures.
3. Knowledge of how g can be determined experimentally and derive satisfaction.
4. Understanding the difference between simple and torsional pendulum and their use in the determination of various physical parameters.
5. Knowledge of how various elastic moduli can be determined.
6. Measuring surface tension and viscosity and appreciate the methods adopted.
7. Hands on experience of different equipments.

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

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6
Fixing units, tabulation of observations, analysis of data (graphical/analytical)	x					
Accuracy of measurement and sources of errors, importance of significant figures		x				
Knowledge of how g can be determined experimentally and derive satisfaction.	x					
Understanding the difference between simple and torsional pendulum and their use in the determination of various physical parameters					x	
Knowledge of how various elastic moduli can be determined	x					
Measuring surface tension and viscosity and appreciate the methods adopted	x					
Hands on experience of different equipments.	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 Phy.DSCT1: Mechanics & Properties of Matter		Hrs
Unit – 1 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 1	**Units and measurements:** System of units (CGS and SI), measurement of length, mass and time, dimensions of physical quantities, dimensional formulae. Minimum deviation, errors.	4
Chapter No. 2	**Momentum and Energy**: Work and energy, Conservation of linear momentum, Conservation of energy with examples, Motion of rockets	4
Chapter No. 3	**Special Theory of Relativity:** Constancy of speed of light. Postulates of Special Theory of Relativity. Length contraction. Time dilation. Relativistic addition of velocities.	5
Topics for Self-study	Variable mass problem & Rocket motion Twin paradox	
	Suggested Activities	
Activity No. 1	i). Measure diameters of small balls of different size and estimate their volumes. ii). Measure lengths of nails of different size. iii). Measure volume of a liquid. iv). Measure distances and put the result both in CGS and SI units in 2, 3 and 4 significant figures. Mention the precision of the measurement. v). Estimate standard deviations wherever possible.	
Activity No. 2	Understand conservation of energy in every day examples like i) What happens in solar energy conversion panels ii) Pushing an object on the table iii) Moving car hits a parked car causes parked car to move. In these cases, it is known that energy is conserved. How? Understand and verify if possible.	
Unit – 2 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 4.	**Laws of Motion:** Newton's Laws of motion, Dynamics of single particle and a system of particles, Centre of mass.	3

Chapter No. 5.	**Dynamics of Rigid bodies**: Rotational motion about an axis, Relation between torque and angular momentum, Rotational energy, Moment of inertia (M.I): M.I of a rectangular lamina and solid cylinders, Flywheel, Theory of compound pendulum and determination of g.	6
Chapter No. 6.	**Gravitation:** Law of Gravitation. Motion of a particle in a central force field (motion is in a plane, angular momentum is conserved, areal velocity is constant). Kepler's laws (statements). Satellite in a circular orbit.	4
Topics for self study	Geosynchronous orbits Basic idea of global positioning system (GPS).	
	Suggested Activities	
Activity No. 3	Moment of inertia is an abstract concept. It simply gives a measure of rotational inertia of a rigid body and it is proportional to the product of the square of radius, r of the body and its mass, m. Refer to different websites to construct and perform simple experiments to verify that M.I.	
	Reference : www.khanacademy.org, www.pinterest.com, www.serc.cerleton.edn	
Activity No. 4	Prepare suitable charts and give seminar talks in the class.	
	Reference : Weblink/Youtube/Book	
Unit – 3 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 7	**Elasticity:** Hooke's law - Stress-strain diagram, elastic moduli-relation between elastic constants, Poisson's Ratio-expression for Poisson's ratio in terms of elastic constants. Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder. Beams, bending of beams, expression for bending moment, theory of single cantilever. Torsional pendulum, expression for time-period of torsional oscillations, determination of rigidity modulus (static and dynamic methods) and moment of inertia, determination of q, η and σ by Searle's double bar with necessary theory.	13
Topics for self study	Time period of oscillations of a spring-mass system with non-negligible mass of the spring.	

	Suggested Activities	
Activity No. 5	Arrange a steel spring with its top fixed with a rigid support on a wall and a meter scale along side. Add 100 g load at a time on the bottom of the hanger in steps. This means that while putting each 100g load, we are increasing the stretching force by 1N. Measure the extension for loads up to 500g. Plot a graph of extension versus load. Shape of the graph should be a straight line indicating that the ratio of load to extension is constant. Go for higher loads and find out elastic limit of the material.	
	Reference : Weblink/Youtube/Book	
Activity No.6	Repeat the above experiment with rubber and other materials and find out what happens after exceeding elastic limit. Plot and interpret.	
	Reference : Weblink/Youtube/Book	
Unit – 4 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 8	**Surface tension:** Definition of surface tension. Surface energy, relation between surface tension and surface energy, pressure difference across curved surface example, excess pressure inside spherical liquid drop, angle of contact.	7
	Text Book : Units/sections to be Referred:	
Chapter No. 9	Topics to be covered: **Viscosity:** Streamline flow, turbulent flow, equation of continuity, determination of coefficient of viscosity by Poisulle's method, Stoke's method. Problems	6
	Text Book : Units/sections to be Referred:	
Topics for self study	Capillarity determination of surface tension by drop weight method.	
	Suggested Activities	
Activity No.7	Measure surface tension of water and other common liquids and compare and learn i) Why water has high ST? think of reasons. ii) Check whether ST is a function of temperature? You can do it by heating the water to different temperatures and measure ST. iii) Plot ST versus T and learn how it behaves.	

	Mix some quantity of kerosene or any oil to water and measure ST. Check whether ST for the mixture is more or less than pure water. Think of reasons.	
	Reference : Weblink/Youtube/Book	
Activity No. 8	Collect a set of different liquids and measure their viscosity. i) Find out whether sticky or non sticky liquids are most viscous. Think of reasons. ii) Mix non sticky liquid to the sticky liquid in defined quantities and measure viscosity. Find out viscosity is increasing or decreasing with increase of non-sticky liquid concentration. iii) Do the above experiment by mixing sticky liquid to the non sticky liquid. Find out change in viscosity with increase of concentration of sticky liquid. Think why anyone should know viscosity of a liquid.	
	Reference : Weblink/Youtube/Book	

Text Books

Sl No	Title of the Book	Author(s)	Publisher	Year of Publication
1	Mechanics	D. S. Mathur	S.Chand &Co.	2000
2	Mechancis and Relativity (3rd Edition)	Vidwan Singh Soni,	PHI Learning Pvt. Ltd.	2013
3	Mechanics (In SI Units): Berkeley Physics Course Vol 1	Charles Kittel, Walter Knight, et al	Tata McGraw-Hill	2007
4	Properties of Matter	Brij Lal & Subrahmanyam	S.Chand &Co.	2002

References Books

Sl No	Title of the Book	Author(s)	Publisher	Year of Publication
1	Principles of Physics	David Halliday, Jearl Walker & Robert Resnick	Wiley India Pvt. Ltd	2010
2	Physics (8^{th} Edition)	David Halliday & Robert Resnick	Wiley India Pvt Ltd	2008

Paper Code: Phy-DSCP1 - Lab I (2 credits, 4 hours per week)
List of Experiments to be performed in Lab I

1.	Determination of g using bar pendulum (L versus T and L versus LT^2 graphs)
2.	Determination of moment of inertia of a Fly Wheel.
3.	Determination of rigidity modulus using torsional pendulum
4.	Verification of parallel and perpendicular axis theorems.
5.	Determine the Young's Modulus a bar by uniform bending method
6.	Determination of elastic constants of a wire by Searle's method
7.	Young's modulus by Koenig's method
8.	Modulus of rigidity of a rod –Static torsion method.
9.	Viscosity by Stokes method
10.	Radius of capillary tube by mercury pellet method
11.	Verification of Hook's law.
12.	Determination of surface tension of a liquid and the interfacial tension between two liquids using drop weight method.
13.	Critical pressure for stream line flow
14.	Determine the Young's Modulus a bar by single cantilever method.
15.	Study of motion of a spring and to calculate Spring constant, g and unknown mass.

Note: A minimum of EIGHT experiments to be carried out

Reference Books for Laboratory Experiments

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Physics through experiments	B. Saraf	Vikas Publications	2013
2	A laboratory manual of Physics for undergraduate classes, 1st Edition,	D P Khandelwal	Vikas Publications.	1985
3	B.Sc. Practical Physics (Revised Edition)	C. L Arora	S.Chand & Co.	2007
4	An advanced course in practical physics.	D. Chatopadhyay, PC Rakshit, B. Saha	New Central Book Agency Pvt Ltd.	2002

Course Content: 2nd Semester

Phy-DSCT2: Electricity and Magnetism	Course Credits (L+T+P) : 4+0+0=4
Total Contact Hours: 52	Duration of ESA: 3 hours

Course Outcomes (COs):

1. Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.
2. Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.
3. Apply Gauss's law of electrostatics to solve a variety of problems.
4. Describe the magnetic field produced by magnetic dipoles and electric currents.
5. Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.
6. Describe how magnetism is produced and list examples where its effects are observed.
7. Apply Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.
8. Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity,• Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis, and electrical machines.

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

Course Outcomes (COs) / Program Outcomes (POs)	1	2	3	4	5	6
Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point, line, surface, and volume distributions of charges.	x	x				
Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.	x					
Apply Gauss's law of electrostatics to solve a variety of problems.	x	x			x	
Describe the magnetic field produced by magnetic dipoles and electric currents.	x					
Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.	x					
Describe how magnetism is produced and list examples where its effects are observed.	x				x	x
Apply Kirchhoff's rules to analyze AC circuits consisting of parallel and/or series combinations of voltage sources and resistors and to describe the graphical relationship of resistance, capacitor and inductor.	x	x			x	x
Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity,• Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis, and electrical machines.	x	x			x	x

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 Phy-DSCT2:Electricity and Magnetism		Hrs
Unit – 1 **(13 hours of teaching includes 3 hours of activities)**		
Chapter No. 1	**Electric charge and field:** Coulomb's law, electric field strength, electric field lines, point charge in an electric field and electric dipole, work done by a charge (derivation of the expression for potential energy)	3
Chapter No. 2	**Gauss law:** Gauss's law and its applications - electric fields of a (i) spherical charge distribution, (ii) line charge and (iii) an infinite flat sheet of charge.	3
Chapter No. 3	**Electrostatic potential** Electric potential, line integral, gradient of a scalar function, relation between field and potential. Potential due to point charge and distribution of charges (Examples: potential associated with a spherical charge distribution, infinite line charge distribution, infinite plane sheet of charges). Constant potential surfaces, Potential due to a dipole and electric quadrupole.	7
Topics for self study	Concept of Voltage and Current Sources, Kirchhoff's Laws	
	Suggested Activities	
Activity No. 1	(i) Learn the difference between and DC and AC electricity and their characteristics. (ii) Voltage and line frequency standards in different countries. (iii) A small project report on production of electricity as a source of energy: Different methods	
	Reference : Weblink/Youtube/Book	
Activity No. 2	(i) Learn to use a multimeter (analog and digital) to measure voltage, current and resistance. Continuity testing of a wire. (ii) Learn about household electrical connection terminals: Live, neutral and ground and voltage between the terminals. Role of earthing and safety measures	
	Reference : Weblink/Youtube/Book	

Unit – 2 (13 hours of teaching includes 3 hours of activities)		
Chapter No. 4.	**Conductors in electrostatic field:** Conductors and insulators, conductors in electric field. Capacitance and capacitors, expression for capacitance in a parallel plate capacitor, parallel plate capacitor with dielectric, Dielectrics: an atomic view. Energy stored in a capacitor, Dielectric and Gauss's law.	6
Chapter No. 5.	**DC currents:** Electric currents and current density. Electrical conductivity and Ohm's law. Physics of electrical conduction, conduction in metals and semiconductors, circuit elements and circuits: Transient currents in RC, LR and LCR circuits. Force on a moving charge.	7
Topics for self study	Currents and voltage in combination of R, L and C circuits	
	Suggested Activities	
Activity No. 3	(i) Learn about electrical appliances which work with AC and DC supply. (ii) Learn about types of resistors and their colour codes and types of capacitors (electrolytic and non-electrolytic)	
	Reference : Weblink/Youtube/Book	
Activity No. 4	(i) Learn about power transmission: 3-phase electricity, voltage and phase (ii) Visit a nearby electrical power station. Interact with line men, Electrical engineers and managers. Discuss about power loss in transmission. How to reduce it? (iii) Prepare a small project report on street lighting and types of electrical bulbs.	
	Reference : Weblink/Youtube/Book	

Unit – 3 (13 hours of teaching includes 3 hours of activities)		
Chapter No.6	**Magnetism:** Definition of magnetic field, Ampere's law and Biot-Savart law (magnetic force and magnetic flux), Magnetic force on a current carrying conductor, Hall effect in a conductor. Electromagnetic induction, conducting rod moving in a magnetic field, Faraday's laws of induction, Lenz's Law, expression for self-inductance and energy stored in a magnetic field. Mutual inductance.	7
Chapter No. 7	**AC circuits:** RMS and average value of AC, Response of series RL, RC, LC, LCR circuits using j-operator method, quality factor, admittance and impedance, power and energy in AC circuits.	6
Topics for self study	Response of parallel RL, RC, LC, LCR circuits using j-operator method	
	Suggested Activities	
Activity No. 5	(i) Prepare a small project report on street lighting and types of electrical bulbs. (ii) Learn the measurement of electric current using tangent galvanometer.	
	Reference : Weblink/Youtube/Book	
Activity No.6	Build a small coil with insulated copper wire. Connect an ammeter micro/milli ammeter. Verify magnetic induction using a powerful bar magnet.	
	Reference : Weblink/Youtube/Book	
Unit – 4		
Chapter No. 8	**Electromagnetic waves:** Equation of continuity, Maxwell's equations, displacement current, equation for propagation of electromagnetic wave, transverse nature of electromagnetic wave, energy transported by electromagnetic waves. Poynting vector, magnetic moment of a point charge moving in a circular loop, electric current in atoms, electron spin and magnetic moment, magnetization and magnetic susceptibility.	8

Chapter No. 9	**Magnetic materials:** Magnetic intensity and magnetic induction, Intensity of magnetization, Susceptibility, Permeability, Types of magnetic materials: diamagnetic, paramagnetic and ferromagnetic materials. Classical Langevin's theory of diamagnetism, B-H hysteresis curves, Hard and soft magnetic materials.	5
Topics for self study	1. Super conductivity 2. At least two Applications of magnetic materials	
	Suggested Activities	
Activity No.7	(i) Prepare a small project report on production of magnetic field: Permanent magnets, electromagnets and superconducting magnets. (ii) Learn the principle of working of a Gauss meter to measure magnetic field	
	Reference : Weblink/Youtube/Book	
Activity No. 8	(i) Model the earth's magnetic field with a diagram. (ii) Explain the effect of tilt of the earth's axis and reasons for the change in the tilt of the earth's axis over thousands of years.	
	Reference : Weblink/Youtube/Book	

Text Books

Sl No	**Title of the Book**	**Author(s)**	**Publisher**	**Year of Publication**
1	Physics-Part-II,	David Halliday and Robert Resnick	Wiley Eastern Limited	2001
2	Berkeley Physics Course, Vol-2, Electricity and Magnetism, Special Edition	Edward M Purcell	Tata Mc Graw-Hill Publishing Company Ltd, New Delhi	2008

Paper Code: Phy-DSCP1-Lab II

List of Experiments to be performed in Lab II

1.	Experiments on tracing of electric and magnetic flux lines for standard configuration.
2.	Determination of components of earth's magnetic field using a Ballistic galvanometer.
3.	Determination of capacitance of a condenser using B.G.
4.	Determination of high resistance by leakage 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.	Frequency response of LCR Series resonance circuit.
8.	Frequency response of LCR Parallel resonance circuit.
9.	Impedance of series RC circuits - determination of frequency of AC.
10.	Study the i-v characteristics of a series RC and RL Circuit.
11.	Determination of self-inductance of a coil.
12.	Verification of laws of combination of capacitances and determination of unknown capacitance using de-Sauty bridge.
13.	Maxwell's impedance bridge to determine L.
14.	Determination of B_H using Helmholtz double coil galvanometer and potentiometer.

Note: A minimum of EIGHT experiments to be performed.

