RANI CHANNAMMA UNIVERSITY, BELAGAVI

PROGRAM /COURSE STRUCTURE AND SYLLABUS

Of

PHYSICS

as per the Choice Based Credit System (CBCS) designed in accordance with
Learning Outcomes-Based Curriculum Framework (LOCF)
of National Education Policy (NEP) 2020
for

Bachelor of Science (Physics)

w.e.f.

Academic Year 2021-22 and onwards

PREAMBLE

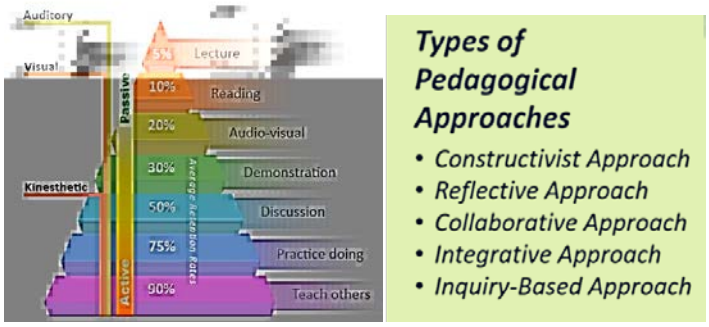
The New Education Policy (2020) is a paradigm shift from the conventional system we practice even today. Giving students the entire freedom to choose what to learn, how to learn, where to learn and when to learn, will enable a personalized education that suits his/her own personality. The drive to change the pedagogy in the curriculum and syllabi will cater to the cognitive, affective and psycho-motor domain of learning, which will fruitfully engage to student and guide him to ascend the Blooms levels of learning hierarchy, elevating them from just remembering to become creative through acquiring skills of application, evaluation and analysis. Such an approach will enable the institution and the individual to design and execute education that is suitable and doable. The wonderful Academic Credit accumulation and the multiple exit/entry options enable multi- disciplinary obtainable from multiple institutions, and even from recognized digital platforms. This will create unprecedented opportunities to the students to self-evaluate and change course at every stage of education as they learn. Introducing the possibility of cutting across disciplines to pursue one's interest and talent can boost curricular and extra-curricular activities by an equal measure. This will definitely enable the blooming of creativity among individuals who will not only be excellent and productive employees, but also assume the mantle of becoming entrepreneurs and job providers. The opportunity for the teacher to adopt novel pedagogies will make classrooms vibrant, meaningful and effective. The student choices will also lead to a healthy cross-disciplinary interaction between institutions and consequently enhancing their capabilities and credibility.

The NEP-2020 is based on Outcome Based Education, where the Graduate Attributes and employment opportunities are first kept in mind to reverse-design the Programs, Courses and Supplementary activities to attain the graduate attributes and learning outcomes.

- Attribute 1: Deep discipline knowledge and intellectual breadth. ...
- Attribute 2: Creative and critical thinking, and problem solving. ...
- Attribute 3: Teamwork and communication skills. ...
- Attribute 4: Professionalism and leadership readiness. ...
- Attribute 5: Intercultural and ethical competency.

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 develop scientific orientation, spirit of enquiry problem solving skills and human and professional will values which foster rational and critical thinking in the students.

It is imperative that in the spirit of the NEP, several academic matters have to change. The most important among these will be the pedagogy that will be adopted in the Teaching-Learning experience to enrol, engage and involve and inspire the students. The learning that happens by employing different types of pedagogies is shown below, and thus need to be adopted in the teaching-learning process for effective cognition by the students using the Auditory, Visual and Kinaesthetic approaches:



Along with conventional teaching methods, Activity based pedagogies are seen to be extremely effective in achieving the Program Educational Objectives. The Committee has attempted to consider both the spirit of the NEP and the existing system and framed the syllabus within the Curriculum options offered by the Higher Education Council. The broad topic level syllabus for all the 5 years (10 semesters) for an integrated B.Sc + M.Sc program has been provided. However, a detailed syllabus has to been provided for the First Two Semester. Attempts have been made to sincerely bring in Activity based pedagogy. The activities have been listed and a few examples have been provided to guide the teacher of how to create their own activities that engage and illuminate students by group and self- involvement methods and a possible evaluation method.

PROGRAM OUTCOMES

Exit with:	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

1. **Discipline Knowledge:** Knowledge of science and ability to apply to relevant areas.
2. **Problem solving:** Execute a solution process using first principles of science to solve problems related to respective discipline.
3. **Modern tool usage:** Use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.
4. **Ethics:** Apply the professional ethics and norms in respective discipline.
5. **Individual and teamwork:** Work effectively as an individual as a team member in a multidisciplinary team.
6. **Communication:** Communicate effectively with the stake holders, and give and receive clear instructions.

Exit with:	Credits Required
A **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

1. **Discipline Knowledge:** Knowledge of science and ability to apply to relevant areas.
2. **Conduct investigations:** Conduct investigations of technical issues as per their level of understanding and knowledge.
3. **Problem solving:** Formulate and implement a solution process using first principles of science to solve problems related to respective discipline.
4. **Modern tool usage:** Apply a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.
5. **Ethics:** Apply and commit to the professional ethics and norms in respective profession.
6. **Individual and teamwork:** Work effectively as an individual in a multidisciplinary team.
7. **Communication:** Communicate effectively with the stake holders, and give and receive clear instructions.

Exit with:	Credits Required
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

1. **Discipline Knowledge:** Knowledge of basics of science and ability to apply the understanding of fundamentals of major discipline in solving complex problems.
2. **Conduct investigations:** Conduct investigations of issues in their respective disciplines and arrive at valid conclusions.
3. **Problem solving:** Implement a solution process using first principles of science to solve problems related to respective discipline.
4. **Modern tool usage:** Select and use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.
5. **Environment and Society:** Evaluate the impact of scientific solutions on society and environment and the need for sustainable solutions.
6. **Ethics:** Demonstrate professional ethics, responsibilities and norms in respective profession.
7. **Individual and teamwork:** Work effectively as an individual as a team member and as a leader in a multidisciplinary team.
8. **Communication:** Communicate effectively with the stake holders, write and comprehend project reports and documentation, deliver effective presentations, and give and receive clear instructions.
9. **Project Management and Finance:** Apply the knowledge of scientific and technological principles to one's own work to manage projects in multidisciplinary settings.
10. **Lifelong Learning:** Engage in lifelong learning in the context of changing trends in respective discipline.

Exit with:	Credits Required
Bachelor Degree with Honours in a Discipline at the Successful Completion of the Fourth Years (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	176 - 192

1. **Discipline Knowledge:** Knowledge of basics of science and research, and ability to apply the understanding of fundamentals of specialized discipline in solving complex scientific problems.
2. **Conduct investigations:** Conduct investigations of issues using research methods and research-based discipline knowledge including design of experiments, data collection, interpretation and analysis to arrive at valid conclusions.
3. **Problem analysis:** Identify, formulate and analyze complex scientific problems using first principles of respective discipline.
4. **Design and Development of solutions:** Design solutions for complex scientific problems and execute them by considering the environmental, societal and public safety aspects appropriately.
5. **Modern tool usage:** Identify, select and use a modern scientific, engineering and IT tool or technique for modelling, prediction, data analysis and solving problems in the areas of their discipline.
6. **Environment and Society:** Evaluate the impact of scientific solutions on society and environment and design sustainable solutions.
7. **Ethics:** Demonstrate professional ethics, responsibilities and norms in respective profession.
8. **Individual and teamwork:** Work effectively as an individual as a team member and as a leader in a multidisciplinary team.
9. **Communication:** Communicate effectively with the stakeholders with emphasis on communicating with scientific community, comprehend scientific reports, write research papers and projects proposals and reports, deliver effective presentations, and give and receive clear instructions.
10. **Project Management and Finance:** Apply the knowledge of scientific and technological principles to one's own work to manage projects in multidisciplinary settings.
11. **Lifelong Learning:** Identify knowledge gaps and engage in lifelong learning in the context of changing trends in respective discipline.

PROGRAM STRUCTURE

Proposed Curricular and Credits Structure under Choice Based Credit System [CBCS] of Physics Major & One Minor Discipline Scheme for the Four Years Physics B.Sc. Undergraduate Honors Programme with effect from 2021-22.

SEMESTER-I									
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**		**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**P**		
L1	21BSC1L1LK1	Kannada	40	60	100	4	-	3	2
	21BSC1L1LFK1	Functional Kannada							
L2	21BSC1L2LEN2	English	40	60	100	4	-	3	2
	21BSC1L2LHI2	Hindi							
	21BSC1L2LSN2	Sanskrit							
	21BSC1L2LTE2	Telugu							
	21BSC1L2LUR2	Urdu							
DSC1	21BSC1C1PHY1L	Mechanics & Properties of Matter	40	60	100	4	-	4	2
	21BSC1C1PHY1P	Practical I	25	25	50	-	4	2	4
DSC1	Another Department Code	Another Department Course Title	40	60	100	4	-	4	2
			25	25	50	-	4	2	4
SEC1	21BSC1SEC1DF1	Digital Fluency	25	25	50	1	2	2	2
VBC1	21BSC1V1PE1	Yoga/Sports	25	--	25	-	2	1	--
VBC2	21BSC1V2HW1	H&W/NCC/NSS/R&R/CA	25	--	25	-	2	1	--
OEC1	21BSC1O1PHY1	Energy Sources	40	60	100	3	-	3	2
Total Marks					**700**	**Semester Credits**		**25**	

SEMESTER-II										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
L3	21BSC2L3LK2	Kannada	40	60	100	4	-	-	3	2
	21BSC2L3FKL2	Functional Kannada								
L4	21BSC2L4EN2	English	40	60	100	4	-	-	3	2
	21BSC2L4HI2	Hindi								
	21BSC2L4SN2	Sanskrit								
	21BSC2L4TE2	Telugu								
	21BSC2L4UR2	Urdu								
DSC2	21BSC2C2PHY1L	Electricity & Magnetism	40	60	100	4	-	-	4	2
	21BSC2C2PHY1P	Practical II	25	25	50	-	-	4	2	4
DSC2	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
AECC1	21BSC2AE1ES1	Environmental Studies	25	25	50	1	-	2	2	2
VBC3	21BSC2V3PE2	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC4	21BSC2V4NC2	H&W/NCC/NSS/ R&R/CA	25	--	25	-	-	2	1	--
OEC2	21BSC2O2PHY2	Optical Instruments	40	60	100	3	-	-	3	2
Total Marks					**700**	**Semester Credits**			**25**	

SECOND YEAR; SEMESTER-III										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
L5	21BSC3L5LK3	Kannada	40	60	100	4	-	-	3	2
	21BSC3L5LFK3	Functional Kannada								
L6	21BSC3L6EN3	English	40	60	100	4	-	-	3	2
	21BSC3L6HI3	Hindi								
	21BSC3L6SN3	Sanskrit								
	21BSC3L6TE3	Telugu								
	21BSC3L6UR3	Urdu								
DSC3	21BSC3C3PHY1L	Wave motion and Optics	40	60	100	4	-	-	4	2
	21BSC3C3PHY1P	Practical III	25	25	50	-	-	4	2	4
DSC3	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
SEC2	21BSC3SEC2AI1	Artificial Intelligence	25	25	50	1	-	2	2	2
VBC5	21BSC3V5PE3	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC6	21BSC3V6NC3	H&W/NCC/NSS/R & R/CA	25	--	25	-	-	2	1	--
OEC3	21BSC3O3PHY3	Physics for All	40	60	100	3	-	-	3	2
Total Marks					**700**	**Semester Credits**			**25**	

SEMESTER-IV										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
L7	21BSC4L7LK4	Kannada	40	60	100	4	-	-	3	2
	21BSC4L7LFK4	Functional Kannada								
L8	21BSC4L8EN4	English	40	60	100	4	-	-	3	2
	21BSC4L8HI4	Hindi								
	21BSC4L8SN4	Sanskrit								
	21BSC4L8TE4	Telugu								
	21BSC4L8UR4	Urdu								
DSC4	21BSC4C2PHY4L	Thermal Physics And Electronics	40	60	100	4	-	-	4	2
	21BSC4C2PHY4P	Practical IV	25	25	50	-	-	4	2	4
DSC4	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
AECC2	21BSC4AE1CoI1	Constitution of India	25	25	50	1	-	2	2	2
VBC7	21BSC4V5PE4	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC8	21BSC4V6NC4	H&W,/NCC/NSS/R&R/CA	25	--	25	-	-	2	1	--
OEC4	21BSC4O4PHY4	Astronomy and Space Mission	40	60	100	3	-	-	3	2
Total Marks					**700**	**Semester Credits**			**25**	

SEMESTER-V										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Physics as Major Discipline										
DSC5	21BSC5C5PHYMJ1L	Classical Mechanics and Quantum Mechanics-	40	60	100	3	-	-	3	2
	21BSC5C5PHYMJ1P	Practical V	25	25	50	-	-	4	2	4
DSC6	21BSC5C5PHYMJ2L	Elements of Atomic, Molecular Physics	40	60	100	3	-	-	3	2
	21BSC5C5PHYMJ2P	Practical VI	25	25	50	-	-	4	2	4
DSC5	Another Department Code as a Minor Subject	Another Department Course Title	40	60	100	3	-	-	3	2
			25	25	50	-	-	4	2	4
VC1	21BSC5VC1PHY1	Vocational 1	40	60	100	3	-	-	3	2
VBC9	21BSC5V5PE5	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC10	21BSC5V6NC5	NCC/NSS/ R&R(S&G) / Cultural	25	--	25	-	-	2	1	--
SEC3	21BSC5SEC3	Cyber Security	25	25	50	1	-	2	2	2
Total Marks					**650**	**Semester Credits**			**22**	

SEMESTER-VI										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Physics as Major Discipline										
DSC7	21BSC6C6PHYMJ1L	Elements of Nuclear Physics and Nuclear Instruments	40	60	100	3	-	-	3	2
	21BSC6C6PHYMJ1P	Practical VII	25	25	50	-	-	4	2	4
DSC8	21BSC6C6PHYMJ2L	Elements of Condensed Matter Physics	40	60	100	3	-	-	3	2
	21BSC6C6PHYMJ2P	Practical VIII	25	25	50	-	-	4	2	4
DSC6	Another Department Code as a Minor Subject	Another Department Course Title	40	60	100	3	-	-	3	2
			25	25	50	-	-	4	2	4
VC2	21BSC6VC2PHYVC2	Vocational 2	40	60	100	3	-	-	3	2
VBC1	21BSC6V5PE6	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC2	21BSC6V6NC6	NCC/NSS/R&R(S&G) / Cultural	25	--	25	-	-	2	1	--
SEC4	21BSC6SEC4PC1	Professional Communication	25	25	50	1	-	2	2	2
INT	21BSC6IN1PHYIN	Internship between 5th and 6th semester	25	25	50	3 to 4 weeks			2	Report & Presentation
Total Marks					**700**	**Semester Credits**			**24**	
Total Marks for BSC Program					**4150**	**Total Credits for BSc Program**			**146**	

Physics Subject as a Minor Discipline

SEMESTER-V										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
DSC5 As a Minor Subject	21BSC5C5PHYMN1L	Modern Physics – I	40	60	100	3	-	-	3	2
	21BSC5C5PHYMN1P	Modern Physics - I lab	25	25	50	-	-	4	2	4

SEMESTER-VI										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
DSC6 As a Minor Subject	21BSC6C6PHYSMN1L	Modern Physics - II	40	60	100	3	-	-	3	2
	21BSC6C6PHYMN1P	Modern Physics - II lab	25	25	50	-	-	4	2	4

Concept Note, Abbreviation Explanation and Coding:

Concept Note:

1. **CBCS** is a mode of learning in higher education which facilitates a student to have some freedom in selecting his/her own choices, across various disciplines for completing a UG/PG program.
2. A credit is a unit of study of a fixed duration. For the purpose of computation of workload as per UGC norms the following is mechanism be adopted in the University:
   One credit (01) = One Theory Lecture (L) period of one (1) hour.
   One credit (01) = One Tutorial (T) period of one (1) hour.
   One credit (01) = One practical (P) period of two (2) hours.
3. Course: paper/subject associated with AECC, DSC, DSEC, SEC, VBC, OEC, VC, IC and MIL

4. In case of **B.Sc**. **Once a candidate chose two courses/subjects of a particular two department in the beginning, he/she shall continue the same till the end of the degree, then there is no provision to change the course(s) and Department(s).**
5. A candidate shall choose **one of the Department's courses as major and other Department course as minor in fifth and sixth semester and major course will get continued in higher semester.**
6. Wherever there is a practical there will be no tutorial and vice-versa
7. A major subject is the subject that's the main focus of Core degree/concerned.
8. A minor is a secondary choice of subject that complements core major/ concerned.
9. Vocational course is a course that enables individual to acquire skills set that are required for a particular job.
10. Internship is a designated activity that carries some credits involving more than **25 days** of working in an organization (either in same organization or outside) under the guidance of an identified mentor. Internship shall be an integral part of the curriculum.
11. **OEC: Open Elective course is for non- Physics students.**

Abbreviation Explanations:

1. AECC: Ability Enhancement Compulsory Course.
2. DSC: Discipline Specific Core Course.
3. DSEC: Discipline Specific Elective Course.
4. SEC: Skill Enhancement Course.
5. VBC: Value Based Course.
6. OEC: Open/Generic Elective Course
7. VC: Vocational Course.
8. IC: Internship Course
9. L1: Language One
10. L2: MIL
11. L= Lecture; T= Tutorial; P=Practical.
12. MIL= Modern Indian Language; English or Hindi or Telugu or Sanskrit or Urdu

Program Coding:

1. Code 21: Year of Implementation
2. Code BSC: BSC Program under the faculty of Applied Science of the University
3. Code 1: First Semester of the Program, (2 to 6 represent higher semesters)
4. Code AE: AECC, (C for DSC, S for SEC, V for VBC and O for OEC)
5. Code 1: First "AECC" Course in semester, similarly in remaining semester for such other courses
6. Code LK: Language Kannada, similarly Language English, Language Hindi, Language Telugu, Language Sanskrit, &Language Urdu
7. Code 1: Course in that semester.
8. PHY: Physics

Course Content Semester – I
Mechanics and Properties of Matter

Course Title: Mechanics and Properties of Matter	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 30	Summative Assessment Marks: 70

Programme Outcomes (POs)

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

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

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

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

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

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

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

Course Outcomes (COs) ***(UGC guidelines)***	**1**	**2**	**3**	**4**	**5**	**6**
CO-1: Will learn fixing units, tabulation of observations, analysis of data (graphical/analytical)	**X**	**x**				X
CO-2: Will learn about accuracy of measurement and sources of errors, importance of significant figures.	**X**	**x**				
CO-3: Will know how g can be determined experimentally and derive satisfaction.	**X**					
CO-4: Will see the difference between simple and torsional pendulum and their use in the determination of various physical parameters.	**X**			**x**	**x**	**X**
CO-5: Will come to know how various elastic moduli can be determined.	**X**				x	**X**
CO-6: Will measure surface tension and viscosity and appreciate the methods adopted.	**X**	**x**				
CO-7: Will get hands on experience of different equipment.	**X**	**x**	**x**		**x**	**X**

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

COURSE-WISE SYLLABUS

Semester I

Mechanics and Properties of Matter

Year	I	**Course Code: 21BSC1C1PHY1L**	**Credits**	**04**
Sem.	1	**Course Title: Mechanics and Properties of Matter**	**Hours**	52
Course Pre-requisites, if any		NA		
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA: 2 hrs.	

