Department of Physics

GB Pant Memorial Govt. College Rampur Bushahr

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Program Specific Outcomes (PSO),

Program Outcomes (PO),

Course Outcomes (CO) & Course Contents

of

Bachelor of Science in Physics

B. Sc. With Physics

Department of Physics

Details of Courses Under Undergraduate Program (B.Sc.)

Course	*Credits	
	Theory+ Practical	Theory +Tutorials
I. Core Course	12×4= 48	12×5=60
(12 Papers) 04 Courses from each of the 03 disciplines of choice		
Core Course Practical / Tutorial*	12×2=24	12×1=12
(12 Practical/ Tutorials*) 04 Courses from each of the 03 Disciplines of choice		
II. Discipline Specific Course Elective Course	6×4=24	6×5=30
(6 Papers) Two papers from each discipline of choice including paper of interdisciplinary nature.		
Discipline Specific Course Practical / Tutorials*	6 × 2=12	6×1=6
(6 Practical / Tutorials*) Two Papers from each discipline of choice including paper of interdisciplinary nature		

- **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 3rd year**
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III. Ability Enhancement Courses

1 **Ability Enhancement Compulsory**	2 × 4=8	2×4=8

(2 Papers of 4 credits each)
Environmental Science English/MIL Communication

2 **Skill Enhancement Course**	4 × 4=16	4 × 4=16

(Skill Based)

(4 Papers of 4 credits each)

Total credit= 132

Total credit= 132 College should evolve a system/policy about ECA/ General Interest/ Hobby/ Sports/ NCC/ NSS/ related courses on its own.

***wherever there is practical there will be no tutorials and vice –versa.**

- **In case of theory and tutorial 1 credit will be of 1 hour class room teaching, while in case of Practical/Practical Skill Exam 1 credit will be of 2 hours Laboratory class/project work.**

Scheme for Choice Based Credit System (CBCS) in Bachelor of Science with Physics Annual Pattern

Year	Core Course (12)	Ability Enhancement Compulsory Course AECC (2)	Skill Enhancement Courses SEC (4)	Elective Course Discipline Specific Elective DSE (6)	Total Credits
I	DSC-1A = 6 Credit DSC-1B = 6 Credit DSC-2A = 6 Credit DSC-2B = 6 Credit DSC-3A = 6 Credit DSC-3B = 6 Credit **Credits = 36**	Eng/MIL Communi/EVS = 4 Credit Eng/MIL Communi/EVS = 4 Credit **Credits = 08**	NIL	NIL	**44**
II	DSC-1C = 6 Credit DSC-1D = 6 Credit DSC-2C = 6 Credit DSC-2D = 6 Credit DSC-3C = 6 Credit DSC-3D = 6 Credit **Credits = 36**	NIL	SEC-1 = 4 Credit SEC-2 = 4 Credit **Credits = 08**	NIL	**44**
III	NIL	NIL	SEC-3 = 4 Credit SEC-4 = 4 Credit **Credits = 08**	DSE-1A = 6 Credit DSE-1B = 6 Credit DSE-2A = 6 Credit DSE-2B = 6 Credit DSE-3A = 6 Credit DSE-3B = 6 Credit **Credits = 36**	**44**
Total Credits in B.Sc. Physical Science and B.Sc. with Physics Degree Courses = 44 × 3					**132**

Credits (hours) Split:

Theory = 04 (4 hours)
Practical = 02 (4 hour

Theory = 05 (5 hours)

Tutorial = 01(1 hour) For SEC:
Theory = 03 (3 hours)

Skill Exam (SE) = 01 (2 hours)

Details of CBCS Scheme for Undergraduate Three Year Degree Course: Bachelor of Science with Physics: Teaching Hours and Credits Plan in Annual System for Three years