Reference Books for Laboratory Experiments

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Physics through experiments	B. Saraf	Vikas Publications	2013
2	A laboratory manual of Physics for undergraduate classes, 1st Edition,	D P Khandelwal	Vikas Publications.	1985
3	B.Sc. Practical Physics (Revised Edition)	C. L Arora	S.Chand & Co.	2007
4	An advanced course in practical physics.	D. Chatopadhyay, PC Rakshit, B. Saha	New Central Book Agency Pvt Ltd.	2002

Open Elective Papers
Phy-OE1: Energy Sources (Credits:3)
3 hours of teaching per week

Unit-I: Non-Renewable energy sources	**Hrs.**
Introduction: Energy concept-sources in general, its significance & necessity, Classification of energy sources: Primary and Secondary energy, Commercial and Non-commercial energy, Renewable and Non-renewable energy, Conventional and Non-conventional energy, Based on Origin-Examples and limitations. Importance of Non-commercial energy resources (5 hours) **Conventional energy sources:** Fossil fuels & Nuclear energy- production & extraction, usage rate and limitations. Impact on environment and their issues & challenges. Overview of Indian & world energy scenario with latest statistics- consumption & necessity. Need of eco-friendly & green energy & their related technology. (8 hours)	**13**
Unit-II: Renewable energy sources	
Introduction: Need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. (05 hours) **Solar energy**: Solar Energy-Key features, its importance, Merits & demerits of solar energy, Applications of solar energy. Solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell -brief discussion of each. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems. (8 hours)	**13**
Unit-III	
Wind and Tidal Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies, Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices, Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy. (8 hours) **Geothermal and hydro energy:** Geothermal Resources, Geothermal Technologies (2 hours), Hydropower resources, hydropower technologies, environmental impact of hydro power sources, Carbon captured technologies, cell, batteries, power consumption (3 hour)	**13**

Suggested Activities

1. Demonstration of on Solar energy, wind energy, etc, using training modules at Labs.
2. Conversion of vibration to voltage using piezoelectric materials.
3. Conversion of thermal energy into voltage using thermoelectric (using thermocouples or heat sensors) modules.
4. Project report on Solar energy scenario in India
5. Project report on Hydro energy scenario in India
6. Project report on wind energy scenario in India
7. Field trip to nearby Hydroelectric stations.
8. Field trip to nearby to wind energy stations.
9. Field trip to nearby to solar energy parks.
10. Videos on solar energy, hydro energy and wind energy.

Reference Books

1. Non-conventional energy sources - G.D Rai - Khanna Publishers, New Delhi
2. Solar energy - M P Agarwal - S Chand and Co. Ltd.
3. Solar energy - Suhas P Sukhative Tata McGraw - Hill Publishing Company Ltd.
4. Godfrey Boyle, “Renewable Energy, Power for a sustainable future”, 2004, Oxford University Press, in association with The Open University.
5. Dr. P Jayakumar, Solar Energy: Resource Assessment Handbook, 2009
6. J.Balfour, M.Shaw and S. Jarosek, Photovoltaics, Lawrence J Goodrich (USA).
7. http://en.wikipedia.org/wiki/Renewable_energy

Phy-OE2: Physics for all (Credits:3)
3 hours of teaching per week

Unit-I	Hrs.
Energy and Power: Explosions and energy; Energy, heat and its units; Energy table and discussions; Discussion of cost of energy; Measuring energy; Power; Different power sources; Kinetic energy.	**13**
Unit-II	
Gravity, Force and Space: The force of Gravity; Newton's third law; Weightlessness; Low earth orbit; Geosynchronous satellites; Spy satellites; Medium Earth Orbit satellite; Circular Acceleration; momentum; Rockets; Airplanes, helicopters and fans; Hot air and helium balloons; angular momentum and torque..	**13**
Unit-III	
Nuclei and radioactivity: Radioactivity; Elements and isotopes; Radiation and rays; Seeing radiation; The REM – The radiation poisoning; Radiation and cancer; The linear hypothesis; Different types of radiation; The half-life rule; Smoke detectors; measuring age from radioactivity; Environmental radioactivity; Glow of radioactivity; Nuclear fusion.	**13**

References Book

This course is extracted from the book titled "Physics and Technology for Future Presidents: An Introduction to the Essential Physics Every World Leader Needs to Know" by Richard A Muller, WW Norton and Company, 2007. (Units 1 to 3 are from chapters 1, 3, 4 respectively).

Phy-OE3: Atmospheric Science (Credits:3)
3 hours of teaching per week

Unit-I	**Hrs.**
Atmosphere: Atmospheric Science (Meteorology) as a multidisciplinary science. Physical and dynamic meteorology, Some terminology, difference between weather and climate, weather and climate variables, composition of the present atmosphere: fixed and variable gases, volume mixing ratio (VMR), sources and sinks of gases in the atmosphere. Green house gases. Structure (layers) of the atmosphere. Temperature variation in the atmosphere, temperature lapse rate, mass, pressure and density variation in the atmosphere. Distribution of winds.	**13**
Unit-II	
Climate Science: Overview of meteorological observations, measurement of : temperature, humidity, wind speed and direction and pressure. Surface weather stations, upper air observational network, satellite observation. Overview of clouds and precipitation, aerosol size and concentration, nucleation, droplet growth and condensation (qualitative description). Cloud seeding, lightning and discharge. Formation of trade winds, cyclones. Modelling of the atmosphere: General principles, Overview of General Circulation Models(GCM) for weather forecasting and prediction. Limitations of the models. R and D institutions in India and abroad dedicated to climate Science, NARL, IITM, CSIR Centre for Mathematical Modeling and Computer Simulation, and many more.	**13**
Unit-III	
Global Climate Change: Green house effect and global warming, Enhancement in concentration of carbon dioxide and other green house gases in the atmosphere, Conventional and non-conventional energy sources and their usage. EL Nino/LA Nino Southern oscillations. Causes for global warming: Deforestation, fossil fuel burning, industrialization. Manifestations of global warming: Sea level rise, melting of glaciers, variation in monsoon patterns, increase in frequency and intensity of cyclones, hurricanes, tornadoes. Geo-engineering as a tool to mitigate global warming, Schemes of geo-engineering.	**13**

Suggested Activities

1. Try to find answer to the following questions:
   (a) Imagine you are going in a aircraft at an altitude greater than 100 km. The air temperature at that altitude will be greater than 200^{o}C. If you put your hands out of the window of the aircraft, you will not feel hot.
   (b) What would have happened if ozone is not present in the stratosphere.
2. Visit a nearby weather Station and learn about their activities.
3. Design your own rain gauge for rainfall measurement at your place.
4. Learn to determine atmospheric humidity using wet bulb and dry bulb thermometers.
5. Visit the website of Indian Institute of Tropical Meteorology (IITM), and keep track of occurrence and land fall of cyclone prediction.
6. Learn about ozone layer and its depletion and ozone hole.
7. Keep track of melting of glaciers in the Arctic and Atlantic region through data base available over several decades.
8. Watch documentary films on global warming and related issues (produced by amateur film makers and promoted by British Council and BBC).

Reference Books

1. Basics of Atmospheric Science – A Chndrashekar, PHI Learning Private Ltd. New Delhi, 2010.
2. Fundamentals of Atmospheric Modelling- Mark Z Jacbson, Cambridge University Press, 2000.

Phy-OE4: Sports Science (Credits:3)
3 hours of teaching per week

Unit-I	Hrs.
Measurement: Physical quantities, Standards and Units, International system of Units, Standards of time, length and mass, Precision and significant figures (4 hours) **Newton's laws of motion**: Newton's first law. Force, mass. Newton's second law. Newton's third law, Mass and weight. Applications of Newton's laws. (5 hours) **Projectile motion**: Shooting a falling target, Physics behind Shooting, Javelin throw and Discus throw. (4 hours) **Topics for self study:** https://www.real-world-physics-problems.com/physics-of_sports.html	**13**
Unit-II	
Conservation laws: Conservation of linear momentum, collisions – elastic and inelastic. Angular momentum. (Physics behind Carom, Billiards, Racing) (4 hours) **Centre of mass**: Physics behind Cycling, Rock climbing, Skating (5 hours) **Gravitation**: Origin, Newton's law of gravitation, Archimedes's principle, Buoyancy & Physics behind swimming (4 hours) **Topic for self-study:** Archimedes' Principle: Made EASY | Physics in You tube	**13**
Unit-III	
Food and Nutrition: Proteins, Vitamins, Fat, Blood pressure. Problems due to the deficiency of vitamins. (4 hours) **Energy:** Different forms of Energy, Conservation of mass-energy (3 hours) **Physical exercises:** Walking, Jogging and Running, Weight management. (3 hours) **Topic for self-study:** 10 Best Exercises for Everyone – Healthline	**13**

Suggested Activities

1. Identify the methods of measurement of time, length and mass from ancient time and build models for them. (Reference : History of measurement - Wikipedia *https://en.wikipedia.org › wiki › History_of_measurement*)
2. Identify Physics principles behind various Sports activities. **https://www.real-world-physics-problems.com/physics-of-sports.html**
3. List the difficulties experienced in Gymnastics, Cycling and Weight lifting.
4. List the difficulties experienced in swimming.
5. Learn breathing exercises.
6. Write an essay on Physical health v/s Mental health or conduct a debate on Physical health v/s Mental health.

Text Books

1. Yakov Perelman. Physics for Entertainment. Createspace Independent Pub, 2010.
2. Yakov Perelman. Physics Everywhere. Prodinnova Publishers, 2014.
3. Yakov Perelman. Mechanics for Entertainment. Prodinnova Publishers, 2014.
4. Vassilios McInnes Spathopoulos. An Introduction to the Physics of Sports. Createspace Independent Publishing Platform, 2013.
5. Walter Lewin. For the Love of Physics. Taxmann Publications Pvt. Ltd., 2012.
6. Swaminathan M. Handbook of Food and Nutrition. Bangalore Press. 2012.
7. Srilakshmi B. Food Science. New Age International Pub. 2015.

Internet Resources for Reference: Internet resources

https://www.topendsports.com/biomechanics/physics.htm
https://www.real-world-physics-problems.com/physics-of-sports.html
https://www.healthline.com/
https://www.mayoclinic.org/
https://www.who.int/news-room/

COURSE PATTERN & SCHEME OF EXAMINATION for B.Sc. / B.Sc. (Hons.) as per NEP-2020

Semester	Title of the Paper	Total No of hours	Hours per week	Marks		Duration of Examination (hours)	Total Marks	Credits
				Theory/Practicals	Internal Assessment (IA)			
				Max	Max			
1st Semester	Phy-DSCT1: Mechanics and Properties of Matter	52	4	60	40	3	100	4
	Phy-DSCP1-Lab I	40	4	25	25	3	50	2
	Phy-OE1 : Energy Sources OR Phy-OE2: Physics for All	39	3	60	40	3	100	3
2nd Semester	Phy-DSCT2: Electricity and Magnetism	52	4	60	40	3	100	4
	Phy-DSCP2-Lab II	40	4	25	25	3	50	2
	Phy-OE3:Atmospheric Science OR Phy-OE4: Sports Science	39	3	60	40	3	100	3

Formative/Internal Assessment for Theory Papers	
Assessment Occasion	Marks
Test-1 (Attendance+Activity + Self-study related)	20
Test-2 (Theory based)	20
Total	40

***Questions should not be set on activity and self-study topics during end semester examinations.**

Distribution of Marks for the Practical Examination (Phy-DSCP1 & Phy-DSCP2)		
Sl No	Particulars	Marks
1	Writing Principle/Statement/Formulae with symbols, units and explanations.	03
2	Drawing illustrative diagrams and expected graphs	03
3	Setting up of the experiment & taking readings	06
4	Calculations and graphs drawn based on experimental data.	05
5	Accuracy of results with units	03
6	Valuation of Practical Record	05
Total Marks		25

QUESTION PAPER PATTERN (INDICATIVE TEMPLATE)

I Semester B.Sc Examination, April/May (September/October) 2022

CBCS - 2021 ONWARDS

Subject: Physics

Phy-DSCT1: Mechanics and Properties of Matter

Time: 2 hours **Max. Marks: 60**

Instruction: Answer *any* FOUR questions from *each* part

PART- A

Each question carries 2 marks (concept based)

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 1,2,3,4,5,6)

PART-B (20 marks)

Each question carries 5 marks (numerical problems)**

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 7,8,9,10,11,12)***

PART-C (32 marks)

Each question carries 8 marks

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 13,14,15,16,17,18)*

*In each part of the question paper first three questions should be set from the first TWO units of the syllabus and next three questions should be set from second half (last TWO units) of the syllabus.
**Questions in Part-B should contain numerical problems in the specific cases of discipline core subjects, where problem solving is an essential component of learning.
*** Questions of Part B and Part C may contain subdivisions i.e., (i) questions 7 to 12 of Part B may be split into a, b & division of marks in such cases should be clearly indicated – for example 2 + 3=5 marks or 1+4=5 marks. Similarly (ii) question 13 to 18 of Part C may be split into a, b, c with division of marks clearly indicated – for example 3+5=8 marks or 2+6=8 marks or 2+3+3=8 marks and so on).

I Semester B.Sc Examination, April/May (September/October) 2022

CBCS - 2021 ONWARDS

Subject: Physics

Phy-OE1 : Energy Sources (Open Elective)

Time: 2 hours **Max. Marks: 60**

Instruction: Answer *any* FOUR questions from *each* part

PART- A

Each question carries 2 marks (concept based)

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 1,2,3,4,5,6)

PART-B (20 marks)

Each question carries 5 marks (numerical problems)**

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 7,8,9,10,11,12)***

PART-C (32 marks)

Each question carries 8 marks

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 13,14,15,16,17,18)**

* All parts should have TWO questions each from 3 units of the open elective syllabus.
** Questions of Part B and Part C may contain subdivisions i.e., (i) questions 7 to 12 of Part B may be split into a, b & division of marks in such cases should be clearly indicated – for example 2 + 3=5 marks or 1+4=5 marks. Similarly (ii) question 13 to 18 of Part C may be split into a, b, c with division of marks clearly indicated – for example 3+5=8 marks or 2+6=8 marks or 2+3+3=8 marks and so on).

Bangalore University
Department of Physics

Jnanabharathi Campus
Bengaluru – 560 056

Syllabus for
3rd & 4th Semester Physics Papers
Under-Graduate(UG) Program

Framed according to the National Education Policy (NEP 2020)

(Effective from the Academic Year 2021-22)

Board of Studies in Physics (UG) Members

Professor Usha Devi A R (Chairperson)	Dept. Physics, Bangalore University, Bengaluru-56
Sri Nanjundaiah	The Rural College, Kanakapura-562 117
Sri. Balakrishna M T	The Rural College, Kanakapura-562 117
Dr. Wajeeha Sulthana	Maharani Science College for Women, Bengaluru-01
Dr Manjunath H C	Govt. Boys College, Kolar-563 101

Board of Studies Members as Invitees

Professor Ramakrishna Damle	Dept. Physics, Bangalore University, Bengaluru-56
Smt Seeta Vasudevrao	Head of Dept. Physics, First Grade College, Kengeri, Bengaluru-60

Date: 23.08.2021
Place: Bengaluru

Department of Physics
Bangalore University, Bangalore-56

Proceedings of the BoS (UG) Physics meeting
held at 11.30 am on 23rd August 2022 at the Department of Physics, BUB

The following agenda was discussed: (1) B.Sc 3rd and 4th Semester Syllabus of Physics papers (2) Panel of Examiners for UG for the academic year 2022-2023 and BOE (Proposed) for the academic year 2022-23. After elaborate discussions and suitable modifications, the members of the BoS approved both the agenda.