Unit No.	**Course Content**	**Hours**
Unit I	**Conservation Laws:** Law of conservation of linear momentum. Centre of mass and expression for position vector, velocity, acceleration and force of centre of mass. Distinction between laboratory frame of reference and centre of mass frame of reference. Concept of elastic collision and inelastic collisions. Derivation of final velocities in case of elastic collision in (i) laboratory frame of reference (ii) centre of mass frame of reference. Derivation of final velocities in case of inelastic collision in (i) laboratory frame of reference (ii) centre of mass frame of reference. Conservation of linear momentum in case of variable mash. Principle of rocket and derivation for equation of motion for single stage rocket. Necessity of multi stage rocket. Basics of angular momentum and torque, relation between angular momentum and torque. Law of conservation of angular momentum with examples. Concept of work and power. Law of conservation of energy with examples. Work energy theorem. Simple harmonic oscillations of light spiral spring. Problems	13
Activity/ Self Study	1 Students can try and find every day examples of conservation of energy. For example: i) What happens in solar panels ii) pushing an object on the table it moves iii) moving car hits a parked car causes parked car to move. In these cases, energy is conserved. How? Understand and verify if possible.	
Unit II	**Gravitation:** Newton's law of Gravitation (statement). Expressions for escape velocity and orbital velocity. Kepler's laws of planetary motion. Derivation for Kepler's 2nd and 3rd law. Concept of Satellite, derivation for binding energy of satellite. Artificial Satellite: Geostationary satellite and polar orbit satellite with different types of orbits (qualitative). Concept of weightlessness. Basic ideas of G.P.S. and NAVIC. Problems **Rigid Body Dynamics**: Moment of Inertia. Radius of Gyration. Statements of theorem of parallel axis and theorem of perpendicular axis. Derivation of expressions for moment of inertia for (i) rectangular lamina (ii) thin uniform rod and (iii) circular disc. Theory of compound pendulum and bar pendulum. Theory of flywheel and its applications. Problems	13
Activity/ Self Study	1. Moment of inertia is an abstract concept. It simply gives a measure of rotational inertia of a rigid body. It is proportional to the product of the square of radius, r of the body and its mass, m. Students by referring to websites, can construct and perform simple experiments to verify that MI α mr^2.	

	2. Performing experiments on gravity and Kepler's laws are somewhat difficult. However, students can prepare suitable charts, understand and give seminar talks in the class. Websites can help in this regard.	
Unit III	**Elasticity:**Definition of Stress-strain, Hooke's law. Types of elastic constants. modulus of elasticity and derivation of expression for relation between elastic constants, Poisson's ratio, expression for Poisson's ratio in terms of elastic constants. Work done in stretching and twisting wire. Theory of torsional pendulum, determination of rigidity modulus and time period. Bending moments. Theory of cantilever. Determination of Youngs modulus by bending of beam supported at its ends and loaded at middle. Problems	13
Activity/ Self Study	1.Verification of Hook's law Arrange a steel spring with its top fixed with a rigid support on a wall and a meter scale alongside. Add 100 g load at a time on the bottom of the hanger in steps. This means that while putting each 100g load, we are increasing the stretching force by 1N. Measure the extension for loads up to 500g. Plot a graph of extension versus load. Shape of the graph should be a straight line indicating that the ratio of load to extension is constant. Go for higher loads and find out elastic limit of the material. 2. Repeat the above experiment with rubber and other materials and find out what happens after exceeding elastic limit.	
Unit IV	**Surface tension :** Definition of surface tension, Angle of contact, Surface energy, relation between surface tension and surface energy, pressure difference across curved surface. Excess of pressure inside spherical liquid drop, Capillary rise, derivation of expression for rise of liquid in a capillary tube. Determination of surface tension by Quinke's method. Effect of temperature, impurity on surface tension. Problems **Viscosity :** Streamline flow, turbulent flow, equation of continuity, determination of coefficient of Viscosity by Poisulle's method, Stoke's law with derivation and expression for terminal velocity. Effect of temperature on viscosity. Problems	13
Activity/ Self study	1. Measure surface tension of water and other common liquids and compare and learn i) Why water has high ST? Give 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. iv) 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. Give reasons. 2**.** 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 whether 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. iv) Think why one should know viscosity of the liquid.	

Recommended Leaning Resources	
Text Books	**Textbooks** 1. Mechanics by D.S.Mathur, New Edition 2000, S. Chand& Co. 2. Classical Mechanics by J. C.Upadhya,2019, Himalaya Publishers. 3. Mechanics and Relativity by Vidwan Singh Soni,3rd Edition, PHIL earning Pvt.Ltd. 4. Mechanics Berkeley PhysicsCourse,Vol.1: Charles Kittel, *et.al*.2007,Tata McGraw-Hill. 5. Engineering Mechanics, Basudeb Bhattacharya, 2ndEdn, 2015, Oxford University Press. 6. Elements of properties of matter by D.S.Mathur, 2010, S. Chand & Co. 7. Properties of Matter by Brijlal & Subramanyam.
Reference Books	1. Physics:Resnick,Halliday&Walter,9thEdn,2010,Wiley. 2. Physics by Halliday and Resnick,Vol1. 3. University Physics,Ronald Lane Reese,2003,Thamson Brooks/Cole.

Laboratory Experiments:

NOTE: Minimum of Eight experiments has to be performed

Year	I	**Course Code: 21BSC1C1PHY1P**	**Credits**	2
Sem.	1	**Course Title: Practical- I**	**Hours**	4 hrs/week

Formative Assessment Marks: 25	Summative Assessment Marks: 25	Duration of ESA: 4 hrs.

Sl. No	**Experiment**
1	Determination of g using bar pendulum (L versus T and L versus LT^2graphs)
2	Determination of moment of inertia of a Fly Wheel
3	Determination of moment of inertia of an irregular body
4	Determination of rigidity modulus using torsional pendulum
5	Verification of parallel axis theorem
6	Verification of perpendicular axis theorem
7	Determination of Young's Modulus of a bar by bending method
8	Verification of Hook's Law by Searle's method.
9	Young's modulus by cantilever–Load versus Depression graph
10	Young's modulus by Koenig's method
11	Young's modulus by stretching (Searle's apparatus).
12	Modulus of rigidity (twisting)
13	Viscosity by Stoke's method
14	Radius of capillary tube by mercury pellet method
15	Surface tension by drop weight method
16	Critical pressure for streamline flow

Recommended Leaning Resources

Text Books	1.Practical Physics-M.A. Hipparagi
Reference Books	1. Physics through experiments,by B. Saraf,2013,Vikas Publications. 2. A labmanual of Physics for undergraduate classes, 1st Edition, Vikas Publications. 3. BSc Practical Physics by CL Arora, Revised Edition 2007, S. Chand & Co. 4.Anadvanced course in practical physics, D. Chattopadhyay, PC Rakshit, B.Saha, Revised Edition 2002, New Central Book Agency Pvt Ltd.

OPEN-ELECTIVE SYLLABUS:

Year	I	**Course Code: 21BSC1O1PHY1**	**Credits**	03
Sem.	1	**Course Title: Energy Sources**	**Hours**	40
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA: 02 hrs.	

Unit No.	**Course Content**	**Hours**
Unit I	**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.	**05**
	Renewable energy sources: 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**
Unit II	**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.	**10**
Unit III	**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.	**10**
Unit IV	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.	**08**
	Geothermal and hydro energy: Geothermal Resources, Geothermal	**02**

	Technologies. Hydropower resources, hydropower technologies, environmental impact of hydro power sources.	
	Activity 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 wind energy stations like Chitradurga, Hospet, Gadag, etc. 9. Field trip to solar energy parks like Yeramaras near Raichur. 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). http://en.wikipedia.org/wiki/Renewable_energy	

Semester – II

Electricity & Magnetism

Course Title: Electricity and Magnetism	Course Credits: 4
Total Contact Hours: 52	Duration of ESA: 2 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Programme Outcomes

1. Discipline Knowledge: Knowledge of science and ability to apply to relevant areas.
2. Problem solving: Execute a solution process using first principles of science to solve problems related to respective discipline.
3. Modern tool usage: Use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.
4. Ethics: Apply the professional ethics and norms in respective discipline.
5. Individual and teamwork: Work effectively as an individual as a team member in a multidisciplinary team.
6. Communication: Communicate effectively with the stake holders, and give and receive clear instructions.

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

Course Outcomes (COs)	Program Outcomes (POs) 1	2	3	4	5	6
i. Demonstrate Gauss law, Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions of charges.	x	x				
ii. Explain and differentiate the vector (electric fields, Coulomb's law) and scalar (electric potential, electric potential energy) formalisms of electrostatics.	x					
iii. Apply Gauss's law of electrostatics to solve a variety of problems.	x	x			x	
iv. Describe the magnetic field produced by magnetic dipoles and electric currents.	x					
v. Explain Faraday-Lenz and Maxwell laws to articulate the relationship between electric and magnetic fields.	x					

vi.	Describe how magnetism is produced and list examples where its effects are observed.	**x**				**x**	**x**
vii.	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**
viii.	Apply various network theorems such as Superposition, Thevenin, Norton, Reciprocity,• Maximum Power Transfer, etc. and their applications in electronics, electrical circuit analysis, and electrical machines.	**x**	**x**			**x**	**x**

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.

Year	I	**Course Code:21BSC2C2PHY2L**	**Credits**	4
Sem.	2	**Course Title : Electricity and Magnetism**	**Hours**	52

Course Pre-requisites, if any	NA	
Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA: 2 hrs.

Unit No.	**Course Content**	**Hours**
Unit I	**Vector Analysis:** Scalar and Vector Products. Gradient of scalar and its physical significance. Divergence of vector and its physical significance. Curl of vector and its physical significance. Vector integration; line, surface & volume integrals of a vector field. Gauss Divergence theorem & Stokes theorem (statement). Problems **Maxwell's Electromagnetic Theory:** Derivation of Maxwell's equations in differential form. Mention of Maxwell's equations in integral form and their physical significances. Derivation for general plane wave equation in free space. Transverse nature of radiation. Derivation of Poynting's theorem. Problems	13
Activity/Self Study	Solving problems on gradient, divergence & curl of a vector	
Unit II	**DC Circuit Analysis:** Voltage and current sources. Kirchhoff's current and voltage laws. Derivation of Thevenin's Theorem. Derivation of Norton's Theorem. Derivation of Superposition Theorem. Derivation of Maximum Power Transfer Theorem. Problems **Transient Circuits:** Theory of growth and decay of current in RL circuit. Theory of charging and discharging of capacitor in RC circuit. Time constants of RL and RC circuits. Measurement of high resistance by leakage method. Problems	13
Activity/Self Study	1.Solving problems on Thevenin's, Norton's, Superposition and Maximum Power Transfer Theorems. 2.Charging and discharging of a capacitor through high resistance. 3.Measurment of time constant of RL and RC circuit.	
Unit III	**Magneto statics:** Statement of Biot Savart's law. Derive an expression for Magnetic field at a point (1) due to a straight conductor carrying current (ii) along the axis of the circular coil carrying current (iii) along the axis of solenoid. Principle, construction and theory of Helmholtz Galvanometer. Problems **Alternating Current:** Definitions of average, peak and rms values of AC. AC circuits containing LR, CR and their responses (using j operator). Expressions for impedance, current & phase angle in series LCR circuit using j operator. Expressions for admittance and condition for resonance in parallel, LCR circuit using j operator. Concept of Series resonance & parallel resonance (sharpness, half power frequency, quality factor, voltage magnification). Comparison between Series resonance & parallel resonance. De Sauty's Bridge. Problems	13
Activity/Self Study	1.Experiments to show the magnetic field due to straight conductor, circular coil and solenoid. 2.Construction of Helmholtz coil using PVC pipe and copper wire.	

	3.To show the lagging of current and voltage in RL, RC and RLC circuits.	
Unit IV	**Electrical Instrument:** Ballistic Galvanometer; Theory of Ballistic Galvanometer (Derivation for current and Charge). Constants of Ballistic Galvanometer and their relationship. Condition for moving coil galvanometer to be ballistic. Determination of self-inductance (L) by Rayleigh's method. Theory of Earth inductor, Measurement of $B_{H,}$ Bv and angle of dip at a place. CRO block diagram. Use of CRO in the measurement of Voltage, Frequency and Phase. Problems **Dielectrics:** Types of dielectrics (polar and non-polar molecules). Electric dipole moment (p), electric polarization (P). Gauss law in dielectrics. Derivation for Relation between D, E and P. Derivation for relation between dielectric constant and electric susceptibility. Boundary conditions for E & D. Problems	13
Activity/Self-Study	1.To show the working of Ballistic Galvanometer 2.Working of CRO and its applications.	
Recommended Leaning Resources		
Print Resources	1) Electricity and magnetism by Brij Lal and N Subrahmanyam, Rathan Prakash an Mandir, Nineteenth Edition, 1993. 2) Principles of Electronics by V K Mehta and Rohit Mehta, S Chand & Company, Eleventh Edition,2008. 3) Fundamentals of Magnetism & Electricity: D. N. Vasudeva, S Chand Publication, (2011). 4) Fundamentals of Electricity and Magnetism – Basudev Ghosh (Books & Allied New Central Book Agency, Calcutta, 2009). 5) Electricity & Magnetism: B. S. Agarwal, Kedarnath Ramnath Publication (2017). 6) Electricity and Magnetism with Electronics: Dr. K.K. Tewari, S. Chand Publications (1995). 7) Fundamentals of electric circuit theory: Dr. D. Chattopadhyay & Dr. P. C. Rakshit, S. Chand Publications, 7th Rev. Edn. (2006). 8) Electricity and Magnetism: John Yarwood, University Tutorial Press, (1973). 9) Electricity & Magnetism, N S Khare& S S Srivastava, AtmaRam & Sons, New Delhi. 10) Electricity & Magnetism, D L Sehgal, K L Chopra, N K Sehgal, S Chand & Co, Sixth Edition, (1988). 11) Electricity & Electronics, D C Tayal, Himalaya Publishing House, Sixth Edition (1988). 12) Electricity and Magnetism, S P Taneja, R Chand & Co. New Delhi.	

Laboratory Experiments:

NOTE: Minimum of Eight experiments has to be performed

Year	I	**Course Code: 21BSC2C2PHY2P**	**Credits**	2
Sem.	2	**Course Title: Practical-II**	**Hours**	4 hrs/week
Formative Assessment Marks: 25		Summative Assessment Marks: 25	Duration of ESA: 4 hrs.	

Sl. No	**Experiment**
1	Thevenin's & Norton's theorem (Ladder Network)
2	Thevenin's & Norton's theorems (Whetstone Bridge)
3	High resistance by leakage method
4	Time constant of RC circuit by charging and discharging method.
5	Calibration of Ammeter using Helmholtz Galvanometer
6	Constants of Ballistic Galvanometer
7	LCR series / parallel resonance circuit
8	De Sauty's AC bridge
9	Self-Inductance by Rayleigh's method
10	Use of CRO to find voltage, frequency and phase.
11	L & C by Equal Voltage Method
12	Black Box- Identify & Measure R, L & C
13	Anderson's Bridge to determine the self-inductance of the coil (L).
14	Verification of Superposition Theorem
15	Verification of maximum Power Transfer Theorem

Recommended Leaning Resources

Reference Books	1. Physics through experiments. B Saraf etc, - Vikas Publications (2013) 2. D P Khandelwal – A Laboratory Manual of Physics for Undergraduate Classes, Vikas Publications First ed (1985) 3. Advanced Practical Physics for Students – Workshop & Flint, Methuen & Co, London. 4. An Advanced Course in Practical Physics, D Chattopadhyay, P C Rakshit, B Saha, New Central Book Agency (P) Limited, Kolkata, Sixth Revised Edition, (2002) 5. BSC, Practical Physics, CL Arora, SChand& Co, New Delhi, (2007) Revised Edition. 6. B.Sc. Practical Physics, Geeta Sanon R. Chand & Co. New Delhi Rani Channam University, Belagavi, B.Sc. (CBCS) Physics Syllabus

OPEN-ELECTIVE SYLLABUS:

Year	I	**Course Code: 21BSC2O2PHY1**	**Credits**	03
Sem.	2	**Course Title:** OPTICAL INSTRUMENTS	**Hours**	40
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:.02 hrs.	

Unit No.	**Course Content**	**Hours**
Unit I	**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.	10
Unit II	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. (Expressions need not be derived, but have to be discussed qualitatively).	10
Unit III	**Camera and microscopes** Human eye (constitution and working), Photographic camera (principle, construction and working), construction, working and utilities of Simple microscopes, Compound microscope, Electron microscopes, Binocular microscopes **Self study** Experimental determination of magnifying power of a microscope. (Construction part can be discussed through block diagrams)	10
Unit IV	**Telescopes and Spectrometer** Construction, working and utilities of Astronomical telescopes Terrestrial telescopes Reflecting telescopes, Construction, working and utilities of Eyepieces or Oculars (Huygen, Ramsden's, Gauss) Spectrometer - Construction, working and utilities, measurement of refractive index. **Self study** Telescopes used at different observatories in and outside India. Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Carbon captured technologies, cell, batteries, power consumption	10
	Activities: 1) Find position and size of the image in a magnifying glass and magnification. 2) Observe rain bows and understand optics. 3) Create a rainbow. 4) Find out what makes a camera to be of good quality.	

	5) Observe the dispersion of light through prism. 6) Make a simple telescope using magnifying glass and lenses. 7) Learn principle of refraction using prisms. 8) Check bending of light in different substances and find out what matters here. 9) Learn about different telescopes used to see galaxies and their ranges. Many more activities can be tried to learn optics by going through you tubes and webistes such as https://spark.iop.org, http://www.yenka.com, https://publiclab.org etc.	

ASSESSMENT METHODS

Evaluation Scheme for Internal Assessment:

Theory:

Assessment Criteria	40 marks
1st Internal Assessment Test for 30 marks 1 hr after 8 weeks and 2nd Internal Assessment Test for 30 marks 1 hr after 15 weeks . Average of two tests should be considered.	30
Assignment	05
Activity	05
Total	**40**

Assessment Criteria	25 marks
1st Internal Assessment Test for 20 marks 1 hr after 8 weeks and 2nd Internal Assessment Test for 20 marks 1 hr after 15 weeks. Average of two tests should be considered.	20
Assignment/Activity	05
Total	**25**

Practical:

Assessment Criteria	25 marks
Internal test	15
Viva Voce / basic understanding of the concept	05
Journal/Practical Record	05
Total	**25**

Scheme of Evaluation for Practical Examination

Sl. No.	Particulars	Marks Allotted Max. 25
1.	Basic formula with description, nature of graph if any & indication of unit	05
2.	Tracing of schematic ray diagram/Circuit diagram with description and tabulation	05
4.	Experimental skill & connection	05
5.	Record of observation,	05
6.	Calculation including drawing graph	04
7.	Accuracy of result with unit	01
	Total	**25**

Question Paper Pattern:

RANI CHANNAMMA UNIVERSITY
Department of PHYSICS

I /II Semester B.Sc.

Sub: **Code:** **Maximum Marks: 60**

Q.No.1.	**Answer any Six Questions** ***(Two question from Each Unit to be asked)*** **a.** **b.** **c.** **d,** **e.** **f.** **g.** **h.**	**6X2=12**
Q.No.2.	**(Questions from Unit-I)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.3.	**(Questions from Entire Unit-II)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.4.	**(Questions from Unit-III)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.5.	**(Questions from Unit-IV)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**

Note:

i. There should be a problem of marks from each unit and may be asked in either b or d in questions 2 to 5.

ii. If necessary, sub questions a and c from 2 to 5 may be subdivided in to i. and ii. Without exceeding maximum 08 marks.

RANI CHANNAMMA UNIVERSITY, BELAGAVI

PROGRAM /COURSE STRUCTURE AND SYLLABUS

Of

PHYSICS

as per the Choice Based Credit System (CBCS) designed in accordance with
Learning Outcomes-Based Curriculum Framework (LOCF)
of National Education Policy (NEP) 2020
for

Bachelor of Science (Physics)

I to IV Semesters

w.e.f.