S. No.	Name of Course (6 Credits)	*Teaching Hrs.		Credits as per annual Plan				
				Non Practical Course (2Weeks Teaching Hours)		Practical Course (2Weeks Teaching Hours)		Total Credits in a Year
1	Core Courses (12)	1st Week	2nd Week	Theory	Tutorial	Theory	Practical	
a	Discipline Specific Courses (4+4+4 =12)							
i	DSC-1A	03	06	05	01	04	02	06
	DSC-1B	03	06	05	01	04	02	06
	DSC-1C	03	06	05	01	04	02	06
	DCS-1D	03	06	05	01	04	02	06
ii	DSC-2A	03	06	05	01	04	02	06
	DSC-2B	03	06	05	01	04	02	06
	DSC-2C	03	06	05	01	04	02	06
	DCS-2D	03	06	05	01	04	02	06
iii	DSC-3A	03	06	05	01	04	02	06
	DSC-3B	03	06	05	01	04	02	06
	DSC-3C	03	06	05	01	04	02	06
	DCS-3D	03	06	05	01	04	02	06
Total Credits of Core Courses								72
2	Ability Enhancement Courses (6)							
a	Ability Enhancement Compulsory Courses (2)							
i	Eng/MIL Communication/EVS	02	04	03	01	--	--	04
	Eng/MIL Communication/EVS	02	04	03	01	--	--	04
Total Credits of Ability Enhancement Compulsory Courses (AECC)								08
b	Skill Enhancement Courses (4)					Theory	Practical Skill Exam	
	SEC-1	02	04	04	--	03	01	04
	SEC-2	02	04	04	--	03	01	04

	SEC-3	02	04	04	--	03	01	04
	SEC-4	02	04	04	--	03	01	04
Total Credits of Skill Enhancement Courses (SEC)								**16**
Total Credits of Ability Enhancement Courses (AEC) = 08 + 16								**24**

3	**Elective Courses (6)**							
a	**Discipline Specific Elective Courses**					**Theory**	**Practical**	
i	DSE-1A	03	06	05	01	04	02	06
	DSE-1B	03	06	05	01	04	02	06
	DSE-2A	03	06	05	01	04	02	06
	DSE-2B	03	06	05	01	04	02	06
	DSE-3A	03	06	05	01	04	02	06
	DSE-3B	03	06	05	01	04	02	06
Total Credits of Discipline Specific Elective (DSE) Courses								**36**
Grand Total Credits in Three Year Degree Course: B.Sc. Physical Science and B.Sc. with Physics: 72 + 24 +36								**132**

***** *As per teaching hours given in column three above table, each course of 6 credits* **[{4 credits Theory (4 hours) + 2 credits Practical (4 hours)} or {5 credits Theory (5 hours) + 1 credits Tutorial (1 hours)}]** *and of 4 credits* **{3 credits SEC Theory (3hours) + 1 Credit Practical Skill based on Project work (2 hours)}** should be completed within every two weeks of the annual system.

HIMACHAL PRADESH UNIVERSITY
SYLLABUS AND SCHEME OF EXAMINATION FOR BACHELOR OF SCIENCE WITH PHYSICS

Year	Course Type	Course Code	Title of paper	*Credits
I	CORE COURSE-I	PHYS101TH PHYS101IA	MECHANICS Theory	**4**
		PHYS101PR	MECHANICS Lab	**2**
	CORE COURSE-II	COMP101TH	PROBLEM SOLVING USING COMPTER	**4**
		COMP101PR	SOFTWARE LAB USING PYTHON	**2**
	CORE COURSE-III	MATH101TH MATH101IA	DIFFERENTIAL CALCULUS	**6**
	A.E.C. COURSE-I		ENVIRONMENTAL SCIENCE	**4**
	CORE COURSE-IV	PHYS102TH PHYS102IA	ELECTRICITY, MAGNETISIM AND EMT Theory	**4**
		PHYS102PR	ELECTRICITY, MAGNETISIM AND EMT Lab	**2**
	CORE COURSE-V	COMP102TH	OFFICE AUTOMATION TOOLS	**4**
		COMP102PR	OFFICE ATOMATION TOOLS LAB	**2**
	CORE COURSE-VI	MATH102TH MATH102IA	DIFFERENTIAL EQUATIONS	**6**
	A.E.C.COURSE-II		ENGLISH/MIL COMMUNICATION	**4**
II	CORE COURSE-VII	PHYS201TH PHYS201IA	STATISTICAL AND THERMAL PHYSICS Theory	**4**
		PHYS201PR	STATISTICAL AND THERMAL PHYSICS Lab	**2**
	CORE COURSE-VIII	COMP201TH	COMPUTER SYSTEM ARCHITECTRE	**6**
	CORE COURSE-IX	MATH201TH MATH201IA	REAL ANALYSIS	**6**
	CORE COURSE-X	PHYS202TH PHYS202IA	WAVES AND OPTICS Theory	**4**
		PHYS202PR	WAVES AND OPTICS Lab	**2**
	CORE COURSE-XI	COMP202TH	DATEBASE MANAGEMENT SYSTEM	**4**
		COMP202PR	DATEBASE MANAGEMENT SYSTEM LAB	**2**