Sl. No.	Name & Affiliation of the BoS Member	Signature
1	Dr. Usha Devi A R, Professor & Chairperson Dept. Physics, Bangalore University, Bengaluru-56	
2	Dr. Venkateshappa Y Govt. First Grade College, Vijayanagar, Bengaluru-04	- ABSENT -
3	Sri Nanjundaiah The Rural College, Kanakapura-562 117	
4	Sri Ramesh T Govt. First Grade College, Channapattana-571 501.	- ABSENT -
5	Sri. Balakrishna M T The Rural College, Kanakapura-562 117	
6	Dr. Wajecha Sulthana Maharani Science College for Women, Bengaluru-01	23/08/22
7	Sri Krishnappa H Fatteper (Superintendent) The National Degree College, Basavanagudi, Bengaluru-04	- ABSENT -
8	Dr Manjunath H C Govt. Boys College, Kolar-563 101	23/8/22
	Invitees	
9	Professor Ramakrishna Damle Dept. Physics, Bangalore University, Bengaluru-56	
10	Smt Seeta Vasudevrao Head of Dept. Physics, First Grade College, Kengeri, Bengaluru-60	23/08/2022

The Chairperson 23.08.2022
Department of Physics
Bangalore University
Bangalore - 560056

Course Structure
(Major Discipline: Physics)
Semester 1 - 10

SEMESTER	Discipline Core Theory (DSCT)	Core Papers
SEMESTER -1	Phy.DSCT1	Mechanics & Properties of Matter
SEMESTER -2	Phy.DSCT2	Electricity and Magnetism
SEMESTER -3	**Phy.DSCT3**	**Wave motion and optics**
SEMESTER -4	**Phy.DSCT4**	**Thermal Physics & Electronics**
SEMESTER -5	Phy.DSCT5 Phy.DSCT6	1. Classical Mechanics and Quantum Mechanics- I 2. Elements of Atomic, Molecular Physics
SEMESTER -6	Phy.DSCT7 Phy.DSCT8	1. Elements of Nuclear Physics and Nuclear Instruments 2. Elements of Condensed Matter Physics
SEMESTER -7	Phy.DSCT9 Phy.DSCT10 Phy.DSCT11	1. Mathematical Methods of Physics – I 2. Classical Electrodynamics. 3. Experimental methods of Physics 4. Research Methodology
SEMESTER -8	Phy.DSCT12 Phy.DSCT13 Phy.DSCT14	1. Classical Mechanics and Quantum Mechanics-II 2. Statistical Mechanics 3. Astrophysics & Astronomy 4. Research Project* (Select Two DSE subjects from the Pool B-II shown below) *In lieu of the research Project, two additional elective papers/ Internship may be offered.
SEMESTER -9	Phy.DSCT15	1. Mathematical Methods of Physics – II (Select One DSE subjects from the Pool B-III shown below) 2. Research Project
SEMESTER -10	Phy.DSCT17	1. Quantum Mechanics – III (Select One DSE subjects from the Pool B-IV shown below) 2. Research Project

Open Electives

1st Semester	
1.	Phy-OE1: Energy Sources
2.	*Phy-OE2: Physics for All.
2nd Semester	
3.	Phy-OE3: Atmospheric Science
4.	Phy-OE4: Sports Science
3rd Semester	
5.	**Phy-OE5: Optical Instruments**
6.	**Phy-OE6: Elements of Astronomy and Astrophysics**
4th Semester	
7.	**Phy-OE7: Medical Physics**
8.	**Phy-OE9: Electrical Instruments**

***Students who have chosen Phy-DST1 are not eligible to take Open Elective paper Phy-OE2.**

Discipline Specific Electives for 7 to 10 Semesters

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

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

Detailed Syllabus
for 3rd & 4th Semester Physics Papers
Under-Graduate(UG) B.Sc/B.Sc (Hon) Program
Framed according to the National Education Policy (NEP)

3rd Semester B.Sc

Phy-DSCT3: Wave Motion and Optics	**Course Credits (L+T+P) : 4+0+0**
Total Contact Hours: 52	**Duration of ESA: 4 hours**

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

Prerequisites

Fundamentals of waves

Course Learning Outcomes

At the end of the course it should be ensured that students understand the following concepts:

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

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

Course Content Phy.DSCT3: Wave Motion and Optics		Hrs
Unit – 1: Waves and Superposition of Harmonic Waves (11 hours of teaching plus 2 hours of activities)		
Chapter No. 1	**Waves:** Plane and Spherical Waves. Longitudinal and Transverse Waves. Characteristics of wave motion, Plane Progressive (Travelling) Wave and its equation (derivation), Wave Equation – Differential form (derivation). Particle and Wave Velocities - Relation between them, Energy Transport – Expression for intensity of progressive wave, Newton's Formula for Velocity of Sound. Laplace's Correction (Derivation). Brief account of Ripple and Gravity Waves. **(Text Books : 1-4)**	**5 hours**
Chapter No. 2	**Superposition of Harmonic Waves** : Linearity and superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats) – Analytical treatment. Superposition of two perpendicular harmonic oscillations: Lissajous Figures with equal and unequal frequency- Analytical treatment. Uses of Lissajous' figures. **(Text Books : 1-4)**	**6 hours**
Topics for Self-study	Study of coupled pendulum. Explain the impact on the motion of one pendulum due to that of the other pendulum by varying the length, and mass of pendulum. Prepare a report.	
Suggested Activities (Any two activities to be conducted compulsorily)		
Activity No. 1	We know that sound is produced because of vibration. Look into at least 10 musical instruments and identify the regions of vibrations that produces the sound and those parts which enhances the sound because of reverberation. 1. Identify one common element in all of these. 2. Identify equipments which creates beats and try to explain the underlying basic principles. Demonstrate the examples of beats using two tuning forks. 3. Identify what will happen when you drop a stone in a standing water, and when your drop two stones side by side. Make your observations sketch them and comment on it in a report.	
Activity No. 2	Draw two sine waves (Amplitude vs time) one shifted with other in phase. Identity where the resonation occurs for each phase shift. Plot phase vs time taken for resonance.	
Activity No. 3	Take smooth sand, place a pointed edged pen vertically on the sand. To the mid of the pen, connect two perpendicular threads. Pull these perpendicular threads by varying the forces and timings. Note down the different shapes produced on the sand. Try to interpret the shapes. Make a report of it	
Activity No. 4	Hang a pot with sand, which has a hole in the bottom. Gently pull the pot on one side and observe the pattern formed by the sand on the floor. Report the observations.	

Activity No. 5	Take a stretched spring. Stretch it across two edges. Put a weight on the string, pluck it and measure the amplitude of the vibration. Students should measure the total damping time of oscillating spring. (Using mobile or scale) And plot graphs by 1.Varying load on the spring and amplitude at the centre. 2. Take another weight and put that in another place and measure the amplitude of vibration at the centre. 3. Vary the load in the centre of the spring and measure the amplitude at the centre. **Note for the teachers for the activity:** Make 3 groups among students and assign each group the activity of drawing one of the 3 graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.

Topic Learning Outcomes

At the end of the topic, students should be able to understand the following concepts:

SL No	TLO's	CO	PO
1.	Explain the difference between plane and spherical waves, longitudinal and transverse waves and give their characteristics.	**1**	**1-6, 11-12**
2.	Write down an equation for the progressive wave in its differential form.	**1**	**1-6, 11-12**
3.	Obtain the relation between particle and wave velocity.	**1**	**1-6, 11-12**
4.	Obtain an expression for intensity of progressive waves.	**1**	**1-6, 11-12**
5.	Obtain Newton's formula for the velocity of sound and discuss the factors for which sound velocity is dependent.	**2**	**1-6, 11-12**
6.	Apply the Laplace's correction to the equation of motion of a progressive wave.	**2**	**1-6, 11-12**
7.	With examples explain ripple and gravity waves.	**2**	**1-6, 11-12**
8.	Give the theory of superposition of two linear waves having equal frequencies and different frequencies.	**3**	**1-6, 11-12**
9.	Discuss the formation of different Lissajous figures under different conditions of amplitude and frequency when they superimpose perpendicularly.	**3**	**1-6, 11-12**
10.	Give some applications of an Lissajous figures.	**3**	**1-6, 11-12**

Unit – 2 - Standing Waves and Acoustics
(11 hours of teaching plus 2 hours of activities)

Chapter No. 3	**Standing Waves :** Velocity of transverse waves along a stretched string (derivation), Standing (Stationary) Waves in a String - Fixed and Free Ends (qualitative). Theory of Normal modes of vibration in a stretched string, Energy density and energy transport of a transverse wave along a stretched string. Vibrations in rods – longitudinal and transverse modes (qualitative). Velocity of Longitudinal Waves in gases (derivation). Normal Modes of vibrations in Open and Closed	**8 hours**

	Pipes – Analytical treatment. Concept of Resonance, Theory of Helmholtz resonator. **(Text Books: 1-4)**	
Chapter No. 4	**Acoustics**: Absorption coefficient, Reverberation time - Sabine's Reverberation formula (derivation), Factors affecting acoustics in buildings, Requisites for good acoustics. Acoustic measurements – intensity and pressure levels. **(Text Books : 1-4)**	**3 hours**
Topics for Self-study	List different phenomenon where standing waves are found in nature. Identify the phenomena and reason for standing waves. Also identify the standing waves in musical instruments. Make a report of it**.**	
Suggested Activities (Any two activities to be conducted compulsorily)		
Activity No. 6	1. Go to 5 different newly constructed houses when they are not occupied and when they are occupied. Make your observations on sound profile on each room. Give the reasons. Make a report of it**.** 2. Visit three very good auditoriums, list out different ways in which the acoustic arrangements have been done (as decoration and Civil works). Look for the reasons in Google and identify which is acoustically the best auditorium among the three you visited. Make a report of it**.**	
Activity No. 7	Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO4) solution. Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop a marble on the liquid at the centre of the bowl. Repeat the experiment by dropping the marble from the different heights. Plot a graph of- 1. Height v/s time of oscillation 2. Weight of the marble v/s time of oscillation **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.	
Activity No. 8	Take two marbles of same weight. Drop both the marbles on the surface of the liquid from some height. With the help of the mobile take the picture and measure the position of interface of two wave fronts formed in the liquid. Plot graphs for different activities by doing the following activities. 1. By dropping two marbles of same weight from different heights. 2. By dropping two marbles of different weight from the same height **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.	

Topic Learning Outcomes At the end of the topic, students should be able to understand the following concepts				
SL No	**TLO's**	**BL**	**CO**	**PO**
1.	Discuss the Transverse waves produced in stretched string and obtain the expression for the same.	**L2**	**3**	**1-6, 11-12**
2.	Give a qualitative treatment of vibration of a string when it's both ends are fixed and free.	**L2**	**3**	**1-6, 11-12**
3.	Explain normal modes of a stretched string. Obtain an expression for the energy density and discuss how this energy is transported along a stretched string.	**L2**	**3**	**1-6, 11-12**
4.	Quantitatively bring about the mode of vibrations created in a rod.	**L2**	**4**	**1-6, 11-12**
5.	Explain types of waves that are produced in gas. Obtain an expression for the same.	**L2**	**4**	**1-6, 11-12**
6.	With an analytical treatment explain the concept of resonance using the normal modes of vibrations of open and closed pipes.	**L2**	**5**	**1-6, 11-12**
7.	Give the theory of Helmholtz resonator and explain how it is used to calculate some parameters of the way the standing waves are set in there.	**L2**	**5**	**1-6, 11-12**
8.	Define Reverberation, Reverberation time and absorption coefficient of a material.	**L1**	**5**	**1-6, 11-12**
9.	Obtain Sabine's Reverberation formula and discuss what are the factors on which the Reverberation time depends on.	**L2**	**5**	**1-6, 11-12**
10.	List out which are different parameters within a building which effects the acoustics.	**L1**	**6**	**1-6, 11-12**
11.	Explain what are good acoustics of a building and how acoustics is measured in terms of intensity and pressure inside a building.	**L2**	**6**	**1-6, 11-12**
Teaching and Learning Methodology				
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc				
Formative Assessment Techniques				

One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

<table>
<tr><th colspan="3">Unit – 3: Nature of light and Interference
(11 hours of teaching plus 2 hours of activities)</th></tr>
<tr><td>Chapter No. 5</td><td>Nature of light : Corpuscular theory- laws of reflections and refraction; The Wave model, Group velocity & wave velocity - relation between them, Maxwell’s electromagnetic waves. (Text Book No 5)</td><td>2 hours</td></tr>
<tr><td>Chapter No. 6</td><td>Interference of light by division of wave front: Coherent source-Interference of light waves by division of wave-front, Young’s double slit interference- theory and experiment, Fresnel Biprism- theory and experiment (determination of wavelength) (Text Book No 5)</td><td>4 hours</td></tr>
<tr><td>Chapter No. 7</td><td>Interference of light by division of amplitude: Interference at thin films - reflected and transmitted light, Colours of thin films; Theory of air wedge; Theory of Newton's rings (Reflection). Determination of Refractive index of a liquid, Michelson Interferometer-Determination of wavelength of light (Text Book No 5)</td><td>5 hours</td></tr>
<tr><td>Topics for Self-study</td><td colspan="2">Why colour strips are seen in paddles on roads in rainy seasons? Give reasons. Make a report of it.</td></tr>
<tr><th colspan="3">Suggested Activities (Any two activities need to be conducted compulsorily)</th></tr>
<tr><td>Activity No. 9</td><td colspan="2">In the table given below explore which phenomenon can be explained by what and prepare report explaining it.
<table>
<tr><th>Sl No</th><th>Phenomenon</th><th>Corpuscular Nature</th><th>Wave Nature</th></tr>
<tr><td>1.</td><td>Formation of images on lenses</td><td></td><td></td></tr>
<tr><td>2.</td><td>Formation of images on mirror</td><td></td><td></td></tr>
<tr><td>3.</td><td>Interference</td><td></td><td></td></tr>
<tr><td>4.</td><td>Polarization</td><td></td><td></td></tr>
<tr><td>5.</td><td>Diffraction due to single slit</td><td></td><td></td></tr>
</table></td></tr>
<tr><td>Activity No. 10</td><td colspan="2">Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO4) solution). Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop two marbles of same weight (mass) from the same height on to the surface of the water but at the different time intervals. Analyze the wavefronts and draw pictures of different observations.

Note to the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.
1. The first slide will explain the process of doing the experiment.
2. In the second slide. Students will show the graph of measurement.
3. In the third slide, they will list three observations from that study.</td></tr>
<tr><td>Activity No. 11</td><td colspan="2">Teachers should demonstrate the formation of Lissajous Figure using a CRO. Give different shapes of Lissajous Figure with varying frequency and amplitude. Then ask the students to comment on the observations and prepare a report.</td></tr>
<tr><td colspan="3"></td></tr>
</table>

Topic Learning Outcomes **At the end of the topic, students should be able to understand the following concepts**				
SL No	**TLO's**	**BL**	**CO**	**PO**
1.	Discuss the wave model and the Corpuscular model of light.	**L2**	**7**	**1-6, 11-12**
2.	Give the Huygen theory of wave-front.	**L1**	**7**	**1-6, 11-12**
3.	Define Interference. Give some examples of Interference.	**L1**	**7**	**1-6, 11-12**
4.	Give the theory of interference due to two coherent sources of light and obtain an expression for the wavelength of monochromatic source of light (Young's double slit experiment)	**L2**	**7**	**1-6, 11-12**
5.	Explain how using personal biprism, a monochromatic coherent source of light are obtained. Using this experimental setup explain how the wavelength of monochromatic sources of light is determined.	**L2**	**7**	**1-6, 11-12**
6.	Give the theory of interference due to division of amplitude by parallel and non-parallel plates.	**L1**	**7**	**1-6, 11-12**
7.	Explain how Newton's rings are obtained and discuss how the wavelength of light is determined using this experiment.	**L2**	**7**	**1-6, 11-12**
Teaching and Learning Methodology				
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.				
Formative Assessment Techniques				
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc				

Unit – 4 - Diffraction and Polarisation

Chapter No. 8	**Fraunhofer diffraction**: Introduction- Fraunhofer diffraction- Theory of single slit diffraction, Two slit diffraction pattern, Theory of diffraction Grating, Normal and oblique incidence – experimental determination of wavelength, Resolving power – Rayleigh criterion, Expression for resolving power of grating and telescope (Text Book No 5)	**4 hours**
Chapter No. 9	**Fresnel Diffraction**- Concept of Fresnel half period zones, Comparison of Zone plate with lens, Theory of diffraction at a straight edge, Qualitative discussion on diffraction by a circular aperture and diffraction by an opaque disc (Text Book No 5)	**3 hours**
Chapter No. 10	**Polarisation:** Production of polarized light, Malus' law, Phenomenon of double refraction in crystals, Quarter wave plate and half wave plate, Optical activity, Laurent's half shade polarimeter (Text Book No 5)	**4 hours**
Using CDs and DVDs as diffraction Grating Ref:https://www.nnin.org/sites/default/files/files/Karen_Rama_USING_CDs_AND_DVDs_AS_DIFFRACTION_GRATINGS_0.pdf Obtain the diffraction pattern using a CD and design an experiment to find the distance between the tracks on it. (Ref: https://www.brighthubeducation.com/science-lessons-grades-9-12/39347-diffraction-experiment-measuring-groove-spacing-on-cds/, https://silo.tips/download/diffraction-from-a-compact-disk)		

Explain polarization of light with the help of a chart. List out the surfaces that reflect polarized light. Learn how polarization of light can be learnt by both transmission and reflection.
What is the physics behind making 3D movies? Group Discussion (https://www.slideserve.com/rae/physics-behind-3d-movies-powerpoint-ppt-presentation)
List out different types of zone plates and look for their applications in day-to-day life. Prepare a report.
Collect information and study how optically polarizing lenses are made. Visit a nearby lens making facility. Learn the principle behind sunglasses. Prepare a report.