Academic Year 2022-23 and onwards

PREAMBLE

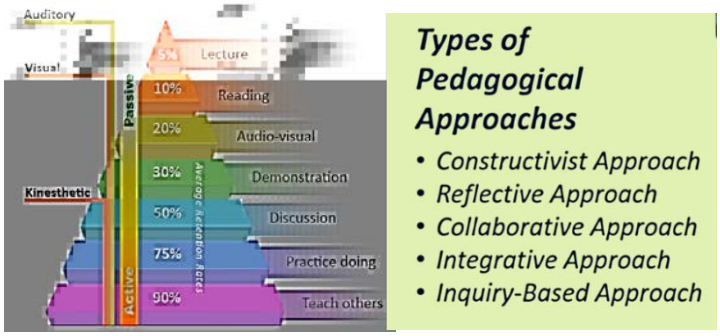
The New Education Policy (2020) is a paradigm shift from the conventional system we practice even today. Giving students the entire freedom to choose what to learn, how to learn, where to learn and when to learn, will enable a personalized education that suits his/her own personality. The drive to change the pedagogy in the curriculum and syllabi will cater to the cognitive, affective and psycho-motor domain of learning, which will fruitfully engage to student and guide him to ascend the Blooms levels of learning hierarchy, elevating them from just remembering to become creative through acquiring skills of application, evaluation and analysis. Such an approach will enable the institution and the individual to design and execute education that is suitable and doable. The wonderful Academic Credit accumulation and the multiple exit/entry options enable multi-disciplinary obtainable from multiple institutions, and even from recognized digital platforms. This will create unprecedented opportunities to the students to self-evaluate and change course at every stage of education as they learn. Introducing the possibility of cutting across disciplines to pursue one's interest and talent can boost curricular and extra-curricular activities by an equal measure. This will definitely enable the blooming of creativity among individuals who will not only be excellent and productive employees, but also assume the mantle of becoming entrepreneurs and job providers. The opportunity for the teacher to adopt novel pedagogies will make classrooms vibrant, meaningful and effective. The student choices will also lead to a healthy cross-disciplinary interaction between institutions and consequently enhancing their capabilities and credibility.

The NEP-2020 is based on Outcome Based Education, where the Graduate Attributes and employment opportunities are first kept in mind to reverse-design the Programs, Courses and Supplementary activities to attain the graduate attributes and learning outcomes.

- Attribute 1: Deep discipline knowledge and intellectual breadth. ...
- Attribute 2: Creative and critical thinking, and problem solving. ...
- Attribute 3: Teamwork and communication skills. ...
- Attribute 4: Professionalism and leadership readiness. ...
- Attribute 5: Intercultural and ethical competency.

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 develop scientific orientation, spirit of enquiry problem solving skills and human and professional will values which foster rational and critical thinking in the students.

It is imperative that in the spirit of the NEP, several academic matters have to change. The most important among these will be the pedagogy that will be adopted in the Teaching-Learning experience to enrol, engage and involve and inspire the students. The learning that happens by employing different types of pedagogies is shown below, and thus need to be adopted in the teaching-learning process for effective cognition by the students using the Auditory, Visual and Kinaesthetic approaches:



Along with conventional teaching methods, Activity based pedagogies are seen to be extremely effective in achieving the Program Educational Objectives. The Committee has attempted to consider both the spirit of the NEP and the existing system and framed the syllabus within the Curriculum options offered by the Higher Education Council. The broad topic level syllabus for all the 5 years (10 semesters) for an integrated B.Sc + M.Sc program has been provided. However, a detailed syllabus has to been provided for the First Two Semester. Attempts have been made to sincerely bring in Activity based pedagogy. The activities have been listed and a few examples have been provided to guide the teacher of how to create their own activities that engage and illuminate students by group and self-involvement methods and a possible evaluation method.

PROGRAM OUTCOMES

Exit with:	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

1. **Discipline Knowledge:** Knowledge of science and ability to apply to relevant areas.
2. **Problem solving:** Execute a solution process using first principles of science to solve problems related to respective discipline.
3. **Modern tool usage:** Use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.
4. **Ethics:** Apply the professional ethics and norms in respective discipline.
5. **Individual and teamwork:** Work effectively as an individual as a team member in a multidisciplinary team.

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

Exit with:	Credits Required
A **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

1. **Discipline Knowledge:** Knowledge of science and ability to apply to relevant areas.
2. **Conduct investigations:** Conduct investigations of technical issues as per their level of understanding and knowledge.
3. **Problem solving:** Formulate and implement a solution process using first principles of science to solve problems related to respective discipline.
4. **Modern tool usage:** Apply a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.
5. **Ethics:** Apply and commit to the professional ethics and norms in respective profession.
6. **Individual and teamwork:** Work effectively as an individual in a multidisciplinary team.
7. **Communication:** Communicate effectively with the stake holders, and give and receive clear instructions.

Exit with:	Credits Required
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

1. **Discipline Knowledge:** Knowledge of basics of science and ability to apply the understanding of fundamentals of major discipline in solving complex problems.
2. **Conduct investigations:** Conduct investigations of issues in their respective disciplines and arrive at valid conclusions.
3. **Problem solving:** Implement a solution process using first principles of science to solve problems related to respective discipline.
4. **Modern tool usage:** Select and use a modern scientific, engineering and IT tool or technique for solving problems in the areas of their discipline.
5. **Environment and Society:** Evaluate the impact of scientific solutions on society and environment and the need for sustainable solutions.
6. **Ethics:** Demonstrate professional ethics, responsibilities and norms in respective profession.
7. **Individual and teamwork:** Work effectively as an individual as a team member and as a leader in a multidisciplinary team.

8. **Communication:** Communicate effectively with the stake holders, write and comprehend project reports and documentation, deliver effective presentations, and give and receive clear instructions.
9. **Project Management and Finance:** Apply the knowledge of scientific and technological principles to one's own work to manage projects in multidisciplinary settings.
10. **Lifelong Learning:** Engage in lifelong learning in the context of changing trends in respective discipline.

Exit with:	Credits Required
Bachelor Degree with Honours in a Discipline at the Successful Completion of the Fourth Years (Eight Semesters) of the multidisciplinary Four-year Undergraduate Programme/Five-year Integrated Master's Degree Programme	176 - 192

1. **Discipline Knowledge:** Knowledge of basics of science and research, and ability to apply the understanding of fundamentals of specialized discipline in solving complex scientific problems.
2. **Conduct investigations:** Conduct investigations of issues using research methods and research-based discipline knowledge including design of experiments, data collection, interpretation and analysis to arrive at valid conclusions.
3. **Problem analysis:** Identify, formulate and analyze complex scientific problems using first principles of respective discipline.
4. **Design and Development of solutions:** Design solutions for complex scientific problems and execute them by considering the environmental, societal and public safety aspects appropriately.
5. **Modern tool usage:** Identify, select and use a modern scientific, engineering and IT tool or technique for modelling, prediction, data analysis and solving problems in the areas of their discipline.
6. **Environment and Society:** Evaluate the impact of scientific solutions on society and environment and design sustainable solutions.
7. **Ethics:** Demonstrate professional ethics, responsibilities and norms in respective profession.
8. **Individual and teamwork:** Work effectively as an individual as a team member and as a leader in a multidisciplinary team.
9. **Communication:** Communicate effectively with the stakeholders with emphasis on communicating with scientific community, comprehend scientific reports, write research papers and projects proposals and reports, deliver effective presentations, and give and receive clear instructions.
10. **Project Management and Finance:** Apply the knowledge of scientific and technological principles to one's own work to manage projects in multidisciplinary settings.
11. **Lifelong Learning:** Identify knowledge gaps and engage in lifelong learning in the context of changing trends in respective discipline.

PROGRAM STRUCTURE

Proposed Curricular and Credits Structure under Choice Based Credit System [CBCS] of Physics Major & One Minor Discipline Scheme for the Four Years Physics B.Sc. Undergraduate Honors Programme with effect from 2022-23.

SEMESTER-I									
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**		**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**P**		
L1	21BSC1L1LK1	Kannada	40	60	100	4	-	3	2
	21BSC1L1LFK1	Functional Kannada							
L2	21BSC1L2LEN2	English	40	60	100	4	-	3	2
	21BSC1L2LHI2	Hindi							
	21BSC1L2LSN2	Sanskrit							
	21BSC1L2LTE2	Telugu							
	21BSC1L2LUR2	Urdu							
DSC1	21BSC1C1PHY1L	Mechanics & Properties of Matter	40	60	100	4	-	4	2
	21BSC1C1PHY1P	Practical I	25	25	50	-	4	2	4
DSC1	Another Department Code	Another Department Course Title	40	60	100	4	-	4	2
			25	25	50	-	4	2	4
SEC1	21BSC1SEC1DF1	Digital Fluency	25	25	50	1	2	2	2
VBC1	21BSC1V1PE1	Yoga/Sports	25	--	25	-	2	1	--
VBC2	21BSC1V2HW1	H&W/NCC/NSS/R&R/CA	25	--	25	-	2	1	--
OEC1	21BSC1O1PHY1	Energy Sources	40	60	100	3	-	3	2
Total Marks					**700**	**Semester Credits**		**25**	

SEMESTER-II										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
L3	21BSC2L3LK2	Kannada	40	60	100	4	-	-	3	2
	21BSC2L3FKL2	Functional Kannada								
L4	21BSC2L4EN2	English	40	60	100	4	-	-	3	2
	21BSC2L4HI2	Hindi								
	21BSC2L4SN2	Sanskrit								
	21BSC2L4TE2	Telugu								
	21BSC2L4UR2	Urdu								
DSC2	21BSC2C2PHY1L	Electricity & Magnetism	40	60	100	4	-	-	4	2
	21BSC2C2PHY1P	Practical II	25	25	50	-	-	4	2	4
DSC2	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
AECC 1	21BSC2AE1ES1	Environmental Studies	25	25	50	1	-	2	2	2
VBC3	21BSC2V3PE2	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC4	21BSC2V4NC2	H&W/NCC/NSS/R&R/CA	25	--	25	-	-	2	1	--
OEC2	21BSC2O2PHY2	Optical Instruments	40	60	100	3	-	-	3	2
Total Marks					**700**	**Semester Credits**			**25**	

SECOND YEAR; SEMESTER-III										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
L5	21BSC3L5LK3	Kannada	40	60	100	4	-	-	3	2
	21BSC3L5LFK3	Functional Kannada								
L6	21BSC3L6EN3	English	40	60	100	4	-	-	3	2
	21BSC3L6HI3	Hindi								
	21BSC3L6SN3	Sanskrit								
	21BSC3L6TE3	Telugu								
	21BSC3L6UR3	Urdu								
DSC3	21BSC3C3PHY1L	Wave motion and Optics	40	60	100	4	-	-	4	2
	21BSC3C3PHY1P	Practical III	25	25	50	-	-	4	2	4
DSC3	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
SEC2	21BSC3SEC2AI1	Artificial Intelligence	25	25	50	1	-	2	2	2
VBC5	21BSC3V5PE3	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC6	21BSC3V6NC3	H&W/NCC/NSS/ R&R/CA	25	--	25	-	-	2	1	--
OEC3	21BSC3O3PHY3	Climate Science	40	60	100	3	-	-	3	2
Total Marks					**700**	**Semester Credits**			**25**	

SEMESTER-IV										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
L7	21BSC4L7LK4	Kannada	40	60	100	4	-	-	3	2
	21BSC4L7LFK4	Functional Kannada								
L8	21BSC4L8EN4	English	40	60	100	4	-	-	3	2
	21BSC4L8HI4	Hindi								
	21BSC4L8SN4	Sanskrit								
	21BSC4L8TE4	Telugu								
	21BSC4L8UR4	Urdu								
DSC4	21BSC4C2PHY4L	Thermal Physics And Electronics	40	60	100	4	-	-	4	2
	21BSC4C2PHY4P	Practical IV	25	25	50	-	-	4	2	4
DSC4	Another Department Code	Another Department Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	4
AECC 2	21BSC4AE1CoI1	Constitution of India	25	25	50	1	-	2	2	2
VBC7	21BSC4V5PE4	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC8	21BSC4V6NC4	H&W,/NCC/NSS/R&R/CA	25	--	25	-	-	2	1	--
OEC4	21BSC4O4PHY4	Electrical Instruments	40	60	100	3	-	-	3	2
Total Marks					**700**	**Semester Credits**			**25**	

SEMESTER-V										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Physics as Major Discipline										
DSC5	21BSC5C5PHYMJ1L	Classical Mechanics andQuantum Mechanics-	40	60	100	3	-	-	3	2
	21BSC5C5PHYMJ1P	Practical V	25	25	50	-	-	4	2	4
DSC6	21BSC5C5PHYMJ2L	Elements of Atomic,MolecularPhysics	40	60	100	3	-	-	3	2
	21BSC5C5PHYMJ2P	Practical VI	25	25	50	-	-	4	2	4
DSC5	Another Department Code as a Minor Subject	Another Department Course Title	40	60	100	3	-	-	3	2
			25	25	50	-	-	4	2	4
VC1	21BSC5VC1PHY1	Vocational 1	40	60	100	3	-	-	3	2
VBC9	21BSC5V5PE5	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC10	21BSC5V6NC5	NCC/NSS /R&R(S& G) / Cultural	25	--	25	-	-	2	1	--
SEC3	21BSC5SEC3	Cyber Security	25	25	50	1	-	2	2	2
Total Marks					**650**	**Semester Credits**			**22**	

SEMESTER-VI										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Physics as Major Discipline										
DSC7	21BSC6C6PHYMJ1L	Elementsof Nuclear PhysicsandNuclearInstruments	40	60	100	3	-	-	3	2
	21BSC6C6PHYMJ1P	Practical VII	25	25	50	-	-	4	2	4
DSC8	21BSC6C6PHYMJ2L	Elementsof Condensed MatterPhysics	40	60	100	3	-	-	3	2
	21BSC6C6PHYMJ2P	Practical VIII	25	25	50	-	-	4	2	4
DSC6	Another Department Code as a Minor Subject	Another Department Course Title	40	60	100	3	-	-	3	2
			25	25	50	-	-	4	2	4
VC2	21BSC6VC2PHYVC2	Vocational 2	40	60	100	3	-	-	3	2
VBC1	21BSC6V5PE6	Yoga/ Sports	25	--	25	-	-	2	1	--
VBC2	21BSC6V6NC6	NCC/NSS/R&R(S&G) / Cultural	25	--	25	-	-	2	1	--
SEC4	21BSC6SEC4PC1	Professional Communication	25	25	50	1	-	2	2	2
INT	21BSC6IN1PHYIN	Internship between 5th and 6th semester	25	25	50	3 to 4 weeks			2	Report & Presentation
		Total Marks			**700**	**Semester Credits**			**24**	
		Total Marks for BSC Program			**4150**	**Total Credits for BSc Program**			**146**	

Physics Subject as a Minor Discipline

SEMESTER-V										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
DSC5 As a Minor Subject	21BSC5C5PHYMN1L	Modern Physics – I	40	60	100	3	-	-	3	2
	21BSC5C5PHYMN1P	Modern Physics - I lab	25	25	50	-	-	4	2	4

SEMESTER-VI										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
DSC6 As a Minor Subject	21BSC6C6PHYSMN1L	Modern Physics - II	40	60	100	3	-	-	3	2
	21BSC6C6PHYMN1P	Modern Physics - II lab	25	25	50	-	-	4	2	4

Concept Note, Abbreviation Explanation and Coding:

Concept Note:

1. **CBCS** is a mode of learning in higher education which facilitates a student to have some freedom in selecting his/her own choices, across various disciplines for completing a UG/PG program.
2. A credit is a unit of study of a fixed duration. For the purpose of computation of workload as per UGC norms the following is mechanism be adopted in the University:
   One credit (01) = One Theory Lecture (L) period of one (1) hour.
   One credit (01) = One Tutorial (T) period of one (1) hour.
   One credit (01) = One practical (P) period of two (2) hours.
3. Course: paper/subject associated with AECC, DSC, DSEC, SEC, VBC, OEC, VC, IC and MIL

4. In case of **B.Sc**. **Once a candidate chose two courses/subjects of a particular two department in the beginning, he/she shall continue the same till the end of the degree, then there is no provision to change the course(s) and Department(s).**
5. A candidate shall choose **one of the Department's courses as major and other Department course as minor in fifth and sixth semester and major course will get continued in higher semester.**
6. Wherever there is a practical there will be no tutorial and vice-versa
7. A major subject is the subject that's the main focus of Core degree/concerned.
8. A minor is a secondary choice of subject that complements core major/ concerned.
9. Vocational course is a course that enables individual to acquire skills set that are required for a particular job.
10. Internship is a designated activity that carries some credits involving more than **25 days** of working in an organization (either in same organization or outside) under the guidance of an identified mentor. Internship shall be an integral part of the curriculum.
11. **OEC: Open Elective course is for non- Physics students.**

Abbreviation Explanations:

1. AECC: Ability Enhancement Compulsory Course.
2. DSC: Discipline Specific Core Course.
3. DSEC: Discipline Specific Elective Course.
4. SEC: Skill Enhancement Course.
5. VBC: Value Based Course.
6. OEC: Open/Generic Elective Course
7. VC: Vocational Course.
8. IC: Internship Course
9. L1: Language One
10. L2: MIL
11. L= Lecture; T= Tutorial; P=Practical.
12. MIL= Modern Indian Language; English or Hindi or Telugu or Sanskrit or Urdu

Program Coding:

1. Code 21: Year of Implementation
2. Code BSC: BSC Program under the faculty of Applied Science of the University
3. Code 1: First Semester of the Program, (2 to 6 represent higher semesters)
4. Code AE: AECC, (C for DSC, S for SEC, V for VBC and O for OEC)
5. Code 1: First "AECC" Course in semester, similarly in remaining semester for such other courses
6. Code LK: Language Kannada, similarly Language English, Language Hindi, Language Telugu, Language Sanskrit, &Language Urdu
7. Code 1: Course in that semester.
8. PHY: Physics

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

Course Content Semester – I
Mechanics and Properties of Matter

Course Title: Mechanics and Properties of Matter	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60
Model Syllabus Authors: Physics Expert Committee	

Prerequisites

i.	Basic Knowledge of Classical Mechanics up to 12th Standard

Course Learning Outcomes

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

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

Course Articulation Matrix

Mapping of Course Outcomes (CO) Program Outcomes

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

Mechanics & Properties of Matter

Unit1 - The Portion to be Covered

Review of Units and measurements: Fundamental and Derived units, Principal System of units (CGS and SI), measurement of length, mass and time.

Dimensions: Dimensional formulae of physical quantities, equations-use of dimensions, conversion of one system of units into another, Minimum deviation and errors. **(3 Hours)**

Vectors: Definition of scalar and vector with examples, types of vectors. Scalar and Vector Products. Gradient of scalar and its physical significance.

Divergence of vector and its physical significance. Curl of vector and its physical significance. Vector integration; line, surface & volume integrals of a vector field. Gauss Divergence theorem & Stokes's theorem(statement). **(4 Hours)**

Momentum and Energy: Work and energy, Conservation of momentum (linear). Conservation of energy with examples. Concept of elastic and inelastic collisions. Derivation of final velocities in case of elastic collision and inelastic collision, Conservation of linear momentum in case of variable mass. Principle of rocket and derivation for equation of motion for single stage rocket.**(6 Hours)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
i.	Define different systems of units in CGS and SI systems.	L1	1	1-6, 11-12
ii.	What is the dimension of physical quantity?	L1	1	1-6, 11-12
iii.	Write a dimension formula for coefficient of Viscosity of a liquid.	L2	1	1-6, 11-12
iv.	With example demonstrate how to calculate conversion of unit using a dimensional formula of a physical quantity.	L2	1	1-6, 11-12
v.	What is an error? Explain how it is calculated using minimum deviation.	L2	1	1-6, 11-12
vi.	What are scalar and vector? Explain with an example.	L1	1	1-6, 11-12
vii.	Explain gradient, divergence and curl in a physical phenomenon and write mathematical formula for the same.	L2	1	1-6, 11-12
viii.	Apply the work-energy theorem for constant forces acting on a particle.	L3	2	1-6, 11-12
ix.	Apply the law of conservation of linear momentum and energy for simple two-particle systems.	L3	2	1-6, 11-12
x.	Apply the conservation of momentum for an isolated one-dimensional collision to relate the initial momenta of the objects to their momenta after the collision.	L3	2	1-6, 11-12
xi.	Relate the rate to the change in momentum for a moving system	L2	2	1-6, 11-12

	undergoing a change in mass at a given rate.			
xii.	Apply the concepts of conservation of energy, momentum, angular momentum on basic problems.	**L3**	**2**	**1-6, 11-12**
xiii.	Describe special relativistic effects and their effects on the mass and energy of a movingobject.	**L2**	**2**	**1-6, 11-12**
xiv.	Higher order problems.	**L3**	**1,2**	**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.

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

Suggested Activities

Activity No. 1	Take different objects of regular shape, write the dimensional equation for their volume, surface area and write their units in SI and CGS systems. For the above calculate the actual volume and surface area using relevant measuring tools. Calculate estimated error using dimensional equation and the actual measurements.
Activity No. 2	Students must identify and explain three examples for Divergence and three examples for Curls in real-world applications.
Activity No. 3	Drop balls of different hardness on different surfaces and list them in order of their energy absorption and give reasons.