	CORE COURSE-XII	MATH202TH MATH202IA	ALGEBRA	**6**
	SEC 1 (CHOOSE ANY ONE FROM GIVEN TWO)	PHYS203TH PHYS203IA	PHYSICS WORKSHOP SKILLS Theory	**3+1** **(TH+IA = 3** **SE = 1)**
		PHYS203SE	PHYSICS WORKSHOP SKILLS Skill Exam	
		PHYS204TH PHYS204IA	COMPUTATIONAL PHYSICS Theory	
		PHYS204SE	COMPUTATIONAL PHYSICS Lab	
	SEC 2 (CHOOSE ANY ONE FROM GIVEN TWO)	PHYS205TH PHYS205IA	ELECTRICAL CIRCUITS AND NETWORK SKILLS Theory	**3+1** **(TH+IA = 3** **SE = 1)**
		PHYS205SE	ELECTRICAL CIRCUITS AND NETWORK SKILLS Skill Exam	
		PHYS206TH PHYS206IA	BASIC INSTRUMENTATION SKILLS Theory	
		PHYS206SE	BASIC INSTRUMENTATION SKILLS Skill Exam	
III	DISCIPLINE SPECIFIC ELECTIVES DSE:1A (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS301TH PHYS301IA	ELEMENTS OF MODERN PHYSICS Theory	**4+2** **(TH+IA = 4** **PR = 2)** **OR** **5+1** **(TH+IA = 5** **TU = 1)**
		PHYS301PR	ELEMENTS OF MODERN PHYSICS Lab	
		PHYS302TH PHYS302IA	SOLID STATE PHYSICS AND ELECTRONICS Theory	
		PHYS302PR	SOLID STATE PHYSICS AND ELECTRONICS Lab	
		PHYS303TH PHYS303IA	ASTRONOMY AND ASTROPHYSICS Theory	
		PHYS303TU	ASTRONOMY AND ASTROPHYSICS Tutorials	
	DISCIPLINE SPECIFIC ELECTIVES (DSE:2A)	COMP301PH	OPERATING SYSTEM	**6**
	DISCIPLINE SPECIFIC ELECTIVES DSE:3A (CHOOSE ANY ONE FROM GIVEN THREE)	MATH301TH MATH301IA	MATRICES	**6**
		MATH302TH MATH302IA	MECHANICS	
		MATH303TH MATH303IA	LINEAR ALGEBRA	
		PHYS304TH PHYS304IA	NUCLEAR AND PARTICLE PHYSICS Theory	