TLO's	**BL**	**CO**	**PO**
Define Fraunhofer diffraction.	**L2**	**8**	**1-6, 11-12**
Give a qualitative treatment of single slit/diffraction double slit diffraction.	**L2**	**8**	**1-6, 11-12**
Explain the theory of diffraction due to grating and the normal and oblique incidence.	**L2**	**8**	**1-6, 11-12**
Explain how the resolving power of a grating depends of the number of slits used.	**L2**	**8**	**1-6, 11-12**
Give the theory of Fersnel half period zones.	**L2**	**8**	**1-6, 11-12**
Discuss zone plates with respect to convex lenses.	**L2**	**8**	**1-6, 11-12**
Explain optical polarization and polaroids.	**L2**	**9**	**1-6, 11-12**
Give different types of polaroids.	**L2**	**9**	**1-6, 11-12**
Give the theory of phenomenon of double refraction and explain what are ordinary and extraordinary rays.	**L2**	**9**	**1-6, 11-12**
Give the theory of quarter wave plates and half wave plates.	**L2**	**9**	**1-6, 11-12**
Explain optical activity with theory. Give an experimental method to measure the optical activity of a material.	**L2**	**9**	**1-6, 11-12**

Textbooks

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

2	Berkeley Physics Course – Waves,	Frank S Crawford Jr.	Tata Mc Graw-Hill Publishing Company Ltd., Special Indian Edition,.	2011
3	Optics	E. Hecht	Pearson Paperback	2019
4	Introduction To Optics	F. L. Pedrotti, L.M. Pedrotti & L.S. Pedrotti	Pearson India	2008
5	Fundamentals of Optics	F. Jenkins & H. White	McGraw Hill Education	2017

Paper Code: Phy-DSCP3 - Lab III

List of Experiments to be performed in Lab III	
1.	Velocity of sound through a wire using Sonometer.
2.	Frequency of AC using Sonometer.
3.	Study of Lissajous' Figures
4.	To verify the laws of transverse vibration using Melde's apparatus.
5.	Helmholtz resonator using tuning fork.
6.	Helmholtz resonator using electrical signal generator.
7.	Study of Lissajous figures using CRO
8.	To determine refractive index of the material of a prism using sodium source.
9.	To determine refractive index of a liquid by parallax method.
10.	To determine the dispersive power and Cauchy constants of the material of a prism using Hg source.
11.	To determine wavelength of sodium light using Fresnel Biprism.
12.	Determination of radius of curvature of a lens using Newton's rings.
13.	To determine the thickness of a paper using air-wedge.
14.	Study of Fraunhofer diffraction at single slit
15.	Study of Diffraction at a straight edge.
16.	To determine wavelength of spectral lines of Hg source using plane diffraction grating.
17.	To determine dispersive power and resolving power of a plane diffraction grating.
18.	To verify Brewster's law.
19.	To determine specific rotation of a solution using Polarimeter.

Note: A minimum of EIGHT experiments must be performed

One hour of Laboratory time every week has to be dedicated for suggested activities in the theory paper DSCT3: Wave Motion and Optics. Note that this is in addition to a total of 8 hour of time allotted during theory teaching during the entire semester (2 hours each for every Unit of the theory paper).

Reference Books 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

4th Semester B.Sc

Phy-DSCT4: Thermal Physics & Electronics	**Course Credits (L+T+P) : 4+0+0**
Total Contact Hours: 52	**Duration of ESA: 4 hours**

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

Prerequisites
Exposure of the topic in Pre-University

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

Course Articulation Matrix													
Mapping of Course Outcomes (CO) - Program Outcomes (PO)													
Course Outcomes / Program Outcomes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
1.	Apply the laws of thermodynamics and analyze the thermal system.	X	X	X	X	X	X					X	X
2.	Apply the laws of kinetic theory and radiation laws to the ideal and practical thermodynamics systems through derived thermodynamic relations.	X	X	X	X	X	X					X	X
3.	Use the concepts of semiconductors to describe different Semiconductor devices like diode transistors, BJT, FET etc and explain their functioning.	X	X	X	X	X	X					X	X
4.	Explain the functioning of OP-AMPS and them as the building blocks of logic gates.	X	X	X	X	X	X					X	X
5.	Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits.	X	X	X	X	X	X					X	X

Course Content **Phy.DSCT4: Thermal Physics & Electronics**		**Hrs**
Unit – 1: Thermodynamics **(11 hours of teaching plus 2 hours of activities)**		
Chapter No. 1	**Laws of Thermodynamics**: Review of the concepts of Heat and Temperature – the zeroth law of thermodynamics, Thermodynamic variables - extensive and intensive, Equations of state, PV diagrams.	**2 hours**
Chapter No. 2	**First Law of Thermodynamics:** Differential form of the First Law of Thermodynamics, Work done in an isothermal and adiabatic process for an ideal gas, Internal Energy as a state function, Equation of state for an adiabatic process Application of the first law for (i) Cyclic Process (ii) Adiabatic Process (iii) Isochoric Process (iv) Isobaric Process and (v) Isothermal Process.	**3 hours**
Chapter No. 3	**Second Law of Thermodynamics:** Second law of thermodynamics (Kelvin's & Clausius' statements and their equivalence); Reversible and irreversible processes with examples; Heat engines: Carnot Engine; Carnot Cycle and its efficiency, Practical internal combustion engines - Otto and Diesel Cycles (qualitative treatment); Carnot theorem, Refrigerator- Coefficient of performance. Concept of Entropy, Second Law of Thermodynamics in terms of Entropy, Entropy in reversible process, Entropy in irreversible process, Principle of increase of entropy, Entropy change in (i)	**6 hours**

	adiabatic process (ii) free expansion (iii) cyclic process (iv) isobaric process **Third Law of Thermodynamics(Nernst Heat theorem):** Statement, Significance and Unattainability of Absolute Zero	
Topics for Self-study	(1) Discuss when the temperature of the body is locked until what time you hold the thermometer in contact with a body. Discuss it in contact with laws of thermodynamics. (2) Discuss why when a person works or does exercise, he sweats. Reason it with the laws of thermodynamics.	

Suggested Activities (Any two activities to be conducted compulsorily)

Activity No. 1	We feel cold because coldness enters our body. Discuss the statement in day-to-day life. Approximately give examples of a) open system b) closed system and c) isolated system
Activity No. 2	Take four different sizes of same metal, preferable of same shape and give one piece to each group. Heat it uniformly on a hot plate. Keep a beaker of water with a thermometer immersed in it. Drop one hot metal into the water and record the temperature with time. Repeat the experiment for the other heated metal pieces of different sizes. 1. Plot a graph for the volume of the metal piece used v/s respective temperature change observed. 2. Determine the heat capacity and specific heat of the metal used. All groups shall also do the following activity: **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. On the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.
Activity No. 3	Take ice cubes of different size and immerse in water and measure the temperature change with time and repeat the experiment. Graph the observations. **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.

Topic Learning Outcomes

At the end of the topic, students should be able to understand the following concepts.

SL No	TLO's	BL	CO	PO
1.	Explain the first law of thermodynamics.	**L1**	**1**	**1-6, 11-12**
2.	Give the differential form of the first law of thermodynamics and define what is the internal energy.	**L2**	**1**	**1-6, 11-12**
3.	Obtain an expression for work done in isothermal and adiabatic processes.	**L2**	**1**	**1-6, 11-12**

4.	Give two systems of units of temperature measurement and give their equivalence.	**L2**	**1**	**1-6, 11-12**
5.	Describe and Discuss heat engine based on Carnot cycle.	**L2**	**1**	**1-6, 11-12**
6.	Explain how the efficiency of refrigeration is measured?	**L2**	**1**	**1-6, 11-12**
7.	Detail out the application of the Carnot engine to a locomotion system.	**L1**	**1**	**1-6, 11-12**
8.	State the third law of thermodynamics and give its significance using the third law of thermodynamics describing why absolute zero temperature is not unattainable.	**L2**	**1**	**1-6,11-12**

Teaching and Learning Methodology

Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Assessment Techniques

One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Unit – 2

(11 hours of teaching plus 2 hours of activities)

Chapter No. 4	**Thermodynamic Potentials**: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy, properties and applications **Maxwell's Thermodynamic Relations**: Internal Energy; Enthalpy; Helmholtz free energy; Gibbs free energy and their significance; Maxwell's thermodynamic relations (using Thermodynamic potentials), Applications of Maxwell's Relations (1) Gibbs potential, First order Phase Transitions with examples, Clausius - Clapeyron Equation (2) Liquifaction of gases, regenerative cooling coupled with Joule Thomson cooling; Adiabatic expansion with Joule Thomson cooling (qualitative)	**5 hours**
Chapter No. 5	**Kinetic Theory of Gases**: Maxwell's law of distribution of velocity (without derivation), Deduction of most probable velocity, mean velocity and root mean square velocity, Degrees of Freedom, Law of Equipartition of Energy. Dearivation of Specific heats of ideal gas.	**3 hours**
Chapter No. 6	**Black body radiation** and its spectral energy distribution; Kirchhoff's law, Stefan-Boltzmann's law, Wien's displacement law, Rayleigh-Jeans law (Statements), Planck's law – deduction of Wien's Law & Rayleigh – Jeans Law.	**3 hours**
Topics for Self-study	(1) Equilibrium between phases - triple point of water. (2) Methods of producing low temperatures: (i) Joule Thomson (Joule Kelvin / Throttling / Porous plug) experiment.	

Suggested Activities (Any two activities to be conducted compulsorily)

Activity No. 4	1. Watch the you tube video: https://www.youtube.com/watch?v=bODiX2PjCPE and write a report on the difference between heat and temperature. 2. Watch the you tube video https://www.youtube.com/watch?v=v5zAiWSi7rs "A simple animation showing the thermoelectric effect"(Seebeck effect) and explain it in your own words.
Activity No. 5	Take two containers (cylindrical jars) A and B of identical size (volume 500 ml). Connect them to a reservoir (huge bottle containing water) though pipes of equal length, but of different radii of cross-section. Let container A be connected using a pipe of inner radius of 5 mm and container B be connected using a pipe of inner radius 1.5 mm. Sketch the graphs for the rise of water levels in containers A and B as a function of time when water was allowed to flow from the reservoir to the containers. Explain the results. What happens if the diameter of the containers A is larger than that of B, but pipes of equal length connecting the containers with the reservoir have same inner radii.
Activity No. 6	A hot object at a temperature T_1 is placed in an environment at a temperature T_0. The temperature of the object will be some function of time, T(t). This function will satisfy the equation: $\frac{dT}{dt} = -k(T - T_0)$ (a) Explain "what this equation explains" in your own words. (b) Show that the function $T(t) = T_0 + ce^{-kt}$ satisfies the above equation. (c) Plot T(t) as a function of time t.
Activity No. 7	Take two dissimilar metal wires. Spot weld them forming two junctions. Dip one junction in ice and heat the other junction with a burner. Plot a graph of time of heating v/s Thermo EFM generated in the voltmeter. **Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.

Topic Learning Outcomes

At the end of the topic, students should be able to understand the following concepts.

SL No	TLO's	BL	CO	PO
1.	State Maxwell relations.	**L1**	**2**	**1-6, 11-12**
2.	Give examples where Maxwells relations are used.	**L1**	**2**	**1-6, 11-12**
3.	Explain the phase transition. Which is called as first order phase transition? Give Examples	**L2**	**2**	**1-6, 11-12**
4.	State Clausius - Clapeyron Equation.	**L1**	**2**	**1-6, 11-12**
5.	Obtain an equation for difference in C_P - C_V.	**L2**	**2**	**1-6, 11-12**
6.	State Joule-Thomson effect and Joule-Thomson coefficient.	**L1**	**2**	**1-6, 11-12**

7.	Obtain an expression, giving the relation between pressure, volume and temperature for a real gas (Vander Waals gas).	**L2**	**2**	**1-6, 11-12**
8.	Explain how low temperature is achieved by the liquefaction of gases?	**L2**	**2**	**1-6, 11-12**
9.	State Maxwell-Boltzmann Law of Distribution of velocities in Ideal gases.	**L1**	**2**	**1-6, 11-12**
10.	Explain the mean RMS and most probable speeds in ideal gases.	**L1**	**2**	**1-6, 11-12**
11.	Explain degrees of freedom associated with particles in an ideal gas.	**L2**	**2**	**1-6, 11-12**
12.	Define the specific heat of a gas.	**L1**	**2**	**1-6, 11-12**
13.	Explain black body radiation and its spectral distribution.	**L1**	**2**	**1-6, 11-12**
14.	Explain the different laws used to describe different parts of the curves of a spectral distribution of black body radiation.	**L2**	**2**	**1-6, 11-12**
15.	Define ultraviolet radiation catastrophe? Discuss its importance in the explanation of black body radiation.	**L2**	**2**	**1-6, 11-12**
16.	Define Planck's law of radiation and discuss how it could describe the whole black body radiation curve.	**L2**	**2**	**1-6, 11-12**
Teaching and Learning Methodology				
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.				
Assessment Techniques				
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc				

Unit – 3: Semiconductor devices **(11 hours of teaching plus 2 hours of activities)**		
Chapter No. 8	**Semiconductor devices**: Intrinsic semiconductors, concept of holes , effective mass expression for carrier concentration Intrinsic semiconductors - concept of holes – effective mass - expression for carrier concentration and electrical conductivity – extrinsic semiconductors and electrical conductivity p-n junction and its characteristics and parameters, diode current, P-N Junction as a rectifier ,Half wave rectifier, full wave rectifier, Zener diode as voltage regulator, regulator circuit with no load & loaded regulator.	**5 hours**
Chapter No. 9	**Junction Transistors**: Basics of Bipolar Junction Transistors (BJT), BJT operation, Common Base, Common Emitter and Common Collector Characteristics. Field Effect Transistor (FET) and its characteristics. Transistor as an Amplifier and Oscillator.	**6 hours**
Topic for Self-study	Diode approximations	
Suggested Activities (Any two activities need to be conducted compulsorily)		

Activity No. 8	a. Learn to identify the terminals of different types (packages) of BJTs. b. In the case of power transistors, learn how to fix a heat sink for the transistor. c. Learn the difference between BJT and FET from operational characteristics.
Activity No. 9	Take any 3 diodes and assign one each to three groups of students. Ask them to measure diode resistance when dipped in ice and while heating the ice till it boils. Using this data, plot calibration curve of temperature v/s resistance and also the cooling curve of temperature v/s time for the diode by each group. **Note for the teachers for the activity:** Form 3 groups. Assign each group the activity of drawing one of the graphs. Provide a few days to complete the activity. On the specific day, each group has to make a ppt presentation of the following three slides. Select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study.
Activity No. 10	Prepare a table consisting of (i) name of the semiconductor diode (Zener diode, Light Emitting Diode, Rectifier Diode, Schottky diode) (ii) its application/s (3) attach a sample photo for each type of semiconductor diode (4) give a link for the website where you got the sample photo of the diode.

Topic Learning Outcomes

At the end of the topic, students should be able to understand the following concepts.