Mechanics & Properties of Matter

Unit2 - The Portion to be Covered

Laws of Motion: Newton's Laws of motion. Dynamics of single and a system of particles. Centre of mass. Derivation for position, velocity, acceleration and force of centre of mass.**(3 Hours)**

Dynamics of Rigid bodies: Rotational motion about an axis, Relation between torque and angular momentum, Rotational energy. Moment of inertia: Radius of Gyration, theorem of parallel axis and theorem of perpendicular axis. M I of a rectangular Lamina, M.I of circular disc and solid cylinders. Theory of compound pendulum and determination of g, Determination of M.I of Flywheel. **(6 Hours)**

Gravitation: Newton's law of Gravitation (statement). Expressions for escape velocity and orbital velocity. The motion of a particle in a central force field. Kepler's laws of planetary motion. Derivation for Kepler's 2nd and 3rd law. Concept of Satellite, derivation for binding energy of Satellite. Satellite in a circular orbit. **(4 Hours)**

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

SL No	TLO's	BL	CO	PO
i.	Apply laws of motionto various dynamical situations and the notion of inertial frames.	**L2**	**3**	**1-6, 11-12**
ii.	Explain what is force based on Newton's laws of motion.	**L2**	**3**	**1-6, 11-12**
iii.	Give the analogy between translational and rotational dynamics with an example of rolling withslipping.	**L2**	**3**	**1-6, 11-12**
iv.	Describe how fictitious forces arise in a non-inertial frame, using this explain why a person sitting in a merry-go-round experiences an outwardpull.	**L2**	**3**	**1-6, 11-12**
v.	Apply Kepler's law to describe the motion of planets and satellites in circular orbit, through the study of law ofGravitation.	**L3**	**3**	**1-6, 11-12**
vi.	Apply Kepler's law for the orbital motion of natural or artificial satelliteand obtain the relation between period, radius and the mass of the satellite.	**L3**	**3**	**1-6, 11-12**
vii.	Determine the location of the centre of mass, given the positions of several particles along an axis of a plane.	**L2**	**3**	**1-6, 11-12**
viii.	Locate the centre of mass of an extended, symmetric object by using symmetry.	**L2**	**3**	**1-6, 11-12**
ix.	Apply newton's laws of motion to moving particles under the gravitational force.	**L3**	**4**	**1-6, 11-12**
x.	Apply Newton's law of gravitation to relate the gravitational force between two particles to their masses and their separation.	**L3**	**4**	**1-6, 11-12**
xi.	Apply the conservation of mechanical energy (including gravitational potential energy) to a particle moving relative to an astronomical body (or some second body that is fixed in place).	**L3**	**4**	**1-6, 11-12**
xii.	For a body moving with constant angular acceleration, obtain the relationships between angular position, angular displacement, angular velocity, angular acceleration, and elapsed time.	**L2**	**4**	**1-6, 11-12**
xiii.	Calculate the rotational kinetic energy of a body in terms of its rotational inertia and its angular speed.	**L2**	**4**	**1-6, 11-12**

xiv.	Apply the work, kinetic energy relationto obtain the work done by a torque.	**L2**	**4**	**1-6, 11-12**
xv.	Higher order problems.	**L3**	**3,4**	**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.

FormativeAssessment Techniques

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

Suggested Activities

Activity No. 4	Prepare and present a report on different types of Geo Satellite orbits and their characteristics
Activity No. 5	Take an irregular two-dimensional sheet of any material (plastic cardboard) etc and find its centre of mass.
Activity No. 6	Devise an experiment that demonstrates that the variation in the distribution of mass in a rotating body affects the rotating speed. Plot a graph of the variation in the position of mass with the centre of the body and the average speed of rotation.
Activity No. 7	Tie a stone through a thread, rotate it with different speeds for a length given then release it. Calculate the distance it flies before it falls to the ground and hence calculate the possible kinetic energy of rotation.

Mechanics & Properties of Matter

Unit3 - The Portion to be Covered

Elasticity: Definition of Stress-strain, Hooke's law. Types of elastic constants. modulus of elasticity and derivation of expression for relation between elastic constants. Poisson's Ratio-expression for Poisson's ratio in terms of elastic constants. **(4 Hours)**

Derivation of work done per unit volume in a deforming body. Work done in stretching and work done in twisting a wire-Twisting couple on a cylinder. Theory of Single Cantilever **(3 Hours)**

Bending Moment: Derivation of bending moments. Theory of cantilever. Determination of Youngs modulus by bending of beam supported at its ends and loaded at middle. **Torsional Pendulu**m: Derivation for time period of torsion pendulum Determination of rigidity modulus and moment of inertia by Searle's method. **(6 Hours)**

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

SL No	TLO's	BL	CO	PO
i.	State Hooke's law and obtain the equation for stress, strain and Young's modulus.	L2	5	1-6, 11-12
ii.	Differentiate between different types of elastic moduli.	L2	5	1-6, 11-12
iii.	For shearing strain, obtain the equation that relates stress to strain and their shear modulus.	L2	5	1-6, 11-12
iv.	Explain the advantages and disadvantages of asingle cantilever.	L2	5	1-6, 11-12
v.	Define what is Poison's ratio and obtain the relation between Young'smodulus, modulus of rigidity, bulk modulus and poisons ratio.	L2	5	1-6, 11-12
vi.	Higher order problems.	L3	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.

FormativeAssessment Techniques

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

Suggested Activities

Activity No. 8	Draw Stress and Strain Curve for Steel, Rubber and Wood.
Activity No. 9	Calculate stored energy in a catapult in the form of elasticity.

Mechanics & Properties of Matter

Unit4 - The Portion to be Covered

Surface tension:

Definition of surface tension, Angle of contact, Surface energy, relation between surface tension and surface energy, pressure difference across curved surface. Excess of pressure inside spherical liquid drop, Capillary rise, derivation of expression for rise of liquid in a capillary tube. Determination of surface tension by Quinke's method. Effect of temperature, impurity on surface tension. Problems .**(7 Hours)**

Viscosity: Streamline flow, turbulent flow, equation of continuity, determination of coefficient of Viscosity by Poisulle's method, Stoke's law with derivation and expression for terminal velocity. Effect of temperature on viscosity. Problems**(6 Hours)**

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

SL No	TLO's	BL	CO	PO
i.	Define and explain the theory ofsurface tension of liquids.	L1	6	1-6, 11-12
ii.	Correlate between surface tension and surface energy.	L2	6	1-6, 11-12
iii.	Correlate the property of surface tension with different natural phenomena.	L2	6	1-6, 11-12
iv.	Explain the concept of capillarity in liquids and relate surface tension with capillarity.	L2	6	1-6, 11-12
v.	What is Angle of contact between different surfaces and explain how pressure differs inside and outside the soap bubbles.	L2	6	1-6, 11-12
vi.	Explain how the coefficient of viscosity is calculated using by postulate method and strokes method.	L2	6	1-6, 11-12
vii.	Define viscosity and describe how viscosity can be measured.	L1	6	1-6, 11-12
viii.	Distinguish fluids from solids.	L2	6	1-6, 11-12
ix.	Classify fluids based on the law of viscosity.	L2	6	1-6, 11-12
x.	Explain the term streamline.	L1	6	1-6, 11-12
xi.	Describe steady flow, incompressible flow, non-viscous flow, and irrotational flow.	L2	6	1-6, 11-12
xii.	Explain fluid friction and the factors affecting it.	L1	6	1-6, 11-12
xiii.	Higher order problems.	L3	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

Suggested Activities	
Activity No. 10	Measure surface tension of water and other common liquids and compare andlearn i) Why water has high surface tension? Think ofreasons. ii) Check whether surface tension is a function of temperature? Youcan do it by heating the water to different temperatures and measureits surface tension. iii) Plot surface tension versus temperature and learn how it behaves. Mix some quantity of kerosene or any oil to water and measure surface tension. Check whether surface tension for the mixtureis more or less than pure water. List thereasons
Activity No. 11	Collect a set of different liquids and measure theirviscosity. i) Find out whether sticky or non-sticky liquids are most viscous. List thereasons. ii) Mix non-sticky liquid with a sticky liquid in defined quantitiesand measure viscosity.Find out whether viscosity is increasing or decreasing with increase of non-sticky liquidconcentration. iii) Do the above experiment by mixing sticky liquid to the non-sticky liquid. Find out change inviscosity with increase of concentration of stickyliquid. List the applications where concept of Viscosity plays a dominant role

Textbooks				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1	Mechanics by, New Eition	D. S. Mathur	S.Chand&Co.	2000
2	Mechancis and Relativity by 3rd Edition,	Vidwan Singh Soni,	PHI Learning Pvt.Ltd.	
3	Mechanics Berkeley Physics Course, Vol.1:	Charles Kittel, *et.al.*	TataMcGraw-Hill	2007
4	Properties of Matter	Brijlal&Subramanyam.		

References Books				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1	Physics. 9thEdn,	Resnick, Halliday & Walter,	Wiley	2010
2	Physics Vol-I	Halliday and Resnick,		

Formative Assessment	
Assessment	**Marks**
C1: Internal Assessment	10

C1: Research Experience at UG (REU) Project	10
C2: Activity	10
C2: Presentation (Oral or Poster)	10
Total	40

List of Experiments to be performed in the Laboratory Note: Minimum EIGHT experiments have to be carried out.	
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 a torsional pendulum.
4.	Modulus of rigidity of a rod – Static torsion method.
5.	Determination of elastic constants of a wire by Searle's method.
6.	Young's modulus by Koenig's method.
7.	Viscosity by Stoke's method.
8.	Verification of Hook's law.
9.	Determination of surface tension of a liquid and the interfacial tension between two liquids using drop weight method.
10.	Study of motion of a spring and to calculate Spring constant, g and unknown mass.
11.	Determination of Young's modulus of a bar by the single cantilever method.
12.	Determination of Young's modulus of a bar by uniform bending method.
13.	Radius of capillary tube by mercury pellet method.
14	Verification of parallel and perpendicular axis theorems.

Reference Book 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 lab manual of Physics for undergraduate classes, 1st Edition,		Vikas Publications.	
3	BSc Practical Physics Revised Ed	CL 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 SYLLABUS:

Year	I	**Course Code: 21BSC1O1PHY1**	**Credits**	03
Sem.	1	**Course Title: Energy Sources**	**Hours**	40

Formative Assessment Marks: 40	Summative Assessment Marks: 60	Duration of ESA: 02 hrs.

Unit No.	**Course Content**
Unit I	**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)**
	Renewable energy sources: Need of renewable energy, non-conventional energy sources. An overview of developments in Offshore Wind Energy, Tidal Energy, Wave energy systems, Ocean Thermal Energy Conversion, solar energy, biomass, biochemical conversion, biogas generation, geothermal energy tidal energy, Hydroelectricity. **(5 Hours)**
Unit II	**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. **(10 Hours)**
Unit III	**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. **(10 Hours)**
Unit IV	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.Hydropower resources, hydropower technologies, environmental impact of hydro power sources. **(2 Hours)**
	Activity 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 wind energy stations like Chitradurga, Hospet, Gadag, etc. 9. Field trip to solar energy parks like Yeramaras near Raichur.

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

Course Content Semester – II

Electricity & Magnetism

Course Title: Electricity and Magnetism	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 2 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60
Model Syllabus Authors: Physics Expert Committee	

Prerequisites

i.	Basic Knowledge of Electricity & Magnetismup to 12th Standard

Course Learning Outcomes

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

i.	Give the applications of charge distribution and energy associated with a charge for various shapes of electrical conductors, using the principles of the different laws of electrostatic field and potential.
ii.	Explain the impact of polarization due to an electrical field on a dielectric material, and the different terms related to dielectrics and the relation between them.
iii.	To obtain the impact of the electrical field in producing a magnetic field with resulting laws and applications.
iv.	Define various terms associated with a magnetic material andthe relation between them, and demonstrate the types of the magnetic material in terms of their respective BH curves.
v.	Obtain Maxwell's equations in differential and integral forms of transverse electromagnetic waves based on Faraday's and Lenz's laws, along with their production.
vi.	Obtain different quantities of resonance, power dissipation, quality factor and bandwidth for RL, RC, LCR series and parallel circuits, using basic laws of electrical circuits.
vii.	Use Ballistic Galvanometer to obtain charge sensitivity and electromagnetic damping.

Course Articulation Matrix

Mapping of Course Outcomes (CO) Program Outcomes

CourseOutcomes/ProgramOutcomes		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
i	Give the applications of charge distribution and energy associated with a charge for various shapes of electrical conductors, using the principles of the different laws of electrostatic field and potential.	X	X	X	X	X	X					X	X
ii	Explain the impact of polarization due to an electrical field on a dielectric material, and the different terms related to dielectrics and the relation between them.	X	X	X	X	X	X					X	X

iii	To obtain the impact of the electrical field in producing a magnetic field with resulting laws and applications.	X	X	X	X	X	X					X	X
iv	Define various terms associated with a magnetic material and the relation between them, and demonstrate the types of the magnetic material in terms of their respective BH curves.	X	X	X	X	X	X					X	X
v	Obtain Maxwell's equations in differential and integral forms of transverse electromagnetic waves based on Faraday's and Lenz's laws, along with their production.	X	X	X	X	X	X					X	X
vi	Obtain different quantities of resonance, power dissipation, quality factor and bandwidth for RL, RC, LCR series and parallel circuits, using basic laws of electrical circuits.	X	X	X	X	X	X					X	X
vii	Use Ballistic Galvanometer to obtain charge sensitivity and electromagnetic damping.	X	X	X	X	X	X					X	X

Electricity & Magnetism

Unit 1 - The Portion to be Covered

Electric Field and Electric Potential

Concept of Electric charge ,Coulomb's law , Electric lines of forces and their properties, Electric field, electric field strength or intensity at point distance. Electric potential, electric potential at point distance, relation between electric field and electric potential. Gauss theorem with application to charge distribution with spherical, cylindrical and planar symmetry.

Electric field and potential of dipole. Force and Torque on a dipole. Problems **(7 hours)**

Electrostatic energy of a system of charges. Electrostatic energy of a charged sphere. Conductors in an electrostatic Field. Surface charge and force on a conductor. The capacitance of a system of charged conductors. Parallel-plate capacitor. The capacitance of an isolated conductor. Method of Electrical Images and its application to (1) Plane Infinite Sheet and (2) Sphere. **(6hours)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
i.	Demonstrate Gauss law and Coulomb's law for the electric field, and apply it to systems of point charges as well as line, surface, and volume distributions ofcharges.	**L2**	**1**	**1-6, 11-12**

ii.	Explain and differentiate the vector(electric fields, Coulomb's law) and scalar(electric potential, electric potential energy) formalisms ofelectrostatics.	**L1**	**1**	**1-6, 11-12**
iii.	Apply Gauss's law of electrostatics to solve a definedproblem.	**L2**	**1**	**1-6, 11-12**
iv.	Articulate knowledge of electric current, resistance and capacitance in terms of electric field and electricpotential.	**L2**	**1**	**1-6, 11-12**
v.	Show that at every point in the space surrounding a charged particlethe particle sets up an electric field, which is a vector quantity and thus has both magnitude and direction.	**L2**	**1**	**1-6, 11-12**
vi.	Explain electric field lines, including where they originate and terminate and what the spacing between them represents.	**L2**	**1**	**1-6, 11-12**
vii.	Define electric flux and calculate the electric flux due to arbitrary distribution of charges.	**L2**	**1**	**1-6, 11-12**
viii.	Determine the electric field due to a uniformly charged spherical shell, cylindrical area and planar surface using Gauss law	**L2**	**1**	**1-6, 11-12**
ix.	Establish the relation between electric potential and electric field;	**L2**	**1**	**1-6, 11-12**
x.	Calculate the electric field at a point knowing the electric potential;	**L2**	**1**	**1-6, 11-12**
xi.	Determine the torque experienced by an electric dipole in a uniform electric field.	**L2**	**1**	**1-6, 11-12**
xii.	Determine the electric potential of a uniformly charged spherical sphere.	**L2**	**1**	**1-6, 11-12**
xiii.	Calculate the electrostatic potential energy for a given charge distribution.	**L2**	**1**	**1-6, 11-12**
xiv.	Determine the capacitance of parallel plate, spherical and cylindrical capacitors.	**L2**	**1**	**1-6, 11-12**
xv.	Apply the method of images for plane infinite sheet and sphere.	**L2**	**1**	**1-6, 11-12**
xvi.	Higher order problems.	**L3**	**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.
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
Suggested Activities

Activity No. 1	Build an electric field detector https://www.sciencebuddies.org/blog/electricity-lessons
Activity No. 2	Connect a circuit as per the given diagram and measure the voltage, current and resistance across each component. Also, measure the input voltage and output voltage for the circuit. (Use only one multimeter for the same)
Activity No. 3	Locate a three-phase power connection in your environment. Measure the voltage between the phases. Comment on the phase angle.

Electricity & Magnetism

Unit 2 - The Portion to be Covered

Dielectric Properties of Matter: Electric Field in the matter. Types of dielectrics (polar and non-polar molecules). Electric dipole moment (p), electric polarization (P),Electric displacement (D),Electric susceptibility ,Dielectric constant (K),Gauss law in dielectrics. Derivation for Relation between D, E and P. Derivation for relation between dielectric constant and electric susceptibility. Boundary conditions for E & D. Capacitor (parallel plate, spherical, cylindrical) filled with dielectric. Problems **(6 hours)**

Magnetic Field: Magnetic force between current elements and definition of Magnetic Field, relation between B and **H.** Statement of Boit Savart's law. Derive an expression for Magnetic field at a point (1) due to a straight conductor carrying current (ii) along the axis of the circular coil carrying current. Principle, construction and theory of Helmholtz Galvanometer.Current Loop as a Magnetic Dipole and its Dipole Moment (Analogy with Electric Dipole). Ampere's Circuital Law and its application to (1) Solenoid and (2) Toroid. Properties of B: curl and divergence. Vector Potential. Magnetic Force on (1) point charge (2) current carrying wire (3) between current elements. Torque on a current loop in a uniform Magnetic Field. Problems**(7 hours)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
xvi.	Explain the electrical polarization and dielectrics of a material.	L1	2	1-6, 11-12
xvii.	Define the electrical susceptibility, dielectric constant and electrical polarizability.	L1	2	1-6, 11-12
xviii.	What is a capacitor and explain its working.	L1	2	1-6, 11-12
xix.	Obtain an expression for the capacitance of a parallel plate capacitor, spherical capacitor and a cylindrical capacitor which is filled with a dielectric constant $\boldsymbol{\varepsilon}$.	L2	2	1-6, 11-12
xx.	Explain the displacement vector(D).	L1	2	1-6, 11-12
xxi.	Obtain the relation between the electrical field, polarizability and displacement vector.	L2	2	1-6, 11-12
xxii.	State and explain Gauss's law of dielectrics.	L1	2	1-6, 11-12
xxiii.	Obtain an expression for the magnetic force between two current elements and hence define a magnetic field B.	L2	3	1-6, 11-12
xxiv.	State Boit-Savart's Law.	L1	3	1-6, 11-12
xxv.	Obtain the magnetic field B around a straight wire and a circular loop.	L2	3	1-6, 11-12
xxvi.	What are the magnetic dipoles and their dipole moment?	L1	3	1-6, 11-12
xxvii.	Define and explain Ampere's circuit law.	L1	3	1-6, 11-12
xviii.	Give the applications of Ampere's circuit law to obtain the magnetic field for solenoid and toroid.	L1	3	1-6, 11-12
xxix.	Explain curl, divergence and vector potential associated with a magnetic field.	L1	3	1-6, 11-12
xxx.	Obtain an expression for magnetic force on a point charge current carrying wire and between current elements.	L2	3	1-6, 11-12
xxxi.	Obtain an expression for torque on the current loop in a uniform magnetic field.	L2	3	1-6, 11-12
xxxii.	Higher order problems.	L3	2,3	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.				
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

Suggested Activities	
Activity No. 4	Design a simple parallel plate capacitor. Using different oils in the gap between two parallel plates, obtain the dielectric constant of the oils used. Compare its value with the literature value at least in the case of three liquids.
Activity No. 5	List the real-time applications where capacitors are used.