	DISCIPLINE SPECIFIC ELECTIVES DSE:1B (CHOOSE ANY ONE FROM GIVEN THREE)	PHYS304TU	NUCLEAR AND PARTICLE PHYSICS Tutorials	**5+1 (TH+IA = 5 TU = 1) OR 4+2 (TH+IA = 4 PR = 2)**
		PHYS305TH PHYS305IA	QUANTUM MECHANICS Theory	
		PHYS305PR	QUANTUM MECHANICS Lab	
		PHYS306TH PHYS306IA	PHYSICS OF DEVICES AND INSTRUMENTS Theory	
		PHYS306PR	PHYSICS OF DEVICES AND INSTRUMENTS Lab	
	DISCIPLINE SPECIFIC ELECTIVES DSE:2B	COMP302TH	DATA STRUCTURE AND FILE PROCESSING	**4**
		COMP302PR	DATA STRUCTURE AND FILE PROCESSING LAB	**2**
	DISCIPLINE SPECIFIC ELECTIVES DSE:3B (CHOOSE ANY ONE FROM GIVEN THREE)	MATH304TH MATH304IA	NUMERICAL METHOD	**6**
		MATH305TH MATH305IA	COMPLEX ANALYSIS	
		MATH306TH MATH306IA	LINEAR PROGRAMMING	
	SEC 3 (CHOOSE ANY ONE FROM GIVEN TWO)	PHYS307TH PHYS307IA	RADIATION SAFETY Theory	**3+1 (TH+IA = 3 SE = 1)**
		PHYS307SE	RADIATION SAFETY Skill Exam	
		PHYS308TH PHYS308IA	APPLIED OPTICS Theory	
		PHYS308SE	APPLIED OPTICS Skill Exam	
	SEC 4 (CHOOSE ANY ONE FROM GIVEN TWO)	PHYS309TH PHYS309IA	WEATHER FORECASTING Theory	**3+1 (TH+IA = 3 SE = 1)**
		PHYS309SE	WEATHER FORECASTING Skill Exam	
		PHYS310TH PHYS310IA	RENEWABLE ENERGY AND ENERGY HARVESTING Theory	
		PHYS310SE	RENEWABLE ENERGY AND ENERGY HARVESTING Skill Exam	

***TH = Theory, IA = Internal Assessment, PR = Practical, TU = Tutorials and SE = Skill Exam**

Years	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	Environmental Science	4
	Core course-I	Mechanics	4
	Core Course-I Practical/Tutorial	Mechanics Lab	2
	Core Course II	DSC 2A	6
	Core Course III	DSC 3A	6
	Ability Enhancement Compulsory Course-II	English/MIL communications/	4
	Core course-IV	Electricity, Magnetism and EMT Electricity, Magnetism and EMT	4
	Core Course-IV Practical/Tutorial	Lab	2
	Core Course V	DSC 2B	6
	Core Course VI	DSC 3B	6
II	Core course-VII	Statistical and Thermal Physics	4
	Core Course-VII Practical/Tutorial	Statistical and Thermal Physics	2
	Core Course VIII	DSC 2C	6
	Core Course IX	DSC 3C	6
	Skill Enhancement Course -1	SEC-1	4
	Core Course-X	Waves and Optics	4
	Core Course-X Practical/Tutorial	Waves and Optics Lab	2
	Core Course XI	DSC 2D	6
	Core Course XII	DSC 3D	6
	Skill Enhancement Course -2	SEC -2	4
III	Skill Enhancement Course -3	SEC -3	4
	Discipline Specific Elective -1	DSE-1A: Physics	6
	Discipline Specific Elective -2	DSE-2A: Computer Science	6
	Discipline Specific Elective -3	DSE-3A: Mathematics	6
	Skill Enhancement Course -4	SEC -4	4
	Discipline Specific Elective -4	DSE-1B: Physics	6
	Discipline Specific Elective -5	DSE-2B: Computer Science	6
	Discipline Specific Elective -6	DSE-3B: Mathematics	6
	Total Credits		**132**

***Wherever there is a practical there will be no tutorial and vice versa. The size of group for practical papers is recommended to be maximum of 12 to 15 students.**

B.Sc. Program with Physics as one subject

Core papers Physics (Credit: 06 each) (CP 1-4):

PHYS101 Mechanics (4) + Lab (2)
PHYS102 Electricity, Magnetism and EMT (4) + Lab (2)
PHYS201 Statistical and Thermal Physics (4) + Lab (2)
PHYS202 Waves and Optics (4) + Lab (2)

Discipline Specific Elective papers (Credit: 06 each) (DSE 1A, DSE 1B):
Choose two courses in 3rd year, any one from each DSE-1A and DSE-1B