SL No	TLO's	BL	CO	PO
1.	Define Semiconductors and Band Gap. Explain on what basis they are classified as intrinsic and extrinsic.	**L2**	**3**	**1-6, 11-12**
2.	Define PN junction. Explain its functioning in forward and reverse bias.	**L1**	**3**	**1-6, 11-12**
3.	Explain the approximation used in a real diode with respect to an ideal PN Junction?	**L2**	**3**	**1-6, 11-12**
4.	With a schematic diagram, explain half wave and full wave rectifiers.	**L1**	**3**	**1-6, 11-12**
5.	Define a Zener diode and explain how it is different from an ordinary diode using V-I curves?	**L2**	**3**	**1-6, 11-12**
6.	With the schematic diagram, explain the working of voltage regulators of different types using a Zener diode.	**L1**	**3**	**1-6, 11-12**
7.	Give the basic concepts used in the instruction of bipolar junction transistor and its operation.	**L1**	**3**	**1-6, 11-12**
8.	Compare the V-I curve of common base common emitter and common collector BJT curves while explaining their working principles.	**L2**	**3**	**1-6, 11-12**
9.	Define FET. Give its characteristics.	**L1**	**3**	**1-6, 11-12**
10.	Explain how a transistor can be used as an amplifier and an oscillator using a circuit diagram.	**L2**	**3**	**1-6, 11-12**

Teaching and Learning Methodology		
Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.		
Assessment Techniques		
One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc		
Unit – 4: Electronics		
Chapter No. 10	**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**
Chapter No. 11	**Digital Electronics:** 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. **Boolean Algebra Theorems:** De Morgan's theorem. Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate, NOR Gate, Algebraic Simplification, Implementation of NAND and NOR functions.	**7 hours**
Topics for Self-study	(i)Understand the concept of virtual ground of an OP-AMP. (ii)Learn the different types of op-amps used for different applications. (iii)What is a buffer? Prepare a report on buffers and its application in instrumentation electronics.	
Suggested Activities (Any two activities need to be conducted compulsorily)		
Activity No. 12	Learn how to implement logic functions (AND, OR, NOT) using just diodes and resistors. With a circuit diagram show how different types of gates can be built by X-NOR gates.	
Activity No. 13	A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by one of the switches irrespective of the state of the other switch. Explain switching of the bulb in terms of logic gate operation.	
Activity No. 14	A man has to take a wolf, a goat, and some cabbage across a river. His rowboat has enough room for the man plus either the wolf or the goat or the cabbage. If he takes the cabbage with him, the wolf will eat the goat. If he takes the wolf, the goat will eat the cabbage. Only when the man is present are the goat and the cabbage safe from their enemies. All the same, the man carries wolf, goat, and cabbage across the river. How? Write the truth table for the above story and implement using digital gates.	
Activity No. 15	A locker has been rented in the bank. Express the process of opening the locker in terms of digital operation.	

Topic Learning Outcomes

At the end of the topic, students should be able to understand the following concepts.

SL No	TLO's	BL	CO	PO
1.	Define op-amps and give the characteristics of an ideal op-amp.	L1	4	1-6, 11-12
2.	Explains an inverting and non-inverting configuration of typical op-amps, with a schematic diagram.	L2	4	1-6, 11-12

3.	Explain how op-amps can be used as a voltage follower, with a schematic diagram and with relevant expressions.	**L2**	**4**	**1-6, 11-12**
4.	Explain how op-amps can be used as a voltage follower, adder and subtractor, with a schematic diagram and with relevant expressions.	**L2**	**4**	**1-6, 11-12**
5.	Give different digital wave forms and explain how one can visualize the switching and logic levels.	**L1**	**5**	**1-6, 11-12**
6.	Write any four-digit numbers other than zero in the decimal number system and convert that into binary and hexadecimal.	**L2**	**5**	**1-6, 11-12**
7.	Write any number in a Binary System of 8 digits other than zero and convert it into decimal and hexadecimal.	**L2**	**5**	**1-6, 11-12**
8.	Write any number in the hexadecimal system of 4 digits other than zero and converted it into a binary and decimal number.	**L2**	**5**	**1-6, 11-12**
9.	Give simplified diagram for a given Boolean circuit diagram of logic gates, and verify using the De-Morgans theorem.	**L2**	**5**	**1-6, 11-12**
10.	Why are X-NOR gates called Universal Gates?	**L2**	**5**	**1-6, 11-12**

Teaching and Learning Methodology

Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Assessment Techniques

One minute paper/ Predict-Observe-Explain/ Think-Pair-Share/ Class Test/ Quiz/ Crosswords/ Group Assessment/ Assignment/ Peer-to-Peer Evaluation/Seminar etc

Textbooks

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1.	Heat and Thermodynamics	Brij lal, N. Subrahmanyam and P.S.Hemne	S. Chand Publishing	2001
2.	Heat and Thermodynamics	D. S. Mathur	S. Chand Publishing	2008
3.	Heat and Thermodynamics	M.W. Zemansky and Richard Dittman	McGraw-Hill Education	2017
4.	Thermal Physics	S C Garg, R M Bansal & C K Ghosh	McGrawHill Education (India)	2013
5.	Fundamentals of Classical Thermodynamics	G. J. V. Wylen, R. E. Sonntag, C. Borgnakke	John Wiley	1994
6.	Integrated Electronics	J. Millman, C. Halkias & C. Parikh	McGraw Hill Education	2017
7.	Digital Fundamentals	T. L. Floyd	Pearson Education	2005
8.	Principals of Electronics	V.K Mehta and Rohit Mehta	S. Chand Publishing	2020

References Books				
Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	A Treatise on Heat	M. Saha & B.N.Srivastava	Hafner Publishing Company, Indian Press	1958
2	Thermodynamics, Kinetic theory & Statistical Thermodynamics	F. W. Sears & G. L. Sailinger	Pearson Education	1975
3	Electronic Principles	A Malvino and D J Bates	McGraw Hill Education	2017
4	Electronic Devices and Circuits	David A. Bell	PHI, New Delhi	2004

Paper Code: Phy-DSCP4 - Lab IV

List of Experiments to be performed in Lab IV **Note: A minimum of EIGHT experiments must be performed in Lab IV of which FOUR experiments should be chosen from 1-13 and FOUR experiments should be chosen from 14-24.**	
1.	Specific heat by Newton's law of cooling
2.	Verification of Newton's law of cooling
3.	Calibration of thermocouple for Temperature measurement
4.	Thermal conductivity of a bad conductor by Lee's and Charlton's method
5.	Thermal conductivity of rubber
6.	Mechanical Equivalent of Heat by Callender and Barne's method
7.	Coefficient of thermal conductivity of Copper by Searle's method
8.	Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method
9.	Determination of Stefan's constant/ Verification of Stefan's law
10.	Variation of thermo-emf across two junctions of a thermocouple with temperature
11.	Verification of Clausius-Clapeyron equation
12	Study of Gaussian distribution using Monte Carlo method.
13	Determination of Planck's constant.
Any FOUR of the above listed experiments 1-13 must be conducted in Lab IV	
14.	V-I Characteristics of Silicon & Germanium PN Junction diodes (FB & RB)
15.	(i) V-I Characteristics of Zener Diode (ii) Regulated power supply (using zener diode).
16.	Characteristics of BJT in Common Emitter Configuration
17.	Half Wave and Full Wave Rectifier without Filter
18.	Half Wave and Full Wave Rectifier with Filter
	Determination of transistor h-parameters.
19.	Frequency response of a CE amplifier.
20.	Frequency response of CC Amplifier (Emitter Follower).
21.	Applications of Operational Amplifier: (i) Non-inverting and Inverting op-amp circuits (ii) Voltage follower, Adder and Subtractor circuits
22.	Truth table verification of logic gates using TTL 74 series ICs.
23.	Logic Gates; Combinational Circuits; Sequential Circuits
24.	Transfer characteristics of a TTL gate using CRO.
Any FOUR of the above listed experiments 14-24 must be conducted in Lab IV	
One hour of Laboratory time every week has to be dedicated for suggested activities in the theory paper DSCT3: Thermal Physics & Electronics. Note that this is in addition to a total of 8 hour during theory teaching during the entire semester (2 hours each for every Unit of the theory paper).	

Reference Books 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	Basic Electronics Lab Manual 2015-16,	National Institute of Science Education and Research, Bhubaneswar, 2015.	NISER, Bhubaneswar	**2015**
3	Engineering Practical Physics	S. Panigrahi, B. Mallick	Cengage Learning India Pvt. Ltd	**2015**

OPEN ELECTIVE PAPERS

Phy-OE5: Optical Instruments (Credits:3)
3 hours of teaching per week

Unit-I	Hrs.
Basics of Optics: Scope of optics, optical path, laws of reflection and refraction as per Fermat's principle, magnifying glass, Lenses (thick and thin), convex and concave lenses, Lens makers formulae for double concave and convex lenses, lens equation. Focal and nodal points, focal length, image formation, combination of lenses, dispersion of light: Newton's experiment, angular dispersion and dispersion power. Dispersion without deviation. (No derivations; concepts to be discussed qualitatively).	**13**
Unit-II	
Camera and microscopes: Human eye (constitution and working), Photographic camera (principle, construction and working), construction, working and utilities of (i) Simple microscopes (ii) Compound microscope (iii) Electron microscopes (iv) Binocular microscopes **Self study:** Experimental determination of magnifying power of a microscope.	**13**
Unit-III	
Telescopes and Spectrometer: Construction, working and utilities of (i) Astronomical telescopes (ii) Terrestrial telescopes (iii) Reflecting telescopes, Construction, working and utilities of Eyepieces or Oculars (Huygen, Ramsden's, Gauss) Spectrometer – Construction, working and utilities, measurement of refractive index.	**13**
Self study — Telescopes used at different observatories in and outside India.	

Suggested Activities

1. Find position and size of the image in a magnifying glass and magnification.
2. Observe rain bows and understand optics. Create a rainbow.
3. Find out what makes a camera to be of good quality.
4. Observe the dispersion of light through prism.
5. Make a simple telescope using magnifying glass and lenses.
6. Learn principle of refraction using prisms.
7. Check bending of light in different substances and find out what matters here.
8. Learn about different telescopes used to see galaxies and their ranges.

Weblinks: **https://spark.iop.org, http://www.yenka.com, https://publiclab.org** etc

Reference Books

1. Galen Duree. Optics for Dummies. Wiley. 2011.
2. Blaker J W. Optics: An Introduction for Students of Engineering. Pearson, 2015.
3. Hecht E. Optics. Pearson. 5th Edition, 2019.
4. Khurana A K. Theory And Practice Of Optics & Refraction. Elsevier India. 2016.
5. FlexBooks® 2.0 https://flexbooks.ck12.org/cbook/ck-12-middle-school-physical-science-flexbook-2.0/section/19.9/primary/lesson/optical-instruments-ms-ps/

Phy-OE6: Elements of Astronomy & Astrophysics (Credits:3)
3 hours of teaching per week

Unit-I : History and Introduction	Hrs.
Ancient Astronomy: Greek Observations, Sumerian Observations, Mayan Observations, Arabic Observations ,Chinese Observations (2 hours) **Indian Astronomy:** Vedic Astronomy, Ancient Astronomy – Aryabhata, Varahamihira, Bhaskara, Astronomy in Indian Scriptures, Precession of the Equinox, Celebrations of Equinox (2 hours) **Medieval & Modern Astronomy:** Invention of Telescopes, Models of the Solar System & Universe, Observations by Tycho Brahe, Kepler, Galileo, Herschel and Other, Modern Astronomy (3 hours) **Optical Tools for Astronomy:** Pin Hole, Binoculars, Telescopes & Imaging (1 hour) **Mathematical Methods of Observations:** Angular Measurement, Trigonometric functions, Stellar Parallax (2 hour) **Observational Terminologies:** Cardinal Directions, Azimuth, Altitude, Measurements using Compass and Hand. Equatorial Co-ordinates, Light years, Magnitude, Colors etc. (3 hours)	**13**
Unit-II: Observations of the Solar System	
The Sun: Ecliptic and the Orientation of the Earth, Seasons - Solstices and Equinox, Observations of the Sun from Earth during seasons. Eclipses, Zero-shadow day, Sunspots (3 hours) **The Moon:** Earth-Moon system – Phases, Lunar Eclipses, Ecliptic and Lunar Orbital Plane – Nodes, Lunar Month, Full Moon Names (3 hours) **Inner Planets: Mercury & Venus** - Observational History, Observational Windows, Appearance, Apparitions, Elongations, Superior Conjunctions, Inferior Conjunctions, Transits. (4 hours) **Outer Planets: Mars, Jupiter & Saturn** - Observational History. Observational Windows, Appearance, Frequency of Oppositions, Conjunctions, Moons Eclipses. Galilean Moons, Saturn's Rings (3 hours)	**13**
Unit-III: Major Astronomy Observations	
March to June: Prominent Stars and Constellations Visible during this period, Methods of Spotting. (4 hours) **June to September:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours) **September to December:** Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours) **December to March**: Prominent Stars and Constellations Visible during this period, Methods of Spotting. (3 hours)	**13**

Suggested Activities

1. Measuring Seasons using Sun's Position.
2. Measuring Distance using Parallax
3. Estimation of the Stellar Diameter using Pin Hole
4. Measuring Height of an Object Using Clinometer.
5. Star spotting using constellation maps
6. Constellation spotting using Skymaps
7. Estimation of 'Suitable Periods' to observe deep sky objects using Planisphere.
8. Estimation of the Size of the Solar System in using Light Years.
9. Identification of Lunar Phases across a year.
10. Measuring Constellation of the Sun using Night Sky maps or Planispheres

Reference Books

1. The Stargazer's Guide - How to Read Our Night Sky by Emily Winterburn
2. A guide to the Night Sky – Beginner's handbook by P.N. Shankar
3. The Complete Idiot's guide to Astronomy by Christopher De Pree and Alan Axelro

Phy-OE7: Medical Physics (Credits:3)
3 hours of teaching per week

Unit-I: Human Anatomy and Physiology	
Overview of human anatomy - cells, cell structure, type of cells and their functions, tissues, organs, and their functions. Different systems in the human body, their structure and function, physiological properties of the circulatory system, digestive system, respiratory system, reproductive system, excretory system, endocrine system and nervous system	(13 hours)
Unit-II: Physics of Medical Diagnostics	
Principle of production of X-rays. Use of X-rays in medical diagnosis, X-ray imaging systems. Computed Tomography (CT): principle and generation of CT. Magnetic Resonance Imaging (MRI): basic principle and image characteristics. Ultrasound Imaging: Interaction of sound waves with body tissues, production of ultrasound, transducers, acoustic coupling, image formation, modes of image display and color Doppler.	(13 hours)
Unit-III: Physics of Radiotherapy	
Clinical aspects of radiation therapy: Biological basis of radiotherapy, radiation sources, radiation dose, time dose fractionation. External beam radiation therapy, radiation therapy modalities, production of radioisotopes, use of radioisotopes in therapy, particle and ion beam radiotherapy. Brachytherapy - principle of brachytherapy and classification of brachytherapy techniques.	(13 hours)
Suggested Activities Unit I: Students may demonstrate the shape, size, positions and functions of different organs in the body with the help of models. Unit II: The use of X-rays in the diagnosis of the fractured bone can be demonstrated with the help of a gamma source and a gamma ray survey meter. As the density of materials between the source and the detector changes the reading on the meter (or intensity of the beefing sound) changes. Unit III: (i) Students can be asked to list out different type of cancers and possible causative factors. They can be asked to list out the healthy practices to reduce the risk of cancers. (ii) As there will be students from different disciplines in the OE course, group discussion can be arranged to discuss about their programme and outcome. This will be an opportunity for the students to know about other disciplines.	

Other related activities/projects

1. Visit to nearby hospitals/diagnostic centers to study the working of X-ray machines.
2. Visit to ultrasound diagnostic centers to study the principle and use of ultrasound in diagnosis.
3. Project on principle and use of X-ray films in imaging.
4. Visit to radiotherapy centers to study the modalities of radiotherapy.