Electricity & Magnetism

Unit 3 - The Portion to be Covered

Magnetic Properties of Matter: Magnetic intensity (H), Magnetic induction (B), Magnetization vector (**M)**, Relation between **B, H, M**. Magnetic potential. Derivation of Magnetic intensity and magnetic potential due to dipole (magnet). Permeability and magnetic susceptibility. Types of magnetic materials, Hysteresis curve, retentivity, coercivity, importance of hysteresis on magnetic material (B-H loop). **(6 hours)**

Electromagnetic Theory: Faraday's laws of electromagnetic induction and Lenz's Laws. Energy stored in a Magnetic Field. Equation of continuity, displacement current, Maxwell's Equations: differential and Integral forms and their physical significance, Production of electromagnetic waves ,Transverse nature of electromagnetic radiation, General plane wave equation in free space, Hertz's experiment. **(7 Lectures)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
vii.	What is a magnetization vector, magnetic intensity, magnetic susceptibility and permeability?	L1	4	1-6, 11-12
viii.	Obtain relation between B, H and M.	L2	4	1-6, 11-12
ix.	What is a BH curve and explain the different types of magnetic materials on the nature of its BH curve?	L1	4	1-6, 11-12
x.	What are Faraday's and Lenz's Laws?	L1	5	1-6, 11-12
xi.	Obtain an expression for the energy stored in a magnetic field.	L2	5	1-6, 11-12
xii.	Explain the displacement current.	L1	5	1-6, 11-12
xiii.	Give the differential form of Maxwell's equation.	L2	5	1-6, 11-12
xiv.	Give the integral form of Maxwell's equation.	L2	5	1-6, 11-12
xv.	Give the physical sign of Maxwell's equation.	L2	5	1-6, 11-12
xvi.	Obtain a general plane wave equation in free space.	L1	5	1-6, 11-12

xvii.	Describe Hertz's experiment.	**L1**	**5**	**1-6, 11-12**
xviii.	Higher order problems.	**L3**	**4, 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.

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

Suggested Activities

Activity No. 5	Make a chart and list out the basic properties of magnets. List some devices that engineers have designed using magnets. List some everyday devices that use magnets.
Activity No. 6	Take 3 unknown materials and classify them based on their BH curve.
Activity No. 7	Construct a vertical AC electromagnet that can be momentarily switched on by a push button. Place a ring over the electromagnet, press the button, stand back and observe. Now try the rings of different metals. Measure roughly how high each ring jumps. Try to explain the underlying physics for the varied behaviour of the different rings. Build a small coil with insulated copper wire. Connect an ammeter micro/milli ammeter. Verify magnetic induction using a powerful bar magnet.
Activity No. 8	Demonstrate the working of the electrical Bell.

Electricity & Magnetism

Unit 4 - The Portion to be Covered

Electrical Circuits: State Kirchhoff's laws,Theory of growth and decay of current in RL circuit. Theory of charging and discharging of capacitor in RC circuit. Time constants of RL and RC circuits. Measurement of high resistance by leakage method. Definitions of average, peak and rms values of AC. AC circuits containing LR, CR and their responses (using j operator). Expressions for impedance, current & phase angle in series, LCR circuit using j operator. Concept of Series resonance &Parallel resonance (sharpness, half power frequency, quality factor, voltage magnification). Comparison between Series resonance & parallel resonance. De Sauty's Bridge. **(8 hours)**

Ballistic Galvanometer: Principle, Construction and working of BallisticGalvanometer. Derivation for current and time period of Ballistic galvanometer. Current, Voltage and Charge Sensitivity. Electromagnetic damping. Earth inductor, determination of B_H, B_v and angle of dip. Problems **(5hours)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
i.	State Kirchhoff's laws.	L1	6	1-6, 11-12
ii.	What is charging and discharging of capacitors? Explain how they are obtained.	L2	6	1-6, 11-12
iii.	Explain Complex reactance and impedance in a capacitor circuit.	L1	6	1-6, 11-12
iv.	With a schematic diagram, explain how time constant of RL and RC circuits are obtained.	L1	6	1-6, 11-12
v.	Give the circuit diagram of LCR circuits for both series and parallel circuits and explain how the resonance, power dissipation, quality factor and bandwidth are obtained for the same.	L2	6	1-6, 11-12
vi.	Give the construction and working of the Ballistic Galvanometer.	L2	7	1-6, 11-12
vii.	What is current and charge sensitivity of a Ballistic Galvanometer?	L2	7	1-6, 11-12
viii.	Higher order problems.	L3	6,7	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

Suggested Activities

Activity No. 9	Design a working model of an electrical oscillator which acts as a transmitter.
Activity No. 10	Design a working model of an electrical oscillator which acts as a receiver.
Activity No. 11	Model the earth's magnetic field with a diagram. Explain the effect of the tilt of the earth's axis and the reasons for the change in the tilt of the earth's axis over thousands of years.

Textbooks				
Sl No	**Title of the Book**	**Authors Name**	**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

References Books				
Sl No	**Title of the Book**	**Authors Name**	**Publisher**	**Year of Publication**
1	Electricity, Magnetism & Electromagnetic Theory	S. Mahajan and Choudhury	Tata Mc Graw-Hill Publishing Company Ltd, New Delhi	2012
2	Electricity and Magnetism	Edward M. Purcell	Tata Mc Graw-Hill Publishing Company Ltd, New Delhi	1986
3	Introduction to Electrodynamics(3rd Edition)	D.J. Griffiths Benjamin Cummings.	Prentice Hall	1998
4	Feynman Lectures Vol.2	R.P.Feynman, R.B.Leighton, M. Sands	Pearson Education	2008
5	Elements of Electromagnetics	M.N.O. Sadiku	Oxford University Press.	2010
6	Electricity and Magnetism	J.H.Fewkes&Yearwood. Vol. I,	Oxford University Press.	1991

Formative Assessment	
Assessment	**Marks**
C1: Internal Assessment	10
C1: REU Project	10
C2: Activity	10
C2: Presentation (Oral or Poster)	10
Total	40

List of Experiments to be performed in the Laboratory **Note:** Minimum EIGHT experiments have to be carried out.	
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.	Series and parallel resonance circuits (LCR circuits).
8.	Impedance of series RC circuits- determination of frequency of AC.
9.	Study the characteristics of a series RC and RL Circuit.
10.	Determination of self-inductance of a coil.
11.	Verification of laws of combination of capacitances and determination of unknown capacitance using De - Sauty bridge.
12.	Determination of B_H using Helmholtz double coil galvanometer and potentiometer.

OPEN-ELECTIVE SYLLABUS:

Year	I	**Course Code: 21BSC2O2PHY2**	**Credits**	03
Sem.	2	**Course Title:** OPTICAL INSTRUMENTS	**Hours**	40
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:.02 hrs.	

Unit No.	**Course Content**
Unit I	**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. **(10 hours)**
Unit II	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. (Expressions need not be derived, but have to be discussed qualitatively). **(10 hours)**
Unit III	**Camera and microscopes** Human eye (constitution and working), Photographic camera (principle, construction and working),construction, working and utilities of Simple microscopes, Compound microscope, Electron microscopes, Binocular microscopes **(10 hours)** **Self study** Experimental determination of magnifying power of a microscope. (Construction part can be discussed through block diagrams)
Unit IV	**Telescopes and Spectrometer** Construction, working and utilities of Astronomical telescopes

	Terrestrial telescopesReflecting telescopes,Construction, working and utilities of Eyepieces or Oculars (Huygen, Ramsden's, Gauss) Spectrometer - Construction, working and utilities, measurement of refractive index. **(10 hours)Self study** Telescopes used at different observatories in and outside India.Hydropower resources, hydropower technologies, environmental impact of hydro power sources. Carbon captured technologies, cell, batteries, power consumption
	Activities: 1) Find position and size of the image in a magnifying glass and magnification. 2) Observe rain bows and understand optics. 3) Create a rainbow. 4) Find out what makes a camera to be of good quality. 5) Observe the dispersion of light through prism. 6) Make a simple telescope using magnifying glass and lenses. 7) Learn principle of refraction using prisms. 8) Check bending of light in different substances and find out what matters here. 9) Learn about different telescopes used to see galaxies and their ranges. Many more activities can be tried to learn optics by going through you tubes and webistes such as https://spark.iop.org, http://www.yenka.com, https://publiclab.org etc.

Syllabus of III Semester Physics

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

Course Content Semester – III

Wave Motion and Optics

Course Title: Wave Motion and Optics	Course Credits:4
Total Contact Hours: 52	Duration of ESA: 3 hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60
Model Syllabus Authors: Physics Expert Committee	

Prerequisites

i.	Fundamentals of waves

Course Learning Outcomes

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

i.	Identify different types of waves by looking into their characteristics.
ii.	Formulate a wave equation and obtainthe expression for different parameters associated with waves.
iii.	Explain and give a mathematical treatment of the superposition of waves under different conditions, such as, when they overlap linearly and perpendicularly with equal or different frequencies and equal or different phases.
iv.	Describe the formation of standing waves and how the energy is transferred along the standing wave in different applications, and mathematically model in the case of stretchedstring and vibration of a rod.

v.	Give an analytical treatment of resonance in the case of open and closed pipes in general and Helmholtz resonators in particular.
vi.	Describe the different parameters that affect the acoustics in a building, measure it and control it.
vii.	Give the different models of light propagation and phenomenon associatedand measure the parameters likethe wavelength of light using experiments like Michelson interferometer, interference and thin films.
viii.	Explain diffraction due to different objects like singles slit, two slits, diffraction of grating, oblique incidence, circular aperture and give the theory and experimental setup for the same.
ix.	Explain the polarization of light and obtain how the polarization occurs due to quarter wave plates, half wave plates, and through theoptical activity of a medium.

Course Articulation Matrix

Mapping of Course Outcomes (CO) Program Outcomes

CourseOutcomes/ProgramOutcomes		1	2	3	4	5	6	7	8	9	10	11	12
i.	Identify different types of waves by looking into their characteristics.	X	X	X	X	X	X					X	X
ii.	Formulate a wave equation and obtainthe expression for different parameters associated with waves.	X	X	X	X	X	X					X	X
iii.	Explain and give a mathematical treatment of the superposition of waves under different conditions such as when they overlap linearly and perpendicularly with equal or different frequencies and equal or different phases.	X	X	X	X	X	X					X	X
iv.	Describe the formation of standing waves and how the energy is transferred along the standing wave in different applications, and mathematically model in the case of stretched string and vibration of a rod.	X	X	X	X	X	X					X	X
v.	Give an analytical treatment of resonance in the case of open and closed pipes in general and Helmholtz resonators in particular.	X	X	X	X	X	X					X	X
vi.	Describe the different parameters that	X	X	X	X	X	X					X	X

	affect the acoustics in a building,measure it and control it.												
vii.	Give the different models of light propagation and phenomenon associatedand measure the parameters likethe wavelength of light using experiments like Michelson interferometer, interference and thin films.	X	X	X	X	X	X					X	X
viii.	Explain diffraction due to different objects like singles slit, two slits, diffraction grating, oblique incidence, circular aperture and give the theory and experimental setup for the same.	X	X	X	X	X	X					X	X
ix.	Explain the polarization of light and obtain how the polarization occurs due to quarter wave plates, half wave plates, and through the optical activity of a medium.	X	X	X	X	X	X					X	X

Wave Motion and Optics

Unit – 1 -Waves and Superposition of Harmonic Waves

The Portion to be Covered

Waves: Plane and Spherical Waves. Longitudinal and Transverse Waves. Characteristics of wave motion, Plane Progressive (Travelling) Wave and its equation, Wave Equation – Differential form (derivation). Particle and Wave Velocities: Relation between them, Energy Transport – Expression for intensity of progressive wave, Newton's Formula for Velocity of Sound. Laplace's Correction (Derivation). **(6 Hours)**

Superposition of Harmonic Waves : Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies .Concept of Beats and its analytical treatment. Superposition of two perpendicular Harmonic Oscillations: Lissajous Figures with equal and unequal frequency- Analytical treatment. Uses of Lissajous' figures. Problems **(7 Hours)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
i.	Explain the difference between plane and spherical	**L2**	**1**	**1-6, 11-12**

	waves,longitudinal and transverse waves and give their characteristics.			
ii.	Write down an equation for the progressive wave in its differential form.	**L2**	**1**	**1-6, 11-12**
iii.	Obtain the relation between particle and wave velocity.	**L2**	**1**	**1-6, 11-12**
iv.	Obtain an expression for intensity of progressive waves.	**L2**	**1**	**1-6, 11-12**
v.	Obtain Newton's formula for the velocity of sound and discuss the factors for which sound velocity is dependent.	**L2**	**2**	**1-6, 11-12**
vi.	Apply the Laplace's correction to the equation of motion of a progressive wave.	**L2**	**2**	**1-6, 11-12**
vii.	With examples explain ripple and gravity waves.	**L1**	**2**	**1-6, 11-12**
viii.	Give the theory of superposition of two linear waves having equal frequencies and different frequencies.	**L2**	**3**	**1-6, 11-12**
ix.	Discuss the formation of different Lissajousfigures under different conditions of amplitude and frequency when they superimpose perpendicularly.	**L2**	**3**	**1-6, 11-12**
x.	Give some applications of an Lissajousfigures.	**L1**	**3**	**1-6, 11-12**
xi.	Higher order problems.	**L3**	**1,2,3**	**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-DirectedLearning 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

Suggested Activities

Activity No. 1	We know that sound is produced because of vibration. Look into at least 10 musical instruments and identify the regions of vibrations that produces the sound and those parts which enhances the sound because of reverberation. 1. Identify one common element in all of these. 2. Identify equipment's which creates beats and try to explain the underlying basic principles. Demonstrate the examples of beats using two tuning forks. 3. Identify what will happen when you drop a stone in a standing water,

	and when your drop two stones side by side. 4. Make your observations sketch them and comment on it in a report.
Activity No. 2	Draw two sine waves (Amplitude vs time) one shifted with other in phase. Identity where the resonation occurs for each phase shift. Plot phase vs time taken for resonance.
Activity No. 3	Take smooth sand, place a pointed edged pen vertically on the sand. To the mid of the pen, connect two perpendicular threads. Pull these perpendicular threads by varying the forces and timings. Note down the different shapes produced on the sand. Try to interpret the shapes. Make a report of it
Activity No. 4	Hang a pot with sand, which has a hole in the bottom. Gently pull the pot on one side and observe the pattern formed by the sand on the floor. Report the observations.
Activity No. 5	Design a coupled pendulum. Study the impact of the motion of one pendulum over the other pendulum by varying the length, direction of the motion of one pendulum and mass of pendulum and observe the resultant changes. Trace the path of the bobs and make a report.
Activity No. 6	**Note for the teachers for the activity:** Make 3 groups among students and assign each group the activity of drawing one of the 3 graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take a stretched spring. Stretch it across two edges. Put a weight on the string, pluck it and measure the amplitude of the vibration. All group will measure the total damping time of oscillating spring. (Using mobile or scale) And plot a graph of the- 1. Varying load on the spring and amplitude at the centre. 2. Take another weight and put that in another place and measure the amplitude of vibration at the centre. 3. Vary the load in the centre of the spring and measure the amplitude at the centre.

Wave Motion and Optics

Unit – 2 - Standing Waves and Acoustics

The Portion to be Covered

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 Pipes – Analytical treatment. Concept of Resonance, Theory of Helmholtz resonator. Problems **(7 Hours)**

Acoustics:

Concept of sound, properties of sound, Musical sound and noises, Characteristic of musical sound,Distingustion between music and noise ,Intensity and loudness of sound-decibels. Intensity level- musical note and scale.Acoustics of building: Reverberation and time of reverberation-absorption coefficient. Derivation of Sabine's formula. Measurement of reverberation time. Acoustic aspects of hall and auditorium.**Problems (6 Hours)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
i.	Discuss the Transverse waves produced in stretched string and obtain the expression for the same.	L2	3	1-6, 11-12
ii.	Give a qualitative treatment of vibration of a string when it's both ends are fixed and free.	L2	3	1-6, 11-12
iii.	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
iv.	Quantitatively bring about the mode of vibrations created in a rod.	L2	4	1-6, 11-12
v.	Explain types of waves that are produced in gas.Obtain an expression for the same.	L2	4	1-6, 11-12
vi.	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
vii.	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

viii.	Define Reverberation,Reverberation time and absorption coefficient of a material.	**L1**	**5**	**1-6, 11-12**
ix.	Obtain Sabine'sReverberation formula and discuss what are the factors on which the Reverberation timedepends on.	**L2**	**5**	**1-6, 11-12**
x.	List out which are different parameters within a building which effects the acoustics.	**L1**	**6**	**1-6, 11-12**
xi.	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**
xii.	Higher order problems.	**L3**	**4,5,6**	**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

Suggested Activities

Activity No. 7	List different phenomenon where standing waves are found in nature. Identify the phenomena and reason for standing waves. Also identify the standing waves in musical instruments. Make a report of it**.**
Activity No. 8	1. Go to 5 different newly constructed houses when they are not occupied and when they are occupied. Make your observations on sound profile on each room. Give the reasons. Make a report of it**.** 2. Visit three very good auditoriums, list out different ways in which the acousticarrangements 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. 9	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment.

	2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO4) solution. Place a small non oily floating material (ex: thin plastic) on the surface of the liquid. Drop a marble on the liquid at the centre of the bowl. Repeat the experiment by dropping the marble from the different heights. Plot a graph of- 1. Height v/s time of oscillation 2. Weight of the marble v/s time of oscillation
Activity No. 10	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take two 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

Wave Motion and Optics

Unit – 3 - Nature of light and Interference

The Portion to be Covered

Nature of light : Theories of light :- Newton's Corpuscular, Wave theory, Electromagnetic theory and Quantum theory of light.**(3 Hours)**

Interference of light by division of wave front: Huygens'sTheory-Concept of wave-front-Interference pattern produced on the surface of water-Coherence-Interference of light waves by division of wave-front- Young's double slit experiment- derivation of expression for fringe width-Fresnel Biprism- Interference with white light .Problems**(5 Hours)**

Interference of light by division of amplitude: Interference by division of amplitude-Interference by a plane parallel film illuminated by a plane wave-Interference by a film with two non-parallel reflecting surfaces- colour of thin films—Newton's rings due to reflected light and transmitted light -Michelson Interferometer-Determination of wavelength of light. Problems**(5 Hours)**

Topic Learning Outcomes **At the end of the topic, students should be able to:**				
SL No	**TLO's**	**BL**	**CO**	**PO**
i.	Explain using Michelson interferometer how to determine the wavelength of light.	**L2**	**7**	**1-6, 11-12**
ii.	Give an account of the different possible shapes that are obtained in Michelson interferometer experiment and their relevance.	**L2**	**7**	**1-6, 11-12**
iii.	Discuss the wave model and the Corpuscular model of light.	**L2**	**7**	**1-6, 11-12**
iv.	ExplainMaxwells electromagnetic waves.	**L2**	**7**	**1-6, 11-12**
v.	Give an account of the phenomenon of wave-particle duality.	**L1**	**7**	**1-6, 11-12**
vi.	Give the Huygens theory of wave-front.	**L1**	**7**	**1-6, 11-12**
vii.	DefineInterference.Give some examples of Interference.	**L1**	**7**	**1-6, 11-12**
viii.	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**
ix.	Explain how using personal biprism,a monochromatic coherent source of light is obtained.Using this experimental setup explain how the wavelength of monochromatic sources of light is determined.	**L2**	**7**	**1-6, 11-12**
x.	Give the theory of interference due to division of amplitude by parallel and non-parallel plates.	**L1**	**7**	**1-6, 11-12**
xi.	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**
xii.	Higher order problems.	**L3**	**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				
Suggested Activities				

Activity No. 11

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

Sl No	Phenomenon	Particle of Light	Wave Nature	Dual Nature
	Pinhole camera			
1.	Formation of images on lenses			
2.	Formation of images on mirror			
3.	Interference			
4.	Polarization			
5.	Diffraction due to single slit			
6.	Black body radiation			
7.	Photoelectric effect			
8.	De-Broglie hypothesis			
9.	Devison&Germer Experiment			

Activity No. 12

Why colour strips are seen in paddles on roads in rainy seasons try to simulate the same. Give the reasons. Make a report of it**.**

Activity No. 13

Note for the teachers for the activity: Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks.