DSE -1 A (Choose one course only):
PHYS301 Elements of Modern Physics (4) + Lab (2)
PHYS302 Solid State Physics and Electronics (4) + Lab (2)
PHYS303 Astronomy and Astrophysics (5) + Tutorials (1)

DSE -1 B (Choose one course only):
PHYS304 Nuclear and particle Physics (5) + Tutorials (1)
PHYS305 Quantum Mechanics (4) + Lab (2)
PHYS306 Physics of Devices and Instruments (4) + Lab (2)

Skill Enhancement Course (any four) (Credit: 04 each) - SEC 1 to SEC 4
SEC- 1 B.Sc. With Physics
PHYS203 Physics Workshop Skills (For B.Sc. Physical Science/ B.Sc. With Physics)
or
PHYS204 Computational Physics (For B.Sc. Physical Science/ B.Sc. With Physics)
or
PHYS205 Electrical Circuits and Network Skills (For B.Sc. Physical Science only)
SEC- 2 B.Sc. With Physics
PHYS205 Electrical Circuits and Network Skills
or
PHYS206 Basic Instrumentation Skills
SEC- 3 B.Sc. With Physics
PHYS307 Radiation Safety
or
PHYS308 Applied Optics
SEC- 4 B.Sc. With Physics
PHYS309 Weather Forecasting
or
PHYS310 Renewable Energy and Energy Harvesting

Yearly Based Examination (YBE) and Comprehensive Continuance Assessment (CCA) Scheme of Three Years Degree of B.Sc. with Physics (Annual Pattern)

➢ Scheme for Examination for each course:

- **The medium of instructions and Examinations shall be English only**
- **YBE, Practical and Skill Examinations shall be conducted at the end of each yearly session as per the Academic Calendar notified by H.P. University, Shimla-5, time to time.**
- **Practical (2 Credits) and Skill Test Examinations (1 Credit) shall be conducted in Laboratory.**
- **Each course of 6 credits (Theory + Practical/Tutorials)/4 credits (SEC Theory + Skill Exam) will carry 100 marks and distribution of marks is given under each courses.**
- **The minimum passing marks will be 40% in aggregate. However, 35% each in Internal Assessment (CCA) and Final Examinations will be compulsory. For Practical/Tutorial/Skill Test Exam 40% passing marks will be compulsory and if candidate fails to obtain 40% marks in Practical/Tutorial/Skill Test Exam will be treated as fail in that subject.**
- **Compartment in at most 2 subjects i.e. (25%) of the total subjects.**
- **Criteria for Class-room and Laboratory/Tutorials Attendance (05 marks):**
  75% attendance is compulsory both in theory and practical. Each seminars and submission of Projects/Dissertation/Assignments are mandatory.

a	**Attendance 75% to 80%**	**1 marks**
b	**Attendance 81% to 85%**	**2 marks**
c	**Attendance 86% to 90%**	**3 marks**
d	**Attendance 91% to 95%**	**4 marks**
e	**Attendance 96% to 100%**	**5 marks**

Note: B.Sc. with Physics qualifications are eligible to apply for master degree courses in Physics/Computer Science/Mathematics.

Introduction to Program Outcomes (POs), Program Specific Outcomes (PSOs), and Course Outcomes (COs)

The educational framework for our B.Sc. Physical Science and B.Sc. Physics programs is designed to provide students with a robust foundation in physical sciences while preparing them for advanced study and professional careers. This framework is structured around the Program Outcomes (POs), Program Specific Outcomes (PSOs), and Course Outcomes (COs) to ensure that graduates are well-equipped to tackle complex scientific challenges and contribute effectively to their fields.