Text Books

1. C. H. Best and N. B. Taylor. A Test in Applied Physiology. Williams and Wilkins Company, Baltimore, 1999.
2. C. K. Warrick. Anatomy and Physiology for Radiographers. Oxford University Press, 2001.
3. Jerrold T. Bushberg. The Essential Physics for Medical Imaging (2nd Edition). Lippincott Williams & Wilkins, 2002.
4. Jean A. Pope. Medical Physics: Imaging. Heinemann Publishers, 2012.
5. Faiz M. Khan and Roger A. Potish. Treatment Planning in Radiation Oncology. Williams and Wilkins, USA, 2003.
6. D. Baltas. The physics of modern brachytherapy for oncology. Taylor and Francis, 2007.

Reference Books

1. J. R. Brobek. Physiological Basis of Medical Practice. Williams and Wilkins, London, 1995.
2. Edward Alcamo, Barbara Krumhardt. Barron's Anatomy and Physiology the Easy Way. Barron's Educational Series, 2004.
3. Lippincott, Anatomy and Physiology. Lippincott Williams & Wilkins, 2002.
4. W. E. Arnould Taylor. A textbook of anatomy and physiology, Nelson Thornes, 1998.
5. G. S. Pant. Advances in Diagnositc Medical Physics. Himalaya Publishing House, 2006.
6. Sabbahaga, Diagnositc Ultrasound applied to OBG. Maryland, 1980.
7. Faiz M Khan. The Physics of Radiation Therapy (3rd edition). Lippincott Williams & Wilkins, USA, 2003.
8. Jatinder R. Palta and T. Rockwell Mackie. Intensity Modulation Radiation Therapy. Medical Physics publishing, Madison, Wisconsin, 2003.
9. AAPM Report No. 72. Basic Applications of Multileaf collimators, AAPM, USA, 2001.
10. AAPM Report No. 91. Management of Respiratory motion in radiation oncology, 2006.
11. CA Joslin, A. Flynn, E. J. hall. Principles and Practice of Brachytherapy. Arnold publications, 2001.
12. Peter Hoskin, Catherine Coyle. Radiotherapy in Practice. Oxford University Press, 2011.
13. W. R. Handee. Medical Radiation Physics. Year Book Medical Publishers Inc., London, 2003.
14. Donald T. Graham, Paul J. Cloke. Principles of Radiological Physics. Churchill Livingstone, 2003.
15. Thomas S. Curry. Christensen',s Physics of Diagnostic Radiology (4th Edition). Lippincott Williams & Wilkins, 1990.
16. Madison. MRI – Perry Sprawls – Medical Physics Publishing. Wisconsin, 2000.
17. Steve Webb. The Physics of Three–Dimensional Radiotherapy. Institute of Physics Publishing, Bristol and Philadelphia, 2002.
18. Radiation oncology physics: A Handbook for teachers and students. IAEA publications, 2005.
19. F. M. Khan. The Physics of Radiation Therapy (3rd Edition), Lippincott Williams and Wilkins, U.S.A., 2003.

Phy-OE8: Electrical Instruments (Credits:3)
3 hours of teaching per week

Content		Hrs
Unit - 1		
Chapter No. 1	Voltage and current sources, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Ammeters,voltmeters: (DC/AC)	03
Chapter No. 2	Representation of sinusoidal waveforms, peak and rms values, power factor. Analysis of single-phase series and parallel R-L-C ac circuits. Three-phase balanced circuits, voltage and current relations in star and delta connections. Wattmeters: Induction type, single phase and three phase wattmeter, Energy meters: AC. Induction type single phase and three phase energy meter	05
Chapter No. 3	Instrument Transformers: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications.	05
Topics for self study (If any)	Types of switches and Circuits, Safety precautions and rules in handling electrical appliances, Electric shock, first aid for electrical shocks, Fuses, MCB, ELCB and Relays, Filament lamp, Tube light, CFL and LED	
	Suggested Activities	
Activity No. 1	Identify variety of electrical switches and note down their applications/utility.	
	Reference: Weblink/Youtube/Book	
Activity No. 2	Identify the hazards involved in handling electrical circuits and instruments, make a list of safety precautions as well as first aid for electrical shocks.	
	Reference : Weblink/Youtube/Book	
Unit - 2		
Chapter No. 4.	Galvanometers: General principle and performance equations of D'ArsonvalGalvanometers, Vibration Galva nometer and Ballistic Galvanometer.	03
Chapter No. 5.	Potentiometers: DCPotentiometer, Crompton potentio meter, construction, standardization, application. AC Potentio meter, Drysdalepolar potentio meter; standardization, application.	03
Chapter No. 6.	DC/AC Bridges: General equations for bridge balance, measurement of self inductance by Maxwell's bridge (with variable inductance & variable capacitance), Hay's bridge, Owen's bridge, measurement of capacitance by Schearing bridge, errors, Wagner's earthing device, Kelvin's double bridge.	07
Topics for self study	Importance of grounding and Earthing, Methods for Earthing,	

Suggested Activities		
Activity No. 3	Make a study of importance of grounding in electrical circuits. Reference : Weblink/Youtube/Book	
Activity No. 4	Prepare a detailed account of various methods of earthing and their utility/applications Reference : Weblink/Youtube/Book	
Unit - 3		
Chapter No.7	Transducer: Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer	06
Chapter No. 8	CRO: Block diagram, Sweep generation, vertical amplifiers, use of CRO in measurement of frequency,phase, Amplitude and rise time of a pulse. Digital Multi-meter: Block diagram, principle of operation	03
Chapter No. 9	Basics of lead acid batteries, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing.	04
Topics for self study (If any)	Basic study of Fuses, MCB, ELCB and Relays, Filament lamp, Tube light, CFL and LED	
Suggested Activities		
Activity No. 5	Prepare a document on evolution of incandescent bulbs to the present-day LED lights Reference : Weblink/Youtube/Book	
Activity No.6	Make a comparative study of Fuses, MCB, ELCB and Relays highlighting their use and applications Reference : Weblink/Youtube/Book	

Text Books

1. A. K.Sawhney, A Course in Electrical.and Electronic Measurements & Instrumentation **, Dhanpat Rai & Sons, 1978**
2. A.D. Helfrick, W.D. Cooper, Modern Electronic Instrumentation and Measurement Techniques, **Prentice Hall India, 1992.**

References Books

1. D C Kulshreshtha, Basic Electrical Engineering, Mc Graw Hill Publications,**2019**
2. David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005
3. Vincent Del Toro, Electrical Engineering Fundamentals Prentice Hall India, **2009**

COURSE PATTERN & SCHEME OF EXAMINATION for B.Sc. / B.Sc. (Hons.) as per NEP-2020

Semester	Title of the Paper	Total No of hours	Hours per week	Marks		Duration of Examination (hours)	Total Marks	Credits
				Theory/ Practicals	Internal Assessment (IA)			
				Max	Max			
3rd Sem.	Phy-DSCT3: Wave motion and Optics	52	4	60	40	$2\frac{1}{2}$	100	4
	Phy-DSCP3-Lab III	40	4	25	25	3	50	2
	Phy-OE5 : Optical Instruments OR Phy-OE6: Elements of Astronomy and Astrophysics	39	3	60	40	$2\frac{1}{2}$	100	3
4th Sem.	Phy-DSCT4: Thermal Physics & Electronics	52	4	60	40	$2\frac{1}{2}$	100	4
	Phy-DSCP4-Lab II	40	4	25	25	3	50	2
	Phy-OE7: Medical Physics OR Phy-OE8: Electrical Instruments	39	3	60	40	$2\frac{1}{2}$	100	3

Formative/Internal Assessment for Theory Papers	
Assessment Occasion	Marks
Test-1 (Attendance+Activity + Self-study related)	20
Test-2 (Theory based)	20
Total	40

***Questions should not be set on activity and self-study topics during end semester examinations.**

Distribution of Marks for the Practical Examination (Phy-DSCP1 & Phy-DSCP2)		
Sl No	Particulars	Marks
1	Writing Principle/Statement/Formulae with symbols, units and explanations.	03
2	Drawing illustrative diagrams and expected graphs	03
3	Setting up of the experiment & taking readings	06
4	Calculations and graphs drawn based on experimental data.	05
5	Accuracy of results with units	03
6	Valuation of Practical Record	05
Total Marks		25

3rd/4th Semester B.Sc Examination, April/May (September/October) 2023

CBCS - 2021 ONWARDS

Subject: Physics

Phy-DSCT3/Phy-DSCT4: …….

Time: 2 $\frac{1}{2}$ hours **Max. Marks: 60**

Instruction: Answer *any* FOUR questions from *each* part

PART- A

Each question carries 2 marks (concept based)

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 1,2,3,4,5,6)

PART-B (20 marks)

Each question carries 5 marks (numerical problems)**

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 7,8,9,10,11,12)***

PART-C (32 marks)

Each question carries 8 marks

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 13,14,15,16,17,18)**

*In each part of the question paper first three questions should be set from the first TWO units of the syllabus and next three questions should be set from second half (last TWO units) of the syllabus.

**Questions in Part-B should contain numerical problems in the specific cases of discipline core subjects, where problem solving is an essential component of learning.

*** Questions of Part B and Part C may contain subdivisions i.e., (i) questions 7 to 12 of Part B may be split into a, b & division of marks in such cases should be clearly indicated – for example 2 + 3=5 marks or 1+4=5

marks. Similarly (ii) question 13 to 18 of Part C may be split into a, b, c with division of marks clearly indicated – for example 3+5=8 marks or 2+6=8 marks or 2+3+3=8 marks and so on).

3rd/4th Semester B.Sc Examination, April/May (September/October) 2023

CBCS - 2021 ONWARDS

Subject: Physics

Phy-OE5/OE6/OE7/OE8 : ……..(Open Elective)

Time: 2 $\frac{1}{2}$ hours **Max. Marks: 60**

Instruction: Answer *any* FOUR questions from *each* part

PART- A

Each question carries 2 marks (concept based)

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 1,2,3,4,5,6)

PART-B (20 marks)

Each question carries 5 marks **

6 QUESTIONS TO BE SET*

(Question Numbers: 7,8,9,10,11,12)***

PART-C (32 marks)

Each question carries 8 marks

6 QUESTIONS TO BE SET* (Answer any 4 questions)

(Question Numbers: 13,14,15,16,17,18)**

* All parts should have TWO questions each from 3 units of the open elective syllabus.
** Questions of Part B and Part C may contain subdivisions i.e., (i) questions 7 to 12 of Part B may be split into a, b & division of marks in such cases should be clearly indicated – for example 2 + 3=5 marks or 1+4=5 marks. Similarly (ii) question 13 to 18 of Part C may be split into a, b, c with division of marks clearly indicated – for example 3+5=8 marks or 2+6=8 marks or 2+3+3=8 marks and so on).

Bangalore University
Department of Physics

Jnanabharathi Campus
Bengaluru – 560 056

Syllabusfor

5rd& 6th Semester B. Sc. Physics

Under-Graduate (UG) Program Framed according to the National Education Policy (NEP 2020)

(Effective from the Academic Year 2023-24)

Board of Studies in Physics (UG) Members

Prof. M. K. Kokila, Dept. of Physics, Bangalore University, Bengaluru-56. (Chairperson)

Sri. Balakrishna M T	**The Rural College, Kanakapura-562 117**
Dr. Ramesh T	**GFGC, Channapatna, Ramanagara.**
Dr.Venkateshappa	**GFGC, Vijayanagar, Bengaluru-40**
Prof.Wajeeha Sultana	**Maharani Cluster University,Bengaluru-1**
Dr.Madhavi K.Y	**GFGC, Channapatna.**
Smt.SeetaVasudevrao	**GFGC, Kengeri, Bengaluru-60**
Dr. Manjunath H C	**GFGC, Devanhalli.**

Board of Studies Members as Invitees

Prof. Ramakrishna Damle	**Department of Physics, Bangalore University, Bengaluru.**
Prof. B. Eraiah	**Department of Physics, Bangalore University, Bengaluru.**
Dr.Sarbari Bhattacharya	**Department of Physics, Bangalore University, Bengaluru.**

Date: 24.08.2023
Place: Bengaluru

Department of Physics
Bangalore University, Bangalore-56

Proceedings of the BOS (UG) Physics meetingheld at 10.30 am on 24th August 2023 at the Department of Physics, BUB-56.

The following agenda was discussed: (1) **B. Sc., 5th and 6th** Semester Syllabus of Physics Papers (2) **Panel of Examiners for UG** for the academic year 2023-2024 and **BOE (Proposed)** for the academic year 2023-24. After elaborate discussions and suitable modifications, the members of the BOS approved both the agenda.

Sl. No.	Name & Affiliation of the BOS Member	Signature
1	Dr. M. K. Kokila, Professor & Chairperson Department Physics, Bangalore University, Bengaluru-56	24/08/23
2	Dr. Venkateshappa Y Govt. First Grade College, Vijayanagar, Bengaluru-04	Absent
3.	SmtSeetaVasudevrao Govt. First Grade College, Kengeri, Bengaluru-60	Absent
4.	Dr.WajeehaSulthana Maharani Science College for Women, Bengaluru-01	
5.	Sri Ramesh T Govt. First Grade College, Channapattana-571 501.	
6.	Sri. Balakrishna M T The Rural College, Kanakapura-562 117	
7.	Dr Manjunath H C Govt. First Grade College, Devanahalli	Absent
8.	Dr.Madhavi, K. Y. Govt. First Grade College, Channapattana-571 501.	
	Invitees	
9.	Prof. Ramakrishna Damle Dept. Physics, Bangalore University, Bengaluru-56	
10.	Prof. B. Eraiah Dept. Physics, Bangalore University, Bengaluru-56	
11.	Prof.Sarbari Bhattacharya Dept. Physics, Bangalore University, Bengaluru-56	

B. Sc. COURSE FOR BANGALORE UNIVERSITY FRAME WORK IN PHYSICS AS PER HIGHER EDUCATION COUNCIL GUIDELINES (for Two Major)

Sem. No.	Course Category	Course Code	Course Title	Credits Assigned	Instructional Hours per week		Duration of Exam (Hrs.)	Marks		
					Theory	Practical		IA	Exam	Total
V	DSC PHYSICS MAJOR	PHY.DSCT5	Classical Mechanics -I and Quantum Mechanics-I	04	04		2½	40	60	100
		PHY.DSCP5	Classical Mechanics -I and Quantum Mechanics-I Practical	02	-	04	04	25	25	50
		PHY.DSCT6	Elements of Atomic, Molecular and Laser Physics	04	04		2 ½	40	60	100
		PHY.DSCP6	Elements of Atomic, Molecular and Laser Physics Practical	02	-	04	04	25	25	50
			Total	**12**				**130**	**170**	**300**
VI	DSC PHYSICS MAJOR	PHY.DSCT7	Elements of Condensed Matter & Nuclear Physics	04	04		2 ½	40	60	100
		PHY.DSCP7	Elements of Condensed Matter & Nuclear Physics Practical	02	-	04	04	25	25	50
		PHY.DSCT8	Electronic Instrumentation & Sensors	04	04		2 ½	40	60	100
		PHY.DSCP8	Electronic Instrumentation & Sensors Practical	02	-	04	04	25	25	50
			Total	**12**				**130**	**170**	**300**

Program Name	B.Sc. in Physics	**Semester**	V
Course Title	Classical Mechanics andQuantumMechanics-I (Theory)		
Course Code	PHY.DSCT5	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	2 ½ Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

Course Outcomes (COs):

- Inertial and non-inertial frames of reference.
- Apply the Lorentz transformations to transform velocities in special relativity.
- Calculate the relativistic Doppler effect.
- Limitations of classical physics.
- Physical significance of wave function: expectation values and probability.
- Understanding uncertainty relation.
- Examples of exactly solvable potentials.
- Importance of commutation relations.