1. The first slide will explain the process of doing the experiment.
2. In the second slide. Students will show the graph of measurement.
3. In the third slide, they will list three observations from that study.

Activity: Take a bowl of different liquids (water, milk, kerosene, salt water, Potassium Permanganate (KMNO4) solution. Place a small non-oily floating material (ex: thin plastic) on the surface of the liquid. Drop two marbles of same weight (mass) from the same height on to the surface of the water but at the different time intervals. Plot graph for the different observations.

For teachers: Demonstrate the formation of Lissajous Figure using a CRO. Give different shapes of Lissajous Figure with varying frequency and amplitude. Ask the students to comment on the observations.

Wave Motion and Optics

Unit – 4 - Diffraction and Polarisation

The Portion to be Covered

Fresnel Diffraction- Fresnel's Diffraction. Half Period Zone using rectilinear propagation of light. Zone plate: Construction, theory and working. Comparison between zone plate and convex lens.Problems.**(3 Hours)**

Fraunhofer diffraction : Fraunhofer's diffraction at single slit. Diffraction grating. Theory of plane transmission grating. Resolving power. Rayleigh's criteria. Resolving power of prism. Resolving power of telescope. Resolving power of grating (qualitative).**Problems (5 Hours)**

Polarisation:

Transverse nature of light waves- plane of vibration and plane of polarisation. Malu's law. Double refraction. Positive and negative plates. Retardation plates: Quarter wave plate and half wave plate. Polaroids and its types, Production of Circular and elliptical polarization, Optical Activity: Fresnel's Theory of optical activity. Specific rotation,Determination of specific rotation of sugar solution using polarimeter.**Problems(5 Hours)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
i.	DefineFraunhofer diffraction.	L2	8	1-6, 11-12
ii.	Give a qualitative treatment of single slit/diffraction double slit diffraction.	L2	8	1-6, 11-12
iii.	Explain the theory of diffraction due to grating and the normal and oblique incidence.	L2	8	1-6, 11-12
iv.	Explain how the resolving power of a grating depends of the number of slits used.	L2	8	1-6, 11-12
v.	Give the theory of Fresnel half period zones.	L2	8	1-6, 11-12
vi.	Discuss zone plates with respect to convex lenses.	L2	8	1-6, 11-12
vii.	Explain optical polarization and polaroid.	L2	9	1-6, 11-12
viii.	Give different types of polaroid.	L2	9	1-6, 11-12
ix.	Give the theory of phenomenon of double refraction and explain what are ordinary and extraordinary rays.	L2	9	1-6, 11-12
x.	Give the theory of quarter wave plates and half wave plates.	L2	9	1-6, 11-12
xi.	Explain optical activity with theory. Give an experimental method to measure the optical activity of a material.	L2	9	1-6, 11-12
xii.	Higher order problems.	L3	8,9	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	
Suggested Activities	
Activity No. 14	Explain polarization of light through a chart. List out the surfaces that reflect polarized light. Learn how polarization of light can be done by both transmission and reflection. Perform an experiment and make a report. USING CDs AND DVDs AS DIFFRACTION Gratings Ref:https://www.nnin.org/sites/default/files/files/Karen_Rama_USING_CDs_AND_DVDs_AS_DIFFRACTION_GRATINGS_0.pdf Obtain the diffraction spectra using a CD and design an experiment to find the distance between the tracks on it) (Ref: https://www.brighthubeducation.com/science-lessons-grades-9-12/39347-diffraction-experiment-measuring-groove-spacing-on-cds/, https://silo.tips/download/diffraction-from-a-compact-disk)
Activity No. 15	What is the physics behind making 3D movies? Group Discussion (https://www.slideserve.com/rae/physics-behind-3d-movies-powerpoint-ppt-presentation)Make a report of it**.**
Activity No. 16	List out different types of zone plates and look for their applications in day to day life. Make a report of it**.**
Activity No. 17	Collect information and study how optically polarizing lenses are made. Visit a nearby lens making facility. Learn the principle behind sunglasses.Make a report of it**.**
Activity No. 18	**Note for the teachers for the activity:** Make 3 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment.

	2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Identify any 3 sharp edges of varying thickness and assign them to 3 groups. Shine a laser light pointing towards the edge of the needle. Observe the patterns formed on the wall or screen and measure the distance between the bands. Correlate the distance between the bands formed with the thickness of the edge and the distance from the edge to the screen. By this, calculate the wavelength of the laser light used.

Textbooks

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

References Books

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

Formative Assessment

Assessment	Marks
Internal Assessment	20

REU based Group Activity (Conduct,Report,Presentation)	20
Total	40

List of Experiments to be performed in the Laboratory Note: Minimum Eight experiments has to be performed	
1.	Velocity of sound through a wire using Sonometer.
2.	Frequency of AC using Sonometer.
3.	Study of Lissajous' Figures using CRO.
4.	Determination of frequency of tuning fork by transverse vibration using Melde's apparatus.
5.	Helmholtz resonator using tuning fork.
6.	Helmholtz resonator using electrical signal generator.
7.	To determine refractive index of the Material of a prism using sodium source.
8.	To determine the R P of telescope, compare the R P with theoretical value by Two Wire gauze.
9.	To determine the dispersive power of a prism using mercury source.
10.	To determine the wavelength of sodium source using Michelson's interferometer.
11.	To determine wavelength of sodium light using Fresnel Biprism.
12.	To determine wavelength of sodium light using Newton's Rings
13.	To determine the thickness of a thin paper by measuring the width of the interference fringes produced by a wedge-shaped Film.
14	To determine wavelength of (1) Na source and (2) Spectral lines of Hg source using plane diffraction grating.
15	To determine dispersive power of a plane diffraction grating.
16	To determine resolving power of a plane diffraction grating.
17	To determine the specific rotation of sugar solution-using Laurent's half shade polarimeter.

Reference Book for Laboratory Experiments

Sl No	Title of the Book	Authors Name	Publisher	Year of Publication
1	Advanced Practical Physics for students	B.L. Flint and H.T. Worsnop	Asia Publishing House.	1971
2	A Text Book of Practical Physics	I. Prakash & Ramakrishna	Kitab Mahal, 11th Edition	2011
3	Advanced level Physics Practicals	Michael Nelson and Jon M. Ogborn	Heinemann Educational Publishers, 4th Edition	1985
4	A Laboratory Manual of Physics for undergraduate classes	D.P.Khandelwal	Vani Publications.	1985

OPEN ELECTIVE SUBJEST

Year	2	**Course Code: 21BSC3O3PHY3**	**Credits**	03
Sem.	3	**Course Title: CLIMATE SCIENCE**	**Hours**	40
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:.02 hrs.	

Unit No.	**Course Content**
Unit I	**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. (10 hours)
Unit II	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. **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). (10 hours)
Unit III	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. (10 hours)
Unit IV	**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. (10 hours)
	Activities to be carried out on Climate Science: 1. Try to find answer to the following questions: (a) Imagine you are going in a aircraft at an altitude greaten 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).

References:

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.

Syllabus of IV Semester Physics

Program Outcomes:	
13.	Disciplinary knowledge
14.	Communication Skills
15.	Critical thinking, Reflective thinking, Analytical reasoning, Scientific reasoning
16.	Problem-solving
17.	Research-related skills
18.	Cooperation/ Teamwork/ Leadership readiness/Qualities
19.	Information/ Digital literacy/Modern Tool Usage
20.	Environment and Sustainability
21.	Multicultural competence
22.	Multi-Disciplinary
23.	Moral and ethical awareness/Reasoning
24.	Lifelong learning / Self-Directed Learning

Course Content Semester – IV

Thermal Physics and Electronics

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

Prerequisites

viii.	Study of Pre-University

Course Learning Outcomes

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

vii.	Apply the laws of thermodynamics and analyzethe thermal system.
viii.	Apply the laws of kinetic theory and radiation laws to the ideal and practical thermodynamics systems through derived thermodynamic relations.
ix.	Use the concepts of semiconductors to describe different Semiconductor devices such as diode transistors, BJT, FET etc and explain their functioning.
x.	Explain the functioning of OP-AMPS and use them as the building blocks of logic gates.
xi.	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

CourseOutcomes/ProgramOutcomes		1	2	3	4	5	6	7	8	9	10	11	12
i	Apply the laws of thermodynamics and analyze the thermal system.	X	X	X	X	X	X					X	X
ii	Apply the laws of kinetic theory and radiation laws to the ideal and practical thermodynamics systems through derived thermodynamic relations.	X	X	X	X	X	X					X	X
iii	Use the concepts of semiconductors to describe different Semiconductor devices like diode transistors, BJT, FET etc and explain their functioning.	X	X	X	X	X	X					X	X
iv	Explain the functioning of OP-AMPS and them as the building blocks of logic gates.	X	X	X	X	X	X					X	X
v	Give the use of logic gates using different theorems of Boolean Algebra followed by logic circuits.	X	X	X	X	X	X					X	X

Thermal Physics and Electronics

Unit – 1

The Portion to be Covered

Laws of Thermodynamics:
Review of the concepts of Heat and Temperature. **(1 Hours)**
First Law of Thermodynamics: Differential form, Internal Energy. Equation of state for an adiabatic process, Work Done during Isothermal and Adiabatic Processes. **(2 Hours)**
Second Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Reversible and Irreversible processes with examples. Concept of Entropy, Change of Entropy in reversible and irreversible process, Refrigeration & coefficient of performance, T-S diagram, Second Law of Thermodynamics in terms of Entropy. Problems **(5 Hours)**
Third Law of Thermodynamics: Statement, Significance and Unattainability of Absolute Zero.
Heat Engines: Carnot engine, Otto and Diesel engines, Derivation for efficiency of Otto and Diesel engines. Applications of Carnot engine in locomotion, Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale. Problems**(5 Hours)**

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

SL No	TLO's	BL	CO	PO
i.	Explain the first law of thermodynamics.	L1	1	1-6,11-12
ii.	Give the differential form of the first law of thermodynamics and define what is the internal energy.	L2	1	1-6,11-12
iii.	Obtain an expression for work done in isothermal and adiabatic processes.	L2	1	1-6,11-12
iv.	Give two systems of units of temperature measurement and give their equivalence.	L2	1	1-6,11-12
v.	Describe and Discuss heat engine based on Carnot cycle.	L2	1	1-6,11-12
vi.	Explain how the efficiency of refrigeration is measured?	L2	1	1-6,11-12
vii.	Detail out the application of the Carnot engine to a locomotion system.	L1	1	1-6,11-12
viii.	Define entropy and write an expression for entropy using the second law of thermodynamics.	L2	1	1-6,11-12
ix.	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
x.	High Order Problems.	L3	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

Suggested Activities

Activity No. 1	I feel cold because coldness enters my body. Discuss the statement in day-to-day life. Approximately give examples of a) open system b) closed system and c) isolated system Discuss when the temperature of the body is locked until what time you hold the thermometer in contact with a body. Discuss it in contact with laws of thermodynamics.

	Discuss why when a person works or does exercise, he sweats. Reason it with the laws of thermodynamics.
Activity No. 2	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take 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:
Activity No. 3	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take ice cubes of different size and immerse in water and measure the temperature change with time and repeat the experiment. Graph the observations.

Thermal Physics and Electronics
Unit – 2
The Portion to be Covered
Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Properties and Applications. **(2 Hours)** **Maxwell's Thermodynamic Relations**: Derivations and applications of Maxwell's Thermodynamic Relations (1) First order Phase Transitions with examples, Clausius - Clapeyron

Equation (2) Values of Cp-Cv (3)Joule-Thomson Effect and Joule-Thomson coefficient and derive an equation for Vander Walls gas. Attainment of low temperature by liquefaction of gases and adiabatic demagnetization. Problems **(4 Hours)**

Kinetic Theory of Gases: Distribution of Velocities: Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas: Mean, RMS and Most Probable Speeds. Degrees of Freedom, Law of Equipartition of Energy. Specific heats of Gases. Problems **(4 Hours)**

Radiation: Blackbody radiation, spectral distribution, the concept of energy density and pressure of radiation, Wien's law, Wien's displacement law,Stefan-Boltzmann law, Rayleigh-Jeans law, and Planck's law of radiation. Problems**(3 Hours)**

Topic Learning Outcomes

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

SL No	TLO's	BL	CO	PO
i.	State Maxwell relations.	L1	2	1-6, 11-12
ii.	Give examples where Maxwells relations are used.	L1	2	1-6, 11-12
iii.	Explain the phase transition. Which is called as first order phase transition? Give Examples	L2	2	1-6, 11-12
iv.	State Clausius - Clapeyron Equation.	L1	2	1-6, 11-12
v.	Obtain an equation for difference in C_P - C_V.	L2	2	1-6, 11-12
vi.	State Joule-Thomson effect and Joule-Thomson coefficient.	L1	2	1-6, 11-12
vii.	Obtain an expression, giving the relation between pressure, volume and temperature for a real gas (Vander Waals gas).	L2	2	1-6, 11-12
viii.	Explain adiabatic demagnetization and how it is used to obtain low temperature by the liquidation of gases?	L2	2	1-6, 11-12
ix.	State Maxwell-Boltzmann Law of Distribution of Velocities in Ideal gases.	L1	2	1-6, 11-12
x.	Explain the mean RMS and most probable speeds in ideal gases.	L1	2	1-6, 11-12
xi.	Explain degrees of freedom associated with particles in an ideal gas?	L2	2	1-6, 11-12
xii.	Define the specific heat of a gas.	L1	2	1-6, 11-12
xiii.	Explain black body radiation and its spectral distribution.	L1	2	1-6, 11-12
xiv.	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
xv.	Define ultraviolet radiation catastrophe? Discuss its importance in the explanation of black body radiation.	L2	2	1-6, 11-12

xvi.	Define Planck's law of radiation and discuss how it could describe the whole black body radiation curve.	**L2**	**2**	**1-6, 11-12**
xvii	High Order Problems.	**L3**	**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

Suggested Activities

Activity No. 4	1. Measuring the Solar Constant Materials: Simple flat sided Jar and Thermometer. Activity: Bottle containing water is exposed to solar radiation. The rise in temperature and time taken are noted. Calculate the heat absorbed by water and relate it to the output of the Sun. 2. Thermo emf Materials: Suitable two dissimilar metal wires, voltage measuring device. Activity: In this experiment student will assemble the thermocouple and study the three effects namely, See beck, Peltier, and Thompson. 3. Inverse square law of radiation Materials: A cardboard with a grid, cardboard with a hole, supporting clips, a ruler, candle. 4. Activity: Students set the device. They count the lighted squares on the cardboard with the grid by varying the distance. And make necessary measurements and calculations to arrive at the inverse square law of radiation. Ref: Activity Based Physics Thinking Problems in Thermodynamics: Kinetic Theory http://www.physics.umd.edu/perg/abp/think/thermo/kt.htm
Activity No. 5	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement.

	3. In the third slide, they will list three observations from that study. **Activity:** Take two dissimilar metal wires. Spot weld them forming two junctions. Dip one junction in ice and heat the other junction with a burner. Plot a graph of time of heating v/s Thermo EFM generated in the voltmeter.
Activity No. 6	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 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:** Make 4 groups and give different-sized balloons to each group.Fit different-sized nozzles into the mouth of the large balloons. Measure the temperature or the EMF generated using a thermocouple placed at the mouth of the nozzle as the pressurised gas is released. Plot a graph of time v/s temperature. Vary the volume of the balloon and repeat the experiment. Plot the graph of volume v/s temperature difference created.

Thermal Physics and Electronics

Unit – 3

The Portion to be Covered

Semiconductor devices: Semiconductor and its types, doping, Intrinsic and Extrinsic semiconductors, semiconductor diode (p-n junction) and its V-I Characteristics (Forword & Reverse).

Rectifier: Rectifications, Half-wave rectifier, Full-wave rectifier-i) Full wave centre tap ii) Full wave Bridge(Qualitative). Comparison between them.

Filters: Capacitor filter, Inductor filter, LC filter, π - section filter(study of waveforms-qualitative),Comparison between them.

Zener diode:V-I Characteristics, Explanation of Zener Breakdown mechanism(Avalanche& Zener).Voltage regulator -Zener diode used as voltage regulator using unregulated DC voltage bridge rectifier.Problems**(6 hours)**

Junction Transistors: Basics of Bipolar Junction (BJT), types of transistors, construction and operation transistors, Transistor configuration , Common Base, Common Emitter and Common Collector Characteristics, h-parameters ofatransistor andtheirdetermination usingCEconfiguration,Transistor as an Amplifier (CE) with frequency response .

Feedback:-Feedback and types of feedback.

Oscillators:-Oscillators and its types, Essentials of a feedback LC oscillator. Hartley and Phase

shift oscillators, Comparison between amplifier and oscillator.
Field Effect Transistor (FET): FET-Types, characteristics and parameters, Relation between FET parameters. FET as a common source amplifier (Qualitative).Problems**(7hours)**

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

SL No	TLO's	BL	CO	PO
i.	DefineSemiconductors and Band Gap. Explain on what basis they are classified as intrinsic and extrinsic.	L2	3	1-6, 11-12
ii.	Define PN junction.Explain its functioning in forward and reverse bias.	L1	3	1-6, 11-12
iii.	Explain the approximation used in a real diode with respect to an ideal PN Junction?	L2	3	1-6, 11-12
iv.	With a schematic diagram, explain half wave and full wave rectifiers.	L1	3	1-6, 11-12
v.	Define a Zener diode and explain how it is different from an ordinary diode usingV-I curves?	L2	3	1-6, 11-12
vi.	With the schematic diagram, explain the working of voltage regulators of different types using a Zener diode.	L1	3	1-6, 11-12
vii.	Give the basic concepts used in the instruction of bipolar junction transistor and its operation.	L1	3	1-6, 11-12
viii.	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
ix.	Define FET? Give its characteristics.	L1	3	1-6, 11-12
x.	Explain how a transistor can be used as an amplifier and an oscillator using a circuit diagram.	L2	3	1-6, 11-12
xi.	High Order Problems.	L3	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

Suggested Activities	
Activity No. 7	a. Activity: Wire a DC power supply on a bread board or groove board to give a regulated output voltage of + 5 V; +15 V; Dual power output : ± 5 V; Dual power output : ± 15 V b. Use: 3-pin regulators c. Learn to identify the terminals of different types (packages) of BJTs. d. In the case of power transistors, learn how to fix a heat sink for the transistor. e. Understand the concept of virtual ground of an OP-AMP. f. Learn the different types of op-amps used for different applications. What is a buffer? Prepare a report on the application of buffers in instrumentation electronics. Seeing ½ wave of a full wave verification on a bread board.
Activity No. 8	(i)Learn to identify the terminals of different types (packages) of BJTs. (ii)In the case of power transistors, learn how to fix a heat sink for the transistor. (iii) Learn the difference between BJT and FET in its operational characteristics.
Activity No. 9	**Build your own Regulated DC power supply (5V)** Components required: 1.Step down transformer- 1 No. (5 V tapping, 100 – 500 mA current rating), BY 127 semiconductor diodes – 4 Nos, Inductor -1, Capacitor - 1, 3 pin 5V regulator-1 Wire a DC power supply on a bread board or groove board to give a regulated output voltage of + 5 V. Search for circuit diagram in books/net.
Activity No. 10	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Form 3 groups and tell them to make a DC supply of low current of different voltages like 5V, 10V, and 15V on a breadboard
Activity No. 11	**Note for the teachers for the activity:** Make 3-4 groups among students and assign each group the activity of drawing one of the graphs given below. Provide a few days to complete the activity. One the specific day, each group has to make a ppt presentation of the following three slides. One the day of the presentation select a member from each group randomly to make the presentation. Based on the work and

	presentation, teacher shall assign marks to each group, wherein all members of the group will get equal marks. 1. The first slide will explain the process of doing the experiment. 2. In the second slide. Students will show the graph of measurement. 3. In the third slide, they will list three observations from that study. **Activity:** Take any 3 diode and assign one to each group. Measure its resistance when dipped in ice and heating the ice till it boils. Using this data, plot calibration curve of temperature v/s resistance and also the cooling curve of temperature V/s time for the diode by each group.