Program Outcomes (POs)

Upon completion of the B.Sc. Physical Science or B.Sc. Physics program, graduates will demonstrate:

1. **PO1: A Solid Foundation in Physical Sciences**
   Graduates will apply their knowledge of physics, chemistry, and mathematics to solve complex problems, demonstrating a comprehensive understanding of fundamental principles.
2. **PO2: Strong Analytical and Problem-Solving Skills**
   They will approach scientific challenges with a systematic and logical mindset, employing critical thinking and analytical skills to address and solve complex issues.
3. **PO3: Proficiency in Conducting Experiments and Analyzing Data**
   Graduates will conduct precise and accurate experiments, analyze data effectively, and draw meaningful conclusions, contributing to the advancement of scientific knowledge.
4. **PO4: Effective Communication of Scientific Information**
   They will communicate scientific findings clearly and effectively, both orally and in writing, to diverse audiences, enhancing their ability to share knowledge and collaborate with others.
5. **PO5: Effective Teamwork and Leadership**
   Graduates will work collaboratively in teams, demonstrating leadership and cooperative skills in laboratory and research settings, fostering a productive and collaborative environment.
6. **PO6: Engagement in Lifelong Learning**
   They will stay updated with advancements in science and technology, engaging in continuous learning to support their professional growth and contribute to societal welfare.

Program Specific Outcomes (PSOs)

The B.Sc. Physical Science and B.Sc. Physics programs aim to:

1. **PSO1: Provide a Comprehensive Understanding of Physical Sciences**
   Students will develop a thorough understanding of physical sciences, encompassing various subfields and integrating their knowledge across different scientific disciplines.

2. **PSO2: Equip Students with Practical Skills and Hands-On Experience**
   The programs emphasize practical skills and hands-on experience in laboratory work, experimental techniques, and scientific problem-solving.
3. **PSO3: Foster Research and Analytical Skills**
   Students will cultivate research and analytical skills, preparing them for advanced studies and professional research roles.
4. **PSO4: Promote Effective Communication and Collaboration**
   The programs will enhance students' ability to communicate scientific information and collaborate effectively with peers and professionals.

Course Outcomes (COs)

Each course within the program is designed to achieve specific outcomes that contribute to the overall educational goals. Course Outcomes (COs) ensure that students gain the following:

1. **CO1: Knowledge and Understanding of Core Concepts**
   Courses are designed to impart essential knowledge and understanding of core scientific concepts and principles.
2. **CO2: Development of Practical and Analytical Skills**
   Students will acquire practical skills and analytical abilities through hands-on experiments, problem-solving tasks, and project work.
3. **CO3: Ability to Apply Knowledge to Real-World Problems**
   Courses aim to equip students with the ability to apply theoretical knowledge to real-world scenarios and scientific challenges.
4. **CO4: Competence in Communication and Collaboration**
   Students will develop effective communication skills and the ability to work collaboratively with others in scientific and professional contexts.

Ist Year

MECHANICS

Name of the Course	**PHYSICS-DSC 1A: MECHANICS (Credits: Theory-04) Theory: 60 Lectures**
Code	PHYS101TH
Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Lab**: Lab Seminar + Lab Attendance = **5+5 marks.**	

Course Objectives

1. **Fundamental Concepts:** To introduce students to the fundamental concepts of classical mechanics, including the principles of motion, forces, energy, and momentum.
2. **Mathematical Framework:** To develop students' ability to apply mathematical techniques, such as differential equations, to solve physical problems related to mechanics.
3. **Relativity:** To familiarize students with the basic concepts of the special theory of relativity and its implications on the understanding of space and time.
4. **Practical Applications:** To provide hands-on experience through laboratory experiments that illustrate the principles of mechanics and enhance understanding through practical application.

Course Outcomes (COs)

By the end of the course, students will be able to:

1. **CO1:** Solve problems involving ordinary differential equations and apply them to describe physical systems in mechanics.
2. **CO2:** Understand and analyze the concepts of inertial and non-inertial reference frames, including the Coriolis force and its applications.
3. **CO3:** Explain the laws of gravitation, central force motion, and apply them to problems such as planetary motion and satellite orbits.
4. **CO4:** Analyze rotational motion, angular momentum, and the dynamics of collisions, distinguishing between elastic and inelastic collisions.
5. **CO5:** Comprehend the basic principles of the special theory of relativity and apply them to phenomena such as time dilation, length contraction, and relativistic energy-mass equivalence.