Contents	**60 Hrs**
Unit1 : Introduction to Newtonian Mechanics: Frames of references, Newton'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 conservation of energy. **Lagrangian formulation**: Constraints, Holonomic constraints, non-holonomic constraints, Scleronomic and Rheonomic constraints. Generalized coordinates, degrees of freedom, Principle of virtual work, D'Alembert's principle, Lagrange equations (No derivation). Newton's equation of motion from Lagrange equations, Lagrange's equations for simple pendulum, Atwood's machine and linear harmonic oscillator. **12 Hours** **Activities:** **03 Hours**	15
Unit 2: Relativity Inertial and Non-inertial frames, fictitious forces, uniformly rotating frames. Special Theory of Relativity: Michelson-Morley Experiment and its outcome, Postulates of Special Theory of Relativity, Lorentz Transformations, Lorentz length contraction, Time dilation, Concept of Simultaneity, Relativistic transformation of velocity, Relativistic addition of velocities, Variation of mass with velocity, Mass energy equivalence, Relativistic Kinematics, Transformation of energy and momentum. **12 Hours** **Activities:** **03 Hours**	15
Unit 3: 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	15

of particles by wave packets, Group and Phase velocities and relation between them, Experimental evidence for matter waves: Davisson- Germer experiment, G.P Thomson experiment. Heisenberg uncertainty relation between: momentum and position, energy and time; Illustration of uncertainty principle by Gamma ray microscope- thought experiment, Consequences of the uncertainty relations: Diffraction of electrons at a single slit, can an electron be part of a nucleus? Two-slit experiment with photons and electrons. **12 Hours** **Activities: 03 Hours**	
Unit 4: Formalism of Quantum Mechanics Probabilistic interpretation of the wave function: Admissibility conditions, normalization, Schrödinger equation for a free particle in one, probability current density, equation of continuity, time-dependent and time-independent Schrodinger equations. Particle in a one-dimensional infinite potential well (derivation), particle in a finite potential well (qualitative), Transmission across a potential barrier, the tunnel effect (qualitative), scanning tunneling microscope, one-dimensional simple harmonic oscillator (qualitative) - concept of zero - point energy. Postulates of Quantum mechanics: States and Observables (position, momentum, angular momentum and energy as examples, Expectation value of observables, time evolution, Ehrenfest theorem (using time evolution) **12 Hours** **Activities: 03 Hours**	15

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
One internal test	20
Assignment/Activities	20
Total	**40**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

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	Concepts of Modern Physics, Arthur Beiser, McGraw-Hill, 2009.
6	Physics for Scientists and Engineers with Modern Physics, Serway and Jewett, 9th edition, Cengage Learning, 2014.
7	Quantum Physics, Berkeley 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&K.Sivaprasath; S. Chand Publishing.
12	G Aruldhas, Quantum Mechanics, Phi Learning Private Ltd., ISBN: 97881203363.
13	Gupta, Kumar & Sharma, Quantum Mechanics, Jai Prakash Nath Publications.
14	Physics for Degree Students B.Sc., Third Year, C.L.Arora and P.S.Hemne, 1st edition, S.Chand& Company Pvt. Ltd., 2014.
15	Introduction to Special Theory of Relativity, Rober Resnick, John Wiley and Sons First Edition
16	Special Relativity, A P French, MIT, w.w.w.Nortan and Company First Ed (1968)

Course Title	Classical Mechanics and Quantum Mechanics-I (**Practical**)	**Practical Credits**	02
Course Code	PHY.DSCP5	**Contact Hours**	04 Hours
Formative Assessment	25 Marks	**Summative Assessment**	25 Marks

Practical Content

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

1) To determine 'g', the acceleration due to gravity, at a given place, from the $L - T^2$ graph, for a simple pendulum.

2) Studying the effect of mass of the bob on the time period of the simple pendulum.

[Hint: With the same experimental set-up, take a few bobs of different materials (different masses) but of same size. Keep the length of the pendulum same for each case. Starting from a small angular displacement of about 10°, find out, in each case, the time period of the pendulum, using bobs of different masses. Does the time period depend on the mass of the pendulum bob? If yes, then see the order in which the change occurs. If not, then do you see an additional reason to use the pendulum as a time measuring device.

3) Studying the effect of amplitude of oscillation on the time period of the simple pendulum.

[Hint: With the same experimental set-up, keep the mass of the bob and length of the pendulum fixed. For measuring the angular amplitude, make a large protractor on the cardboard and have a scale marked on an arc from 0° to 90° in units of 5°. Fix it on the edge of a table by two drawing pins such that its 0°-line coincides with the suspension thread of the pendulum at rest. Start the pendulum oscillating with a very large angular amplitude (say 70°) and find the time period T of the pendulum. Change the amplitude of oscillation of the bob in small steps of 5° or 10° and determine the time period in each case till the amplitude becomes small (say 5°). Draw a graph between angular amplitude and T. How does the time period of the pendulum change with the amplitude of oscillation? How much does the value of T for A = 10° differ from that for A= 50° from the graph you have drawn? Find at what amplitude of

oscillation, the time period begins to vary? Determine the limit for the pendulum when it ceases to be a simple pendulum.]

4) Determine the acceleration of gravity is to use 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) Determination of electron charge 'e' by Millikan's Oil drop experiment.

9) To study the characteristics of solar cell.

10) To find the value of e/m for an electron by Thomson's method using bar magnets.

11) To determine the value of e/m for an electron by magnetron method.

12) To study the tunneling in Tunnel Diode using I-V characteristics.

13) Determination of quantum efficiency of Photodiode.

14) A code in C/C++/Scilab to find the first seven eigen states and eigen functions of Linear Harmonic Oscillator by solving the Schrödinger equation.

15) A code in C/C++/Scilab to plot and analyze the wavefunctions for particle in aninfinite potential well.

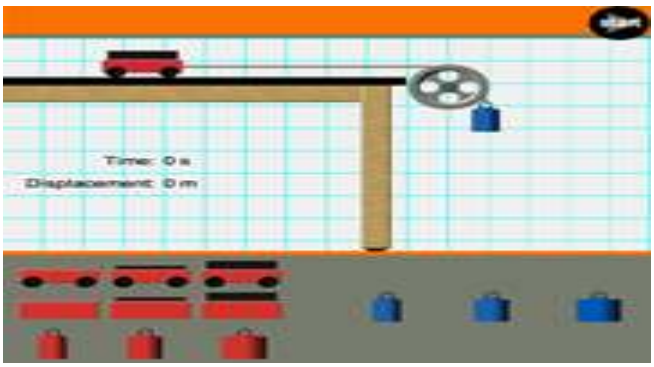
16) Measurement of wavelength of sodium D line/wavelength separation of sodium D doublet lines using Michelson Interferometer.

Pedagogy: Demonstration/Experiential Learning / Self Directed Learning etc.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
One Internal Test	15
Activity	10
Total	**25**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

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

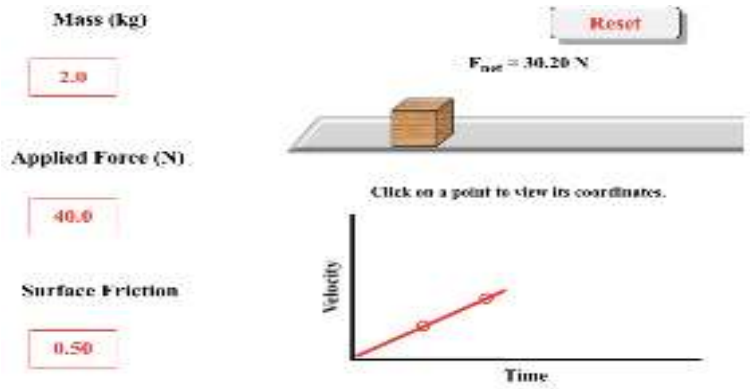
Activities (One activity per unit of theory paper is mandatory)	
1	



1. Atwood's Machine

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

Newton's Laws of Motion



Force

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

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

	Most of the activities and lessons below *focus* on one or two of the laws of motion. The Build a Balloon Car activity specifically **talks about all three of Newton's laws of motion** students can observe when building and experimenting with a simple balloon-powered car. This is an accessible hands-on activity that uses recycled materials and balloons for a fun combined engineering design project and physics experiment. The activity can be used with a wide range of grade levels to introduce and demonstrate the laws of motion. See the "Digging Deeper" section for a straightforward discussion of how each law of motion can be identified in the balloon car activity. (For a related lesson plan, see Balloon Car Lesson Plan, which is NGSS-aligned for middle school and focuses on the third law of motion.) In the Push Harder — Newton's Second Law , students build their own cars using craft materials and get hands-on exploring Newton's second law of motion and the equation "force equals mass times acceleration" (F=ma). Options for gathering real-time data include using a mobile phone and a sensor app or using a meter stick and a stopwatch. *Questions*: What is the relationship between force, mass, and acceleration? As force increases, what happens to acceleration?  In the Skydive Into Forces , students make parachutes and then investigate how they work to slow down a falling object. As students investigate the forces that are involved, educators can introduce Newton's second law of motion and how different forces change the resulting speed of a falling object. *Questions*: What forces help slow down the speed of a falling object? How does a parachute help slow the fall? 
2	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 **photo detectors** and **sensor pixels. Prepare a report on the working of digital camera.**
3	Demonstration of Heisenberg uncertainty principle in the context of diffraction at a single slit: The uncertainty in the momentum Δp_x correspond to the angular spread of principal maxima Θ.

	Then, $\Delta p_x = \sin\theta . p$ where p is the momentum of the incident photon. Conduct the diffraction at a slit experiment virtually using the following link *https://www.walter-fendt.de/html5/phen/singleslit_en.htm* **1.** Measure the angular spread (Θ) for different slit widths (Δx) for given wavelength of the incident photon. **2.** Determine the momentum of the incident photon using, p=h/λ **3.** Create a line of best fit through the points in the plot $\frac{1}{\Delta p_x}$ against $\Delta x$and find its slope. How this exercise is related to Heisenberg Uncertainty principle. Make a report of the observations.
4	Virtual lab to demonstrate Photoelectric effect using *Value@Amritha*: Conduct the virtual experiment using the following link *https://vlab.amrita.edu/?sub=1&brch=195&sim=840&cnt=1* 1. Determine the minimum frequency required to have Photoelectric effectfor an EM radiation, when incident on a zinc metal surface. 2. Determine the target material if the threshold frequency of EM radiation is$5.5x10^{15}$ Hz in a particular photoelectric experimental set up. 3. Determine the maximum kinetic energy of photo-electrons emitted from a Zinc metal surface, if the incident frequency is $3x10^{15}$Hz. **4.** What should be the stopping potential for photoelectrons if the target Material used is Platinum and incident frequency is $2x10^{15}$Hz? Make a report of the calculations.
5	Visualization of wave packets using Physlet@Quantum Physics: The concept of group velocity and phase velocity of a wave packet can be studied using thislink https://www.compadre.org/PQP/quantum-need/section5_9.cfm Students can take up the exercises using the link which is as followshttps://www.compadre.org/PQP/quantum-need/prob5_11.cfm Six different classical wave packets are shown in the animations. Which of the wave packets have a phase velocity that is: greater than / less than / equal to the group velocity? Make a report of the observations.
6	Superposition of eigen states in an infinite one - dimensional potential well using QuVis (Quantum Mechanics Visualization Project): Construct different possible states by considering the first three eigen states and study the variation of probability density with position. Take the challenges after understanding the simulation and submit the report. The link is as follows https://www.standrews.ac.uk/physics/quvis/simulations_html5/sims/SuperpositionStates/SuperpositionStates.html
7	Determination of expectation values of position, momentum for a particle in a an infinite one - dimensional potential well using Physlet@Quantum Physics: The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob10_3.cfm A particle is in a one-dimensional box of length L = 1. The states shown are normalized. The results of the integrals that give $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$. You may vary n from 1 to 10. a) What do you notice about the values of $\langle x \rangle$ and $\langle x^2 \rangle$ as you vary n? b) What do you think $\langle x^2 \rangle$ should become in the limit of $n \to \infty$? Why? c) What do you notice about the values of $\langle p \rangle$ and $\langle p^2 \rangle$ as you vary n? Make a report of the calculations.
8	Determination of expectation values for a particle in a one-dimensional harmonic oscillator using Physlet@Quantum Physics: The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob12_2.cfm A particle is in a one-dimensional harmonic oscillator potential ($\hbar = 2m = 1$; $\omega = k = 2$).

	The states shown are normalized. Shown are ψ and the results of the integrals that give $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$. Vary n from 1 to 10. a) What do you notice about how $\langle x \rangle$ and $\langle x^2 \rangle$ and $\langle p \rangle$ and $\langle p^2 \rangle$ change? b) Calculate $\Delta x \,.\Delta p$ for $n = 0$. What do you notice considering $\hbar = 1$? c) What is E_n? How does this agree with or disagree with the standard case for the harmonic oscillator? d) How much average kinetic and potential energies are in an arbitrary energy state? Make a report of the calculations.
9	Calculate uncertainties of position and momentum for a particle in a boxusing Physlet@Quantum Physics: The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob6_3.cfm A particle is in a one-dimensional box of length $L = 1$. The states shown are normalized. The results of the integrals that give $\langle x \rangle$ and $\langle x^2 \rangle$, and $\langle p \rangle$ and $\langle p^2 \rangle$. You may vary n from 1 to 10. a. For $n = 1$, what are Δx and Δp? b. For $n = 10$, what are Δx and Δp?
10	Write expressions for the three wave functions using Physlet@Quantum Physics:The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob8_1.cfm These animations show the real (blue) and imaginary (pink) parts of three time-dependent energy eigenfunctions. Assume x is measured in cm and time is measured in seconds. a. Write an expression for each of the three time-dependent energy eigenfunctions in the form: $e^{i(kx-wt)}$. b. What is the mass of the particle? c. What would the mass of the particle be if time was being shown in ms? Make a report of the calculations.
11	If you store a file on your computer today, you probably store it on a solid-state drive (SSD), Make a detailed report on the role of quantum tunnelling in these devices.

Program Name	B.Sc. in Physics	**Semester**	V
Course Title	Elements of Atomic, Molecular & Laser Physics (Theory)		
Course Code	PHY.DSCT6	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	2 ½ Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

Course Outcomes (COs):

- Description of atomic properties using basic atomic models.
- Interpretation of atomic spectra of elements using vector atom model.
- Interpretation of molecular spectra of compounds using basics of molecular physics.
- Explanation of laser systems and their applications in various fields.

Contents	**60 Hours**
Unit 1: Basic Atomic models Thomson's atomic model, Rutherford atomic model, Theory of alpha particle scattering, Rutherford scattering formula, Bohr atomic model – postulates, expression for radius, total energy of electron, Sommerfeld's atomic model – model, Derivation of condition for allowed elliptical orbits. Origin of the spectral lines, Spectral series of hydrogen atom,Ritz combination principle, Correspondence principle, excitation potential and ionization potential, Franck-Hertz experiment. Vector atom model – spatial quantization, spin of electron, Quantum numbers associated with vector atomic model. **12 Hours** **Activities:** **03 Hours** 1. Students to estimate radii of orbits and energies of electron in case of hydrogen atom in different orbits and plot the graph of radii / energy versus principal quantum number 'n'. Analyze the nature of the graph and draw the inferences. 2. Students to search excitation and ionisation potentials of different elements and plot the graph of excitation / ionisation potentials versus atomic number/mass number/neutron number of element. Analyze the nature of the graph and draw the inferences.	15
Unit 2: Atomic spectra L-S and j-j coupling schemes, Pauli's exclusion principle, Magnetic dipole moment due to orbital motion of electron – derivation, Magnetic dipole moment due to spin of an 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: Types, Experimental study and classical theory of normal Zeeman effect, Zeeman shift expression (no derivation),	15

examples; Stark effect: Experimental study, Types and examples. **12 Hours** **Activities:** **03 Hours** 1. Students to couple a p-state and s-state electron via L-S and j-j coupling schemes for a system with two electrons and to construct vector diagrams for each resultant. Analyze the coupling results and to draw the inferences. 2. Students to estimate magnetic dipole moment due to orbital motion of electron for different states $^2P_{1/2}$, $^2P_{3/2}$, $^2P_{5/2}$, $^2P_{7/2}$, $^2P_{9/2}$ and $^2P_{11/2}$ and plotting the graph of dipole moment versus total angular momentum "J'. To analyze the nature of the graph and draw the inferences.	
Unit 3: Molecular Physics Types of molecules based on their moment of inertia, Types of molecular motions and energies, Born-Oppenheimer approximation, Origin of molecular spectra; Nature of molecular spectra, rigid rotator – energy levels and spectrum, Qualitative discussion on Non-rigid rotator and centrifugal distortion, vibrating molecule as a simple harmonic oscillator – energy levels and spectrum, Electronic spectra of molecules – fluorescence and phosphorescence, Raman scattering, Stokes and anti-Stokes lines, characteristics of Raman spectra, classical and quantum approaches, Experimental study of Raman effect, Applications of Raman effect. **12 Hours** **Activities:** **03 Hours** 1. Students to estimate energy of rigid diatomic molecules CO, HCl and plot the graph of rotational energy versus rotational quantum number 'J'. Analyse the nature of the graph and draw the inferences. Also students to 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.	15
Unit 4: Laser Physics Ordinary light versus laser light, Characteristics of laser light, Interaction of radiation with matter - Induced absorption, spontaneous emission and stimulated emission, rate equations, Einstein's A and B coefficients – Derivation of relation between Einstein's coefficients and radiation energy density, amplification of light, Population inversion, Methods of pumping, Metastable states, Components of laser system: energy source, active medium and laser cavity, Types of lasers with examples, Construction and Working principle of Ruby Laser and He-Ne Laser, Application of lasers(qualitative): communication, medicine, industry, defense and space. **12 Hours** **Activities:** **03 Hours** 1. Students to search different lasers used in medical field (ex: eye surgery, endoscopy, dentistry etc.), list their parameters and analyse the need of these parameters for specific application, and draw the inferences. Students also make the presentation of the study. 2. Students to search different lasers used in defense 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.	15

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/

Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
One internal test	20
Assignment/Activity	20
Total	**40 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Modern Physics, R. Murugeshan, Kiruthiga Sivaprakash, Revised Edition, 2009, S. Chand & Company Ltd.
2	Atomic & Molecular spectra: Laser, Raj Kumar, Revised Edition, 2008, Kedar Nath Ram Nath Publishers, Meerut.
3	Atomic Physics, S.N. Ghoshal, Revised Edition, 2013, S. Chand & Company Ltd.
4	Concepts of Atomic Physics, S.P. Kuila, First Edition, 2018, New Central Book Agency (P) Ltd.
5	Concepts of Modern Physics, Arthur Beiser, Seventh Edition, 2015, Shobhit Mahajan, S. Rai Choudhury, 2002, McGraw-Hill.
6	Fundamentals of Molecular Spectroscopy, C.N. Banwell and E.M. McCash, Fourth Edition, 2008, Tata McGraw-Hill Publishers.
7	Elements of Spectroscopy – Atomic, Molecular and Laser Physics, Gupta, Kumar and Sharma, 2016, Pragati Publications.