Thermal Physics and Electronics

Unit – 4

The Portion to be Covered

Electronics: Integrated Circuits (Analog and Digital)and their types , Operational Amplifier: Block diagram of Op-Amplifier, symboland polarity convention, Characteristics of Op-Amp, Pin diagram of IC-741, Concept of virtual ground and summing point, Feedback concepts, Advantages of feedback, types of feedback, Expression for Gain; Op-Amp as a feedback amplifier– Non–Inverting and Inverting amplifier, Modification of input and output impedances with feedback; Differential amplifier with feedback;
Op-Amplifier Applications- Voltage Follower, Adder and Subtractor. Problems**(6 hours)**
Digital: Switching and Logic Levels, Digital Waveform. Number Systems: Decimal Number System, Binary Number System, Converting Decimal to Binary, Hexadecimal Number System: Converting Binary to Hexadecimal, Hexadecimal to Binary. Problems**(4 hours)**

Boolean Algebra Theorems: Digital Circuits: Logic gates, NOT Gate, AND Gate, OR Gate, NAND Gate,IC-7400 Pin diagram, NOR Gate, Algebraic Simplification, Implementation of NAND and NOR functions. Boolean algebra, Truth tables, De- Morgan's theorems.Problems**(3 hours)**

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

SL No	TLO's	BL	CO	PO
i.	Define op-amps and give the characteristics of an ideal op-amp.	L1	4	1-6, 11-12
ii.	Explains an inverting and non-inverting configuration of typical op-amps, with a schematic diagram.	L2	4	1-6, 11-12
iii.	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
iv.	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
v.	Give different digital wave forms and explain how one can	L1	5	1-6, 11-12

	visualize the switching and logic levels.			
vi.	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**
vii.	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**
viii.	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**
ix.	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**
x.	Why are X-NOR gates called Universal Gates?	**L2**	**5**	**1-6, 11-12**
xi.	High Order Problems.	**L3**	**4, 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

Suggested Activities

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	**Operational Amplifiers** (i)Understand the concept of virtual ground of an OP-AMP. (ii)Learn the different types of op-amps used for different applications. (iii)What is a buffer? Prepare a report on buffers and its application in instrumentationelectronics.
Activity No. 14	**Activity**A man has to take a wolf, a goat, and some cabbage across a river. His rowboat has enough room for the man plus either the wolf or the goat or the cabbage. If he takes the cabbage with him, the wolf will eat the goat. If he takes the wolf, the goat will eat the cabbage. Only when the man is present are the goat and the cabbage safe from their enemies. All the same, the man carries

	wolf, goat, and cabbage across the river. How? Write the truth table for the above story and implement using gates. **Activity**A locker has been rented in the bank. Express the process of opening the locker in terms of digital operation. **Activity** A bulb in a staircase has two switches, one switch being at the ground floor and the other one at the first floor. The bulb can be turned ON and also can be turned OFF by and one of the switches irrespective of the state of the other switch. The logic of switching of the bulb resembles.

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

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

Formative Assessment	
Assessment	**Marks**
Internal Assessment	20
REU based Group Activity (Conduction, Report, Presentation)	20
Total	40

List of Experiments to be performed in the Laboratory **Note:** Minimum Eight experiments to be carried out	
1.	Mechanical Equivalent of Heat, J by Electrical method.
2.	Coefficient of thermal conductivity of Copper by Searle's apparatus.
3.	Coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
4.	Determination of Stefan's constant/ Verification of Stefan's law.

5.	Variation of thermo-emf across two junctions of a thermocouple with temperature.
6.	Verification of Clausius –Clapeyron equation and determination of specific enthalpy.
7.	V-I Characteristics of Silicon & Germanium PN Junction diodes (FB & RB)
8	Full -Wave bridge Rectifier Without Filter(internalresistance andvoltage regulation).
9	Full- Wave Rectifier bridge with π section Filter(internalresistance andvoltage regulation).
10.	Zenerdiode asvoltage regulatorusingbridge rectifierpowersupply.
11.	H- Parameter of transistor.
12.	Frequency response of CE Amplifier
13.	FET-staticcharacteristics and parameters.
14.	Frequency response of FET Amplifier.
15.	Non-inverting and Inverting using op-amp circuits.
16.	Adder and Subtractor using op-amp circuits.
17.	Realization of basic gates using NAND gate.
18.	Verification Boolean Algebra using NAND gate using IC-7400.
19.	Verification of De -Morgan's laws using IC-7400.

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

OPEN ELECTIVE PAPER

Year	2	**Course Code: 21BSC4O4PHY4**	**Credits**	03
Sem.	4	**Course Title: ELECTRICAL INSTRUMENTS**	**Hours**	40
Formative Assessment Marks: 40		Summative Assessment Marks: 60	Duration of ESA:.02 hrs.	
Unit No.		**Course Content**		
Unit I		**Voltage and current sources**, Kirchoff's current and voltage laws, loop and nodal analysis of simple circuits with dc excitation. Ammeters,voltmeters: (DC/AC) **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 . **(10 Hours)**
Unit II	**Instrument Transformers**: Potential and current transformers, ratio and phase angle errors, phasor diagram, methods of minimizing errors; testing and applications. **Galvanometers:** General principle and performance equations of D'Arsonval Galvanometers, Vibration Galva nometer and Ballistic Galvanometer. **Potentiometers:** DCPotentiometer, Crompton potentio meter, construction, standardization, application. AC Potentio meter, Drysdalepolarpotentio meter; standardization, application. **(10 Hours)**
Unit III	**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. **Transducer:** Strain Gauges, Thermistors, Thermocouples, Linear Variable Differential Transformer (LVDT), Capacitive Transducers, Peizo-Electric transducers, Optical Transducer, Hall Effect Transducer . **(10 Hours)**
Unit IV	**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. **Basics of lead acid batteries**, Lithium Ion Battery , Battery storage capacity, Coulomb efficiency, Numerical of high and low charging rates, Battery sizing. **(10 Hours)**
Activity No. 1	Identify variety of electrical switches and note down their applications/utility.
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.
Activity No. 3	Make a study of importance of grounding in electrical circuits.
Activity No. 4	Prepare a detailed account of various methods of earthing and their utility/applications
Activity No. 5	Prepare a document on evolution of incandescent bulbs to the present day LED lights
Activity No.6	Make a comparative study of Fuses, MCB, ELCB and Relays highlighting their use and applications
	Tex Books
	AK.Sawhney, ACourseinElec.&Electronics Measurements&Instrumentation **,Dhanpatrai& Co. 1978**
	A.D. Helfrick& W.D. Cooper, Modern Electronic Instrumentation and Measurement Techniques **PHI,2016**
	Reference Books
	D C Kulshreshtha, Basic Electrical Engineering, McGraw Hill Publications,**2019**
	David G Alciatore and Michel B Histand, Introduction to Mechatronics and Measurement Systems, 3rd, Tata McGraw Hill Education Private Limited, New Delhi., 2005
	1. Vincent Del Toro, Electrical Engineering Fundamentals Prentice Hall India**2009**

List of Experiments to be performed in the Laboratory

Sl No	Experiments	
1	Introduction to Lab Equipment	
2	Voltmeter Design	
3	Ammeter Design	
4	Ohmmeter Design	
5	Multimeter Design	
6	Measurement of Resistance using Wheatstone Bridge	
7	Measurement of Capacitance using Schering Bridge	
8	Measurement of Inductance using Maxwell Bridge	
9	Measurement of Light Intensity	
10	Measurement of Temperature	
	Reference Book for Laboratory Experiments	
	AK.SawhneyACourseinElec.&Electronics Measurements&Instrumentation:	
	Helfrick& Cooper, Modern Electronic Instrumentation and Measurement Techniques:	

Question Paper Pattern:

RANI CHANNAMMA UNIVERSITY
Department of PHYSICS

I /II/III/IV Semester B.Sc.

Sub: **Code:** **Maximum Marks: 60**

Q.No.1.	**Answer any Six Questions** ***(Two question from Each Unit to be asked)*** **a.** **b.** **c.** **d,** **e.** **f.** **g.** **h.**	**6X2=12**
Q.No.2.	**(Questions from Unit-I)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.3.	**(Questions from Entire Unit-II)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.4.	**(Questions from Unit-III)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.5.	**(Questions from Unit-IV)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**

Note:

i. There should be a problem carrying 4 marks from each unit and may be asked in either b or d in questions 2 to 5.

ii. If necessary, sub questions a and c from 2 to 5 may be subdivided in to i. and ii. Without exceeding maximum 08 marks.

RANI CHANNAMMA UNIVERSITY, BELAGAVI

PROGRAM /COURSE STRUCTURE AND SYLLABUS

Of

PHYSICS

as per the Choice Based Credit System (CBCS) designed in accordance with
Learning Outcomes-Based Curriculum Framework (LOCF)
of National Education Policy (NEP) 2020
for

Bachelor of Science (Physics)

V and VI Semester

(Two major system)

w.e.f.

Academic Year 2023-24 and onwards

ROGRAM STRUCTURE

Curricular and Credits Structure of Physics as one of the two majors for the V and VI semester Physics B.Sc. Undergraduate Programme with effect from 2023-24.

SEMESTER-V										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Physics as Major Discipline										
DSC5	21BSC5C5PHY1L	Classical Mechanics-I and Quantum Mechanics-I	40	60	100	4	-	-	4	2
	21BSC5C5PHY1P	Classical Mechanics-I and Quantum Mechanics-I Practical	25	25	50	-	-	4	2	3
DSC6	21BSC5C5PHY2L	Elements of Atomic, Molecular and Laser Physics	40	60	100	4	-	-	4	2
	21BSC5C5PHY2P	Elements of Atomic, Molecular and Laser Physics Practical	25	25	50	-	-	4	2	3
DSC7	Another Department Code as a second Major Subject	Another Department Major Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
DSC8	Another Department Code as a second Major Subject	Another Department Major Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
SEC3	21BSC5SEC3	Employability Skills: Electrical Circuits and Network Skills	25	25	50	2	-	2	3	-
Total Marks					**650**	**Semester Credits**			**27**	

SEMESTER-VI										
Category	**Course code**	**Title of the Paper**	**Marks**			**Teaching hours/week**			**Credit**	**Duration of exams (Hrs)**
			IA	**SEE**	**Total**	**L**	**T**	**P**		
Physics as Major Discipline										
DSC9	21BSC6C6PHY1L	Elements of Condensed Matter & Nuclear Physics	40	60	100	4	-	-	4	2
	21BSC6C6PHY1P	Elements of Condensed Matter & Nuclear Physics Practical	25	25	50	-	-	4	2	3
DSC10	21BSC6C6PHY2L	Electronic Instrumentation & Sensors	40	60	100	4	-	-	4	2
	21BSC6C6PHY2P	Electronic Instrumentation & Sensors Practical	25	25	50	-	-	4	2	3
DSC11	Another Department Code as a second Major Subject	Another Department Major Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
DSC12	Another Department Code as a second Major Subject	Another Department Major Course Title	40	60	100	4	-	-	4	2
			25	25	50	-	-	4	2	3
INT	21BSC6IN1PHYIN	Internship / Mini Research Project	-	-	50	3 to 4 weeks			2	Report & Presentation
Total Marks					**650**	**Semester Credits**			**26**	

SEMESTER - V

Program Name	BSc in Physics	**Semester**	V
Course Title	Classical Mechanics and Quantum Mechanics- I **(Theory)**		
Course Code	21BSC5C5PHY1L	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	02 Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

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

- Identify the failure of classical physics at the microscopic level.
- Find the relationship between the normalization of a wave function and the ability to correctly calculate expectation values or probability densities.
- Explain the minimum uncertainty of measuring both observables on any quantum state.
- Describe the time-dependent and time-independent Schrödinger equation for simple potentials like for instance one-dimensional potential well and Harmonic oscillator.
- Understand the concept of tunnelling.

Contents	**60 Hrs**
UNIT I **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 conservative 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. Newton's equation of motion from Lagrange equations, simple pendulum, Atwood's machine and linear harmonic oscillator. **12 Hours** **Activities: 03 Hours**	15
UNIT II **Relativity:** Newtonian principle of relativity. Non-Inertial Systems: Non-inertial frames and fictitious forces. Uniformly rotating frame. Special Theory of Relativity: Michelson-Morley Experiment and its outcome. Postulates of Special Theory of Relativity. Lorentz Transformations. Simultaneity and order of events. Lorentz contraction. Time dilation. Relativistic transformation of velocity, frequency and wave number. Relativistic addition of velocities. Variation of mass with velocity. Massless Particles. Mass energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics. Transformation of Energy and Momentum. . **12Hours** **Activities: 03 Hours**	15

UNIT III **Introduction to Quantum Mechanics** Brief discussion on failure of classical physics to explain black body radiation, Photoelectric effect, Compton effect, stability of atoms and spectra of atoms. Compton scattering: Expression for Compton shift (With derivation). Matter waves: de Broglie hypothesis of matter waves, Electron microscope, Wave description of particles by wave packets, Group and Phase velocities and relation between them, Experimental evidence for matter waves: Davisson- Germer experiment, G.P Thomson's experiment and its significance. Heisenberg uncertainty principle: Elementary proof of Heisenberg's 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, why electron cannot exist in nucleus? Two-slit experiment with photons and electrons. Linear superposition principle as a consequence. **12 Hours** **Activities: 03 Hours**	15
UNIT IV Foundation of Quantum Mechanics Probabilistic interpretation of the wave function - normalization and orthogonality of wave functions, Admissibility conditions on a wave function, Schrödinger equation: equation of motion of matter waves - Schrodinger wave equation for a free particle in one and three-dimension, time-dependent and time-independent wave equations, Probability current density, equation of continuity and its physical significance, Postulates of Quantum mechanics: States as normalized wavefunctions. Applications of Schrodinger's equation – for free particle, particle in one dimensional box-derivation of Eigen values and Eigen function for infinite and finite potential well. Tunnelling. Transmission across a potential barrier, the tunnelling effect. Scanning tunnelling microscope (STM). Development of Schrodinger's equation for One dimensional Linear harmonic oscillator. Concept of zero - point energy **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.

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.

PRACTICAL

Course Title	Classical Mechanics and Quantum Mechanics- I **(Practical)**	**Practical Credits**	02
Course Code	21BSC5C5PHY1P	**Contact Hours**	04 Hours
Formative Assessment	25 Marks	**Summative Assessment**	25 Marks

Contents

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) To study the spectral characteristics of a photo-voltaic cell (Solar cell).

9) Determination of electron charge ‘e’ by Millikan’s Oil drop experiment.

10) To study the characteristics of solar cell.

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

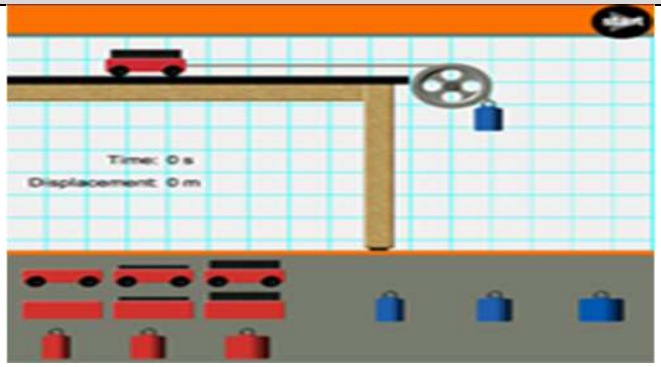
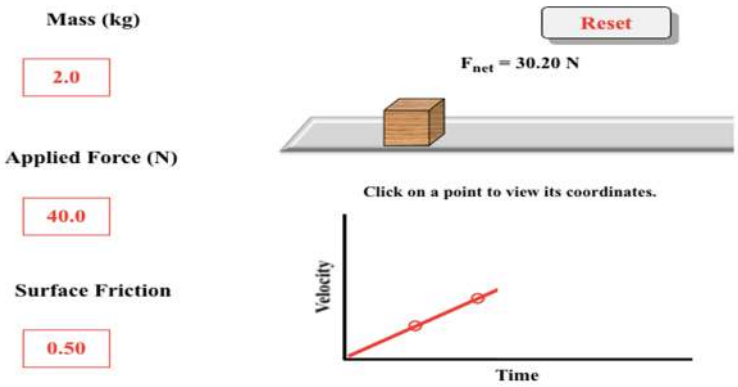
12) To determine the value of e/m for an electron by magnetron method.

13) To study the tunnelling in Tunnel Diode using I-V characteristics.

14) Determination of quantum efficiency of Photodiode.

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

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	
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 **photodetectors** 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 $p = \frac{h}{\lambda}$ **3.** Create a line of best fit through the points in the plot $\frac{1}{\Delta p_x}$ against Δx and find its slope. How this exercise is related to Heisenberg Uncertainty principle. Make a report of the observations.
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 effect for an EM radiation, when incident on a zinc metal surface. 2. Determine the target material if the threshold frequency of EM radiation is 5.5×10^{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 3×10^{15}Hz. **4.** What should be the stopping potential for photoelectrons if the target Material used is Platinum and incident frequency is 2×10^{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 this link https://www.compadre.org/PQP/quantum-need/section5_9.cfm Students can take up the exercises using the link which is as follows https://www.compadre.org/PQP/quantum-need/prob5_11.cfm

	Six different classical wave packets are shown in the animations. Which of the wave packets have a phase velocity that is: greater than / less than / equal to the group velocity? Make a report of the observations.
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 $n \rightarrow \infty$? Why? c) What do you notice about the values of $\langle p \rangle$ and $\langle p^2 \rangle$ as you vary n? Make a report of the calculations.
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 box using Physlet@Quantum Physics: The link to the visualization tool for the calculation is as follows https://www.compadre.org/PQP/quantum-theory/prob6_3.cfm A particle is in a one-dimensional box of length L = 1. The states shown are normalized. The results of the integrals that give $\langle x \rangle$ and $\langle x^2 \rangle$, and $\langle p \rangle$ and $\langle p^2 \rangle$. You may vary n from 1 to 10. a. For n = 1, what are Δx and Δp? b. For n = 10, what are Δx and Δp?

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.

SEMESTER - V

Program Name	BSc in Physics	**Semester**	V
Course Title	Elements of Atomic, Molecular & Laser Physics (Theory)		
Course Code	21BSC5C5PHY2L	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	02 Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

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

- Describe atomic properties using basic atomic models.
- Interpret atomic spectra of elements using vector atom model.
- Interpret molecular spectra of compounds using basics of molecular physics.
- Explain laser systems and their applications in various fields.
- Learn the importance of Statistical mechanics and different distribution functions.

Contents	**60 Hours**
UNIT I **Basic Atomic models** Thomson's atomic model; Rutherford atomic model – Model, Theory of alpha particle scattering, Rutherford scattering formula; Bohr atomic model – postulates, Derivation of expression for radius, total energy of electron; Origin of the spectral lines; Spectral series of hydrogen atom; Effect of nuclear motion on atomic spectra - derivation; Ritz combination principle; Correspondence principle; Critical potentials – critical potential, excitation potential and ionisation potential; Atomic excitation and its types, Franck-Hertz experiment; Sommerfeld's atomic model – model, Derivation of condition for allowed elliptical orbits. **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 critical, excitation and ionisation potentials of different elements and plot the graph of critical /excitation / ionisation potentials versus atomic number/mass number/neutron number of element. Analyze the nature of the graph and draw the inferences.	15
UNIT II **Vector atomic model and optical spectra** Vector atom model – model fundamentals, spatial quantization, spinning electron; Quantum numbers associated with vector atomic model; Optical spectra – spectral terms, spectral notations, selection rules. Spin-orbit coupling/Spin-Orbit Interaction (qualitative). Coupling schemes – L-S and j-j schemes; Pauli's exclusion principle; Magnetic dipole moment due to orbital motion of electron – derivation; Magnetic dipole moment due to spin motion of electron; Stern-Gerlach experiment –	15

Experimental arrangement and Principle; Fine structure of spectral lines with examples. Zeeman effect: Experimental study, Types: normal and anomalous Zeeman effect, Quantum theory of normal Zeeman effect. Energy level diagram for Sodium-D lines. Paschen back effect and Stark effect (qualitative). Lande g-factor and its calculation for different states **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 construct vector diagrams for each resultant. Analyze the coupling results and 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 plot the graph of dipole moment versus total orbital angular momentum "J'. Analyze the nature of the graph and draw the inferences.	
UNIT III **Molecular Physics** Types of molecules based on their moment of inertia; Types of molecular motions: Rotational and Vibrational motions and energies. Microwave Spectra: Theory of rigid rotator – energy levels and spectrum. Infra-Red Spectra: Theory of vibrating molecule as a simple harmonic oscillator – energy levels and spectrum. Raman effect – Stoke's and anti-Stoke's lines, characteristics of Raman spectra, classical and quantum theory of Raman effect. Experimental set up of Raman Effect. Applications of Raman effect. **Laser Physics** Interaction of radiation with matter: Induced absorption, spontaneous emission and stimulated emission. Einstein's A and B coefficients – Derivation of relation between Einstein's coefficients and radiation energy density; Condition for amplification of light; Population inversion; Methods of pumping; Requisites of laser – energy source, active medium and laser cavity; Three level energy diagram. Construction and Working principle of Ruby Laser. Characteristics of laser light and its applications. **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 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. 3. 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. 4. 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

UNIT IV **Statistical Mechanics** Concepts of thermodynamic ensembles (micro-canonical, canonical and grand canonical ensembles). Phase Space- Micro state & Macro state. Thermodynamic probabilities. Maxwell- Boltzmann Statistics. Derivation for Maxwell- Boltzmann distribution function. Limitations of Maxwell- Boltzmann Statistics. Concepts of Bosons and fermions. Bose-Einstein Statistics. Derivation for Bose-Einstein distribution function. Fermi-Dirac Statistics. Derivation for Fermi-Dirac distribution function. Comparison of Maxwell- Boltzmann Statistics, Bose-Einstein Statistics, Fermi-Dirac Statistics.	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.

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.
8	1) Statistical Mechanics, An Introduction, **Evelyn Guha**, Narosa (**2008**) 2) Statistical Mechanics, ***R.K.Pathria***, 2nd edition, Pergamon Press (**1972**) 3) Statistical and Thermal physics, ***F.Reif***, McGraw Hill International(**1985**) 4) Statistical Mechanics, ***K.Huang***, Wiley Eastern Limited, New Delhi (**1975**). 5) Fundamentals of Statistical Mechanics: B. B. Laud, New Age International Publishers, 2nd Edn.

PRACTICAL

Course Title	Elements of Atomic, Molecular & Laser Physics (Practical)	**Practical Credits**	02
Course Code	21BSC5C5PHY2P	**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. Photoconductive cell characteristics
4. Photovoltaic Cell characteristics
5. To determine wavelength of spectral lines of mercury source using spectrometer.
6. To determine the value of Rydberg's constant using diffraction grating and hydrogen discharge tube.
7. To determine the wavelength of H-alpha emission line of Hydrogen atom.
8. To determine fine structure constant using fine structure separation of sodium D-lines using a plane diffraction grating.
9. To determine the value of e/m by Magnetic focusing or Bar magnet.
10. To determine the ionization potential of mercury.
11. To setup the Millikan oil drop apparatus and determine the charge of an electron.
12. To determine the absorption lines in the rotational spectrum of Iodine vapour.
13. To determine the force constant and vibrational constant for the iodine molecule from its absorption spectrum.
14. Characteristics of Laser Diode
15. To determine the wavelength of laser using diffraction by single slit/double slits.
16. To determine wavelength of He-Ne laser using plane diffraction grating.
17. To determine angular spread of He-Ne laser using plane diffraction grating.
18. To determine angular spread of He-Ne laser using plane diffraction
19. Study of Raman scattering by CCl_4 using laser and spectrometer/CDS.

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

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

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.

Employability skills

Program Name	BSc in Physics	**Semester**	VI
Course Title	Electrical Circuits and Network Skills (Theory)		
Course Code:	21BSC5SEC3	**No. of Credits**	03
Contact Hours	45 Hours	**Duration of SEA/Exam**	2 Hours
Formative Assessment Marks	25	**Summative Assessment Marks**	25

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

- Understand the fundamental concepts of electrical circuits and networks.
- Analyze the behavior of a simple electrical circuit.
- Design a circuit to meet a specific set of requirements.
- Apply the principles of electrical circuits and networks to solve real-world problems.
- Troubleshoot an electrical circuit that is not working properly.
- Analyze the behavior of an electrical network.
- Communicate effectively about electrical circuits and networks to both technical and non-technical audiences.

Contents	**45 Hours**
Basic Electricity Principles: Voltage, Current, Resistance, and Power. Ohm's law. Series, parallel, and series-parallel combinations. AC Electricity and DC Electricity. Familiarization with multimeter, voltmeter and ammeter. **Understanding Electrical Circuits**: Main electric circuit elements and their combination. Rules to analyze DC sourced electrical circuits. Current and voltage drop across the DC circuit elements. Single-phase and three-phase alternating current sources. Rules to analyze AC sourced electrical circuits. Real, imaginary and complex power components of AC source. Power factor. Saving energy and money. **Electrical Drawing and Symbols**: Rules for electrical drawing. Drawing symbols. Blueprints. Reading Schematics. Ladder diagrams. Electrical Schematics. Power circuits. Control circuits. Reading of circuit schematics. Tracking the connections of elements and identify current flow and voltage drop. **Generators and Transformers**: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Transformers: Step-up and step-down transformer: principle, design and fabrication. **Electric Motors**: Single phase and three phase AC motor, DC motors, BLDC motor, Capacitor Coupling, AC regulator, Interfacing DC or AC sources to control motors. RPM and Power Consumption of AC motors..	

Electrical Protection: Grounding and isolation, Phase reversal, Surge protection, Fuses and disconnect switches, Circuit breakers, Overload Devices. Relay, Timer relay, Voltage controller, Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device) **Solid-State Devices**: Resistors, inductors and capacitors. Diode and rectifiers. Components in Series or in shunt. Response of inductors and capacitors with DC or AC sources **Electrical Wiring**: Different types of conductors and cables. Basics of wiring-Star and delta connection. Voltage drop and losses across cables and conductors. Instruments to measure current, voltage, power in DC and AC circuits. Insulation. Solid and stranded cable. Conduit. Cable trays. Splices: wirenuts, crimps, terminal blocks, split bolts, and solder. Preparation of extension board. **Reference Books:** 1. A text book in Electrical Technology - B L Theraja - S Chand & Co. 2. A text book of Electrical Technology - A K Theraja 3. Performance and design of AC machines - M G Say ELBS Edn.	
Practicals: **1**. Verification of Ohms law. 2. Verification of Millman's theorem. 3. IV characteristics of a solid-state relay. 4. Capacitor coupled power supply. 5. Load regulation and line regulation of an SMPS Power Supply. 6. TE model characterization using Peltier Cooler 7. Voltage controller using a 3 pin IC 8. IV characteristics of a buck boost converter 9. Monostable multivibrator using IC 555 10. LDR characteristics	

Note: It is the discretion of teacher to combine theory and practical in 45 hrs**.** Some topics can be covered by inviting experts in the field, e.g., electricians and motor winding experts.

SEMESTER - VI

Program Name	BSc in Physics	**Semester**	VI
Course Title	Elements of Condensed Matter & Nuclear Physics (Theory)		
Course Code	21BSC6C6PHY1L	**No. of Credits**	4
Contact Hours	60 Hours	**Duration of SEA/Exam**	3 Hours
Formative Assessment Marks	40	**Summative Assessment Marks**	60

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

- Explain the basic properties of nucleus and get the idea of its inner information.
- Understand the concepts of binding energy and binding energy per nucleon v/s mass number graph.
- Describe the processes of alpha, beta and gamma decays based on well-established theories.
- Explain the basic aspects of interaction of gamma radiation with matter by photoelectric effect, Compton scattering and pair production.
- Explain the different nuclear radiation detectors such as ionization chamber, Geiger-Mueller counter etc.
- Explain the basic concept of scintillation detectors, photo-multiplier tube and semiconductor detectors.

Contents	**60 Hours**
UNIT I **Crystal systems and X-rays:** Crystal structure**:** Space Lattice, Lattice translational vectors, Basis of crystal structure, Types of unit cells, primitive, non-primitive cells.. Seven crystal system, Coordination numbers, Miller Indices, Expression for inter planner spacing. **X Rays**: Production and properties of X rays, Coolidge tube, Continuous and characteristic X-ray spectra; Moseley's law. **X-Ray diffraction**, Scattering of X-rays, Bragg's law. **Crystal diffraction:** Bragg's X-ray spectrometer- powder diffraction method, Intensity vs 2θ plot (qualitative). **Free electron theory of metals:** Classical free electron model (Drude-Lorentz model), expression for electrical and thermal conductivity, Weidman-Franz law, Failure of classical free electron theory; Quantum free electron theory, Fermi level and Fermi energy, Fermi-Dirac distribution function (expression for probability distribution F(E), statement only); Fermi Dirac distribution at T=0 and $E<E_f$, at $T\neq 0$ and $E>E_f$, F(E) vs E plot at T = 0 and $T\neq 0$. Density of states for free electrons (statement only, no derivation). Qualitative discussion of lattice vibration and concept of Phonons.; Specific heats of solids: Classical theory, Einstein's and Debye's theory of specific heats. Hall Effect in metals. **12 HOURS** **ACTIVITIES: 03 HOURS**	15
UNIT II **Magnetic Properties of Matter** Magnetic susceptibility (χ), magnetization (M), Classification of Dia, Para, and ferro magnetic materials; Langevin theory of diamagnetism. Langevin Classical and Quantum Theory of Paramagnetism. Curie's law, Ferromagnetism and Ferromagnetic Domains (qualitative). Discussion of M-H Curve. Hysteresis and Energy Loss, Hard and Soft magnetic materials.	15

Dielectric Materials: Static dielectric constant, Types of polarization (electronic, ionic and orientation), calculation of Lorentz field (derivation), Clausius-Mosotti equation (derivation), dielectric loss. Piezo electric effect, cause, examples and applications. **Superconductivity:** Definition, Experimental results – Zero resistivity and Critical temperature– The critical magnetic field – Meissner effect, Type I and type II superconductors. **Thermoelectricity:** Thermoelectric effect: Peltier and Seebeck effects. Principle of thermocouple. **12 Hours** **ACTIVITIES: 03 Hours**	
UNIT III **General Properties of Nuclei**: Constituents of nucleus and their intrinsic properties, quantitative facts about mass, radii, charge density (matter density), binding energy, main features of binding energy versus mass number curve, angular momentum, parity, magnetic moment, electric moments **Radioactivity decay:** Radioactivity: definition of radioactivity, half-life, mean life, radioactivity equilibrium **(**a) Alpha decay: basics of α-decay processes, theory of α decay (Gamow theory). Geiger-Nuttall law. (b) β-decay: energy kinematics for β-decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays' emission & kinematics, internal conversion (Definition). **12 Hours** **ACTIVITIES: 03 Hours**	15
UNIT IV **Interaction of Nuclear Radiation with matter**: Gamma ray interaction through matter, photoelectric effect, Compton scattering, pair production (qualitative). **Nuclear models:** liquid drop model: explanation of semiempirical formula. Explanation of nuclear fission on the basis of liquid drop model. **Nuclear power reactors:** Controlled chain reaction. Nuclear reactor and brief explanation of its components, types of reactors: fast breeder reactor, heavy water reactor and research reactor. **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). **Accelerators:** Linear accelerators and Cyclotrons. Elementary particles: Classification of elementary particles. Concept of Quark model. **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 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.

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,Pragati prakashan Meerut(2017).
3. Introductory nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
4. Nuclear Physics, Irving Kaplan, Narosa Publishing House
1. Introduction to solid State Physics, ***Charles Kittel***, VII edition, (**1996**)
5. Solid State Physics- **A J Dekker**, MacMillan India Ltd, (**2000**)
6. Essential of crystallography**, M A Wahab**, Narosa Publications (**2009)**
7. Solid State Physics-**S O 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).

PRACTICAL

Course Title	Elements of Condensed Matter & Nuclear Physics (Practical)	**Practical Credits**	02
Course Code	21BSC6C6PHY1P	**Contact Hours**	04 Hours
Formative Assessment	25 Marks	**Summative Assessment**	25 Marks

Practical Content

CONDENSED MATTER PHYSICS

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

NUCLEAR PHYSICS

1. Study the characteristics of Geiger-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.

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

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**)

SEMESTER VI

Program Name	BSc in Physics	**Semester**	VI
Course Title	Electronic Instrumentation & Sensors (Theory)		
Course Code:	21BSC6C6PHY2L	**No. of Credits**	04
Contact Hours	60 Hours	**Duration of SEA/Exam**	2 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, colour 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.
- Learn about Fourier series and its applications.

Contents	**60Hours**
UNIT I **Power supply** AC power and its characteristics, Single phase and three phase, Need for DC power supply and its characteristics, line voltage and frequency, Bridge rectifier, Filters: Capacitor and inductor filers, L-section and π-section filters, ripple factor, electronic voltage regulators, stabilization factor, voltage regulation using ICs. **Basic electrical measuring instruments** Cathode ray oscilloscope- Block diagram, basic principle, electron beam, CRT features, signal display. Basic elements of digital storage oscilloscopes. Generation of Lissajous figures. Basic DC voltmeter for measuring potential difference, Extending Voltmeter range, AC voltmeter using rectifiers	15

Basic DC ammeter, requirement of a shunt, Extending of ammeter ranges. Electrical fuses: different types. Circuit breakers: types, principle and applications. *Topics for self-study:* *Average value and RMS value of current, Ripple factor, Average AC input power and DC output power, efficiency of a DC power supply. Multirange voltmeter and ammeter.* **12 Hours** **ACTIVITIES: 3 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 II **Wave form generators and Filters** Basic principle of standard AF signal generator: Fixed frequency and variable frequency, AF sine and square wave generator, basic Wein-bridge network and oscillator configuration, Triangular and saw tooth wave generators, circuitry and waveforms. Passive and active filters. Fundamental theorem of filters, Proof of the theorem by considering a symmetrical T-network. Types of filters, Circuitry and Cut-off frequency and frequency response of Passive (RC) and Active (op-amp based) filters: Low pass, high pass and band pass. **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.	15

Verify the truth table. Hint: LM3900 op-amp may be used. The status of the output may be checked by LED.	
UNIT III **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). Observe a solar water heater. Some solar water heaters are fitted with an anode rod (alloy of aluminium). Study why it is required. Describe the principle behind solar water heater	15
UNIT IV **MATHEMATICAL PHYSICS** **Fourier Series**: Periodic functions. Orthogonality of sine and cosine functions, Dirichlet Conditions (Statement only). Expansion of periodic functions in a series of sine and cosine functions and determination of Fourier coefficients. Complex representation of Fourier series. Expansion of functions with arbitrary period. Expansion of non-periodic functions over an interval. Application. Summing of Infinite Series. **Laplace transform:** Definition, transform of elementary functions, inverse transforms, transform of derivations, differentiation and integration of transforms. Difference between Laplace and Fourier transform.	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.

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)

References
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). 4. Mathematical Physics ---H. K. Dass and Dr. Rama Verma 5. Mathematical Methods for Physicists (4th Edition) George Arfken and Hans J. Weber Academic Press San Diego(1995). 6. Mathematical Physics - P.K. Chatopadhyay-Wiley Eastern Limited New Delhi (1990). 7. Introduction to mathematical Physics – Charlie Harper, Prentice-Hall of India Private Limited New-Delhi (1995)

PRACTICAL

Course Title	Electronic Instrumentation & Sensors (Practical)	**Practical Credits**	02
Course Code	21BSC6C6PHY2P	**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 low 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.

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.

B.Sc. Semester–VI
Internship/Mini Research Project

Course Title	Internship/Mini Research Project	**Practical Credits**	02
Course Code	21BSC6IN1PHYIN	**Contact Hours for Mini Project**	04 Hours
Report and Presentation			50 Marks

Course Outcomes (COs): At the end of the course the students will be able to

CO1: The students learn the scientific methodology in carrying out internship/project work including planning and execution of the experiment.

CO2: The students acquire experiential learning by handling instruments/devices, etc., while setting up an experiment or by reading in-depth assigned subject for theoretical analysis.

CO3: The students learn the importance of team work, mutual participation and nurture their motivation either towards theoretical or experimental internship/project work.

CO4: Internship/project helps students to get research and industrial exposure and application of knowledge.

Internship:

A course requiring students to participate in a professional activity or work experience, or cooperative education activity with an entity external to the education institution, normally under the supervision of an expert of the given external entity. A key aspect of the internship is induction into actual work situations for 2 credits. Internships involve working with local industry, local governments (such as panchayats, municipalities) or private organizations, business organizations, artists, crafts persons, and similar entities to provide opportunities for students to actively engage in on-site experiential learning.

Note:

1. **One credit** internship is equal to 30 hrs on field experience.
2. Internship shall be Discipline Specific of 45-60 hours (2 credits) with duration 1-2 weeks.
3. Internship may be full-time/part-time (full-time during last 1-2 weeks before closure of the semester or weekly 4 hrs. in the academic session for 13-14 weeks).
4. College shall decide the suitable method for program wise but not subject wise.
5. Internship mentor/supervisor shall avail work allotment during 6^{th} semester for a maximum of 20hrs.
6. The student should submit the final internship report (45-60 hours of Internship) to the mentor for completion of the internship.
7. Method of Evaluation: Power Point Presentations, Submission of Report and Internship Completion Certificate.

Mini Research Project:

Physics deals with various concepts and material properties. Students can get good knowledge on Physics principles after doing project work in the area of experimental and theoretical Physics.

The objective of the Project work is to provide a platform for the students to demonstrate their ability to apply their technical/theoretical knowledge and skills gained from theory lectures and practical work throughout the course.

COs: After completing the project work students will be able to

1) Understand, plan and execute a mini project with team with the help of a supervisor.
2) implement the theoretical knowledge of Physics in model building, material synthesis.
3) learn software such as LabViwew, Phyton and MATLAB and solve Physics problems.
4) Prepare a technical report on the mini project work.
5) Deliver a presentation based on the mini project work.

Mini project work is carried out in the following form:

This course will be conducted for students as an individual or in a group of three to four students under the guidance of a staff member in the college.

Course Guidelines:

1) Students should select a problem which addresses some basic home, office or other real life applications.
2) A written report of about 5 to 10 pages should be submitted individually.
3) A group of maximum four students can be permitted to work on one mini project.
4) Student should deliver presentation about the project and demonstrate its working individually.
5) The evaluation of the project carries a maximum of 50 marks. The experimental work and preparation of the report carries 40 Marks. The viva-voce examination carries a maximum of 10 marks and will be in the form of presentation by the student.

ASSESSMENT METHODS

Evaluation Scheme for Internal Assessment:

Theory:

Assessment Criteria	40 marks
1st Internal Assessment Test for 30 marks 1 hr after 8 weeks and 2nd Internal Assessment Test for 30 marks 1 hr after 15 weeks . Average of two tests should be considered.	30
Assignment	05
Activity	05
Total	**40**

Assessment Criteria	25 marks
1st Internal Assessment Test for 20 marks 1 hr after 8 weeks and 2nd Internal Assessment Test for 20 marks 1 hr after 15 weeks. Average of two tests should be considered.	20
Assignment/Activity	05
Total	**25**

Practical:

Assessment Criteria	25 marks
Internal test	15
Viva Voce / basic understanding of the concept	05
Journal/Practical Record	05
Total	**25**

Scheme of Evaluation for Practical Examination

Sl. No.	Particulars	Marks Allotted Max. 25
1.	Basic formula with description, nature of graph if any & indication of unit	05
2.	Tracing of schematic ray diagram/Circuit diagram with description and tabulation	05
4.	Experimental skill & connection	05
5.	Record of observation,	05
6.	Calculation including drawing graph	04
7.	Accuracy of result with unit	01
	Total	**25**

Question Paper Pattern:

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Department of PHYSICS

V / VI Semester B.Sc.

Sub: **Code:** **Maximum Marks: 60**

Q.No.1.	**Answer any Six Questions** ***(Two question from Each Unit to be asked)*** **a.** **b.** **c.** **d,** **e.** **f.** **g.** **h.**	**6X2=12**
Q.No.2.	**(Questions from Unit-I)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.3.	**(Questions from Entire Unit-II)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.4.	**(Questions from Unit-III)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**
Q.No.5.	**(Questions from Unit-IV)** **a.** **b.** **OR** **c.** **d.**	 **08** **04** **08** **04**

Note:

i. There should be a problem of marks from each unit and may be asked in either b or d in questions 2 to 5.

ii. If necessary, sub questions a and c from 2 to 5 may be subdivided in to i. and ii. Without exceeding maximum 08 marks.