Course Title	Elements of Atomic, Molecular & Laser Physics (Practical)	**Practical Credits**	02
Course Code	PHY.DSCP6	**Contact Hours**	04 Hours
Formative Assessment	25 Marks	**Summative Assessment**	25 Marks

Practical Content

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 ionization potential of mercury.
8. To determine the force constant and vibrational constant for the iodine molecule from its absorption spectrum.
9. To determine the wavelength of laser using diffraction by single slit/double slits.
10. To determine wavelength of He-Ne laser using plane diffraction grating.

11. To determine angular spread of He-Ne laser using plane diffraction grating.
12. Absorption bands of $KMnO_4$using Hartmann's method.
13. Analysis of rotational Raman spectra of N_2 molecule.
14. Analysis of rotational-vibrational spectra of HBr Molecule.

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

Pedagogy: Demonstration/Experiential Learning / Self Directed Learning etc.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
One Internal test	15
One activity	10
Total	**25 Marks**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References	
1	Practical Physics, D.C. Tayal, First Millennium Edition, 2000, Himalaya Publishing House.
2	B.Sc. Practical Physics, C.L. Arora, Revised Edition, 2007, S. Chand &Comp.Ltd.
3	An Advanced Course in Practical Physics, D. Chatopadhyaya, P.C. Rakshith, B. Saha, Revised Edition, 2002, New Central Book Agency Pvt. Ltd.
4	Physics through experiments, B. Saraf, 2013, Vikas Publications.

Program Name	B.Sc. in Physics	**Semester**	VI
Course Title	Elements of Condensed Matter and Nuclear Physics (Theory)		
Course Code	PHY.DSCT7	**No. of Credits**	4
Contact Hours	60 Hours	**Duration of SEA/Exam**	2 ½ Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

Course Outcomes (COs):

Course Outcomes of condensed matter physics:

- Elemental Crystallography.
- Knowledge about X-rays and Diffraction of X-rays.
- Discussion of Classical and Quantum free electron theory including their limitations.
- Explanation the basic properties of nucleus.
- Understanding the concepts of binding energy and binding energy per nucleon v/s mass number graph.
- Explanation of alpha, beta and gamma decays.
- Study of interaction of gamma radiation with matter by photoelectric effect, Compton scattering and pair production.
- Study of different nuclear detectors such as ionization chamber, Geiger-Mueller counter, Scintillation detectors, photo-multiplier tube and semiconductor detectors.

Contents	**60 Hrs**
Unit 1: Crystal systems and X-rays: Crystal structure**:** SpaceLattice, Lattice translational vectors, Basis of crystal structure, Types of unit cells, primitive, non-primitive cells. Seven crystal systems, Bravais lattices, Miller Indices, Expression for inter planar spacing. **X Rays**: Production and properties of X rays, Continuous and characteristic X-ray spectra; Moseley's law. **X-Ray diffraction**: Scattering of X-rays, Bragg's law, 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, Weidemann-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 (qualitative). **12 HOURS** **ACTIVITIES: 03 HOURS**	15
Unit 2: Magnetic Properties of Matter, Dielectrics and Superconductivity **Magnetic Properties of Matter** Classification of magnetic materials, Langevin quantum theory of diamagnetism and paramagnetism. Curie's law, Ferromagnetism and magnetic domains (qualitative), anti-ferromagnetism and ferrimagnetism. **Dielectrics**: Electric dipole moment, dielectric susceptibility, dielectric constant, polarizability (electronic, ionic and orientational), calculation of Lorentz field (derivation), Clausius-Mossotti equation (derivation), dielectric loss. Piezo electric effect, cause, examples and applications. **Superconductivity:** Definition, experimental results – Zero resistivity and Critical	15

temperature– The critical magnetic field – Meissner effect, Type I and type II superconductors. **12 Hours** **ACTIVITIES: 3 Hours**	
Unit 3: General Properties of Nuclei: Constituents of nucleus, intrinsic properties of nucleus, quantitative facts about mass, radii, charge density, binding energy, binding energy versus mass number curve. **Radioactivity decay:** Radioactivity: definition of radioactivity, half-life, mean life,Alpha decay: basics of α-decay, Gamow's theory of α emission, Geiger-Nuttall law. β-decay: positron emission, electron capture, neutrino hypothesis. Gamma decay: Selection rules, internal conversion process. **12 Hours** **ACTIVITIES: 03 Hours**	15
Unit 4: Interaction of Nuclear Radiation with matter: interaction of Gamma rays with matter, Compton scattering, photoelectric effect, pair production, Energy loss due to ionization (quantitative description of Bethe-Bloch formula). **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. **12 Hours** **ACTIVITIES: 03 Hours**	15
Suggested 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. 3)Magnetic field lines are invisible. Students to trace the magnetic field lines using bar magnet and needle compass.https://nationalmaglab.org/magnet-academy/try-this-at-home/drawing-magnetic-field-lines/ , 4)Using vegetable oil and iron fillings students to make ferrofluids and see how it behaves in the presence of magnetic field. https://nationalmaglab.org/magnet-academy/try-this-at-home/making-ferrofluids/ 1) Study the decay scheme of selected alpha, beta & gamma radioactive sources with the help of standard nuclear data book. 2) Calculate binding energy of some selected light, medium and heavy nuclei. Plot the graph of binding energy versus mass number A 3) Study the decay scheme of standard alpha, beta and gamma sources using nuclear data book. 4) 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. 5) Study the Z dependence of photoelectric effect cross section. 6) Study the Z dependence of common cross section for selected gamma energies and selected elements through theoretical calculation. 7) List the materials and their properties which are used for photocathode of PMT. 8) Study any two types of PMT and their advantages and disadvantages.	

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
One internal test	20
Assignment/Activity	20
Total	**40**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References

1. Solid State Physics-R. K. Puri and V.K. Babber., S.Chand publications,1st Edition(2004).
2. Fundamentals of Solid State Physics-B.S.Saxena,P.N. Saxena,Pragatiprakashan Meerut(2017).
3. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
4. Nuclear Physics, Irving Kaplan, Narosa Publishing House
1. Introductiontosolid StatePhysics,***CharlesKittel***, VIIedition, (**1996**)
5. Solid State Physics-**A JDekker**, MacMillanIndia Ltd, (**2000**)
6. Essentialof crystallography**,MA Wahab**, NarosaPublications (**2009)**
7. Solid State Physics-**SO Pillai**-New Age Int. Publishers(**2001**).
8. Concepts of nuclear physics by Bernard L. Cohen. (Tata McGraw Hill, 1998).
9. Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004).
10. Introduction to High Energy Physics, D.H. Perkins, Cambridge Univ. Press
11. Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (Institute of Physics (IOP) Publishing, 2004).
12. Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
13. Physics and Engineering of Radiation Detection, Syed Naeem Ahmed (Academic Press, Elsevier, 2007).

Course Title	Elements of Condensed Matter & Nuclear Physics (Practical)	Practical Credits	02
Course Code	PHY.DSCP7	Contact Hours	04 Hours
Formative Assessment	25 Marks	Summative Assessment	25 Marks

Practical Content

CONDENSED MATTER PHYSICS

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

NUCLEAR PHYSICS

1. Study the characteristics of Geiger-Mùller 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. Study the absorption of beta particles in thin copper foils using G M counter and determine mass attenuation coefficient.
4. Study the attenuation of gamma rays in lead foils using Cs-137 source and G M counter. Calculate mass attenuation coefficient of Lead for Gamma.
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 G M counter.
7. Simulation of nuclear decay using dice (Monte Carlo simulation)

Pedagogy: Demonstration/Experiential Learning / Self Directed Learning etc.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
One Internal test	15
One Activity	10
Total	**25**

Formative Assessment as per UNIVERSITY guidelines are compulsory

References	
1	IGNOU: Practical Physics Manual
2	Saraf: Experiment in Physics, Vikas Publications
3	S.P. Singh: Advanced Practical Physics
4	Melissons: Experiments in Modern Physics
5	Misra and Misra, Physics Lab.Manual, South Asian publishers, (**2000**)
6	Gupta and Kumar, Practical physics, Pragati prakashan,(**1976**)

Program Name	B.Sc. in Physics	**Semester**	VI
Course Title	Electronic Instrumentation & Sensors (Theory)		
Course Code:	PHY.DSCT8	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	2 ½ Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

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

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

Contents	**60 Hours**
Unit 1: Power supply AC power and its characteristics, Single phase and three phase, Need for DC power supply and its characteristics, line voltage and frequency, Rectifier bridge, Filters: Capacitor and inductor filers, L-section and π-section filters, ripple factor, electronic voltage regulators, stabilization factor, voltage regulation using ICs. **Basic electrical measuring instruments** Cathode ray oscilloscope- Block diagram, basic principle, electron beam, CRT features, signal	15

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. Multi range voltmeter and ammeter.* **12 Hours** **ACTIVITIES: 03 Hours** **Activities** Design and wire your own DC regulated power supply. Power output: 5 V, 10 V, ± 5 V. Components required: A step down transformer, semiconductor diodes (BY126/127), Inductor, Capacitor, Zener diode or 3-pin voltage regulator or IC. Measure the ripple factor and efficiency at each stage. Tabulate the result. 1. Extend the range of measurement of voltage of a voltmeter (analog or digital) using external component and circuitry. Design your own circuit and report. 2. Measure the characteristics of the signal waveform using a CRO and function generator. Tabulate the frequency and time period. Learn the function of Trigger input in an CRO. 3. Learn to use a Storage Oscilloscope for measuring the characteristics of a repetitive input signal. Convince yourself how signal averaging using Storage CRO improves S/N ratio.	
Unit 2: Wave form generators and Filters Basic principle of standard AF signal generator: Fixed frequency and variable frequency, AF sine and square wave generator using op amps, 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. **12 Hours** **ACTIVITIES: 03 Hours** **Activities** 1. Measure the amplitude and frequency of the different waveforms and tabulate the results. Required instruments: A 10 MHz oscilloscope, Function generators (sine wave and square wave). 2. Explore where signal filtering network is used in real life. Visit a nearby telephone exchange and discuss with the Engineers and technicians. Prepare a report. 3. Explore op-amp which works from a single supply biasing voltage (+15V). Construct an inverting/non-inverting amplifier powered by a single supply voltage instead of dual or bipolar supply voltage. 4. Op-amp is a linear (analog) IC. Can it be used to function as logic gates? Explore, construct and implement AND, OR, NAND and NOR gate functions using op-amps. Verify the truth table. Hint: LM3900 op-amp may be used. The status of the output may be checked by LED.	15
Unit 3: Data Conversion and display Digital to Analog (D/A) and Analog to Digital (A/D) converters – A/D converter with pre-amplification and filtering. D/A converter - Variable resistor network, Ladder type (R-2R) D/A converter, Op-amp based D/A converter. Digital display systems and Indicators- Classification of displays, Light Emitting Diodes (LED) and Liquid Crystal Display (LCD) – Structure and working. Data Transmission systems – Advantages and disadvantages of digital transmission over analog transmission, Pulse amplitude modulation (PAM), Pulse time modulation (PTM) and Pulse width modulation (PWM)- General principles. Principle of Phase Sensitive Detection (PSD). *Topic for self-study*: *Lock-in amplifier and its application, phase locked loop.* **12 Hours** **ACTIVITIES: 03 Hours**	15

Activities 1. Explore where modulation and demodulation technique is employed in real life. Visit a Radio broadcasting station. (Aakashavani or Private). Prepare a report on different AM and FM stations. 2. Explore and find out the difference between a standard op-amp and an instrumentation op-amp. Compare the two and prepare a report.	
Unit 4: 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. **12 Hours** **ACTIVITIES: 03 Hours** **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 at 0^o C, melting ice) and another junction at variable temperature bath. Tabulate the voltages induced and temperatures read out using standard chart (Chart can be downloaded from the internet). 2. Observe a solar water heater. Some solar water heaters are fitted with an anode rod (alloy of aluminum). Study why it is required. Describe the principle behind solar water heater.	15

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
One internal test	20
Assignment/Activity	20
Total	**40**
Formative Assessment as per UNIVERSITY guidelines are compulsory	

References

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

Course Title	Electronic Instrumentation & Sensors (Practical)	**Practical Credits**	02
Course Code	PHY.DSCT9	**Contact Hours**	04 Hours
Formative Assessment	25 Marks	**Summative Assessment**	25 Marks

Practical Content

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

1. Construct a DC power supply using a bridge rectifier and a capacitor filter. Use a Zener diode or a 3-pin voltage regulator and study the load and line regulation characteristics. Measure ripple factor with and without filter and compare with theoretical values.
2. Calibration of a low range voltmeter using a potentiometer
3. Calibration of an ammeter using a potentiometer
4. Design and construct a Wien bridge oscillator (sine wave oscillator) using μA 741 op-amp. Choose the values of R and C for a sine wave frequency of 1 KHz. Vary the value of R and C to change the oscillation frequency.
5. Design and construct a square wave generator using μA 741 op-amp. Determine its frequency and compare with the theoretical value. Also measure the slew rate of the op-amp. If the 741 is replace by LM318, study how does the waveform compare with the previous one.
6. Study the frequency response of a first order op-amp low pass filter
7. Study the frequency response of a first order op-amp 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 standard 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.

Pedagogy: Lecture/ PPT/ Videos/ Animations/ Role Plays/ Think-Pair-Share/ Predict-Observe-Explain/ Demonstration/ Concept mapping/ Case Studies examples/ Tutorial/ Activity/ Flipped Classroom/ Jigsaw/ Field based Learning/ Project Based Learning/ Mini Projects/ Hobby Projects/ Forum Theatre/ Dance/ Problem Based Learning/ Game Based Learning/ Group Discussion/ Collaborative Learning/ Experiential Learning / Self Directed Learning etc.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
One internal test	15
One Activity	10
Total	**25**
Formative Assessment as per University guidelines are compulsory	

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

Employability and skill development

The whole syllabus is prepared with a focus on employability.

Skill development achieved: Fundamental understanding of the working of test and measuring instruments. Operating and using them for measurements. Servicing of laboratory equipment for simple cable faults, loose contacts and discontinuity.

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