Program Specific Outcomes (PSOs)

For the B.Sc. Physical Science or B.Sc. with Physics program, the specific outcomes are:

1. **PSO1:** Gain a thorough understanding of classical and modern physics, enabling them to apply physical principles in various real-world contexts.
2. **PSO2:** Develop proficiency in experimental techniques and data analysis, equipping them for further studies or careers in physics and related fields.
3. **PSO3:** Apply computational and mathematical skills to model physical systems and solve complex problems.
4. **PSO4:** Acquire the ability to conduct independent research, critically analyze scientific literature, and present findings effectively.

Program Outcomes (POs)

Upon completion of the B.Sc. Physical Science or B.Sc. with Physics program, graduates will be able to:

1. **PO1:** Demonstrate a solid foundation in physical sciences, with the ability to apply knowledge of physics, chemistry, and mathematics to solve complex problems.
2. **PO2:** Develop strong analytical and problem-solving skills, enabling them to approach scientific challenges with a systematic and logical mindset.
3. **PO3:** Conduct experiments, analyze data, and draw meaningful conclusions, with a focus on precision and accuracy.
4. **PO4:** Communicate scientific information effectively, both orally and in writing, to diverse audiences.
5. **PO5:** Work effectively in teams, demonstrating leadership and collaborative skills in laboratory and research settings.
6. **PO6:** Engage in lifelong learning and stay updated with advancements in science and technology, contributing to their professional growth and societal welfare.

Matrix Articulation Table for PHYSICS-DSC: MECHANICS AND SPECIAL RELATIVITY

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	3	3	2	2	1	3	2	2	2
CO2	3	3	2	2	1	1	3	2	3	2
CO3	3	3	3	2	1	1	3	3	3	3
CO4	3	2	3	2	2	1	3	2	2	2
CO5	3	3	2	2	2	2	3	2	3	3

Legend:

- **3**: Strong contribution

- **2**: Moderate contribution
- **1**: Slight contribution

Instructions for Paper Setters and Candidates:

1 *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*

2 *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Ordinary Differential Equations: 1st order homogeneous differential equations. 2nd order homogeneous differential equations with constant coefficients.

Coordinate systems and motion of a particle: Volume, velocity and acceleration in Cartesian and Spherical co-ordinate systems, Solid angle. **(6 Lectures) Space Time Symmetry and Conservation Laws:** Relationship of conservation laws and symmetries of space and time. **(4 Lectures)**

Frames of Reference: Inertial frames of reference, Galilean transformation and Galilean invariance. Non-inertial frames, Coriolis force and its applications; Foucault's pendulum.

(5 Lectures)

Unit-II

Gravitation and Inverse Square Force Law: Newton's Law of Gravitation, Various forces in nature (qualitative). Central and non-central forces, Inverse square force, Centre of mass. Equivalent one body problem. Reduced mass, angular momentum in central force field.Equation of motion under a force law**.** Equation of orbit and turning points. relationship between eccentricity and energy, Kepler's laws., Basic idea of global positioning system (GPS).

(15 Lectures)

Unit-III

Rotational Motion and Kinematics of Elastic and Inelastic Collisions : Angular velocity, angular momentum, Torque, Conservation of angular momentum,: Elastic and inelastic collisions, coefficient of restitution, Elastic collisions in laboratory and C.M. systems, Velocities, angle and energies in elastic collisions in C.M. and lab. Systems,

Classical Scattering: Cross- section for elastic scattering, Rutherford scattering (with derivation).

(15 Lectures)

Unit IV

Special Theory of Relativity: Concept of stationary universal frame of reference and search for ether. Michelson- Morley experiment, postulates of special theory of relativity. Lorentz transformations. Observer in relativity. Relativity of simultaneity. **(8 Lectures)**

Effects of Relativity: Length contraction. Time dilation. Relativistic addition of velocities. Relativistic Doppler effect. Variation of mass with velocity and mass energy equivalence. Increase of mass in an inelastic collision, Relativistic momentum and energies. Transformation of momentum, energy. Minkowsky space. **(7 Lectures)**

Reference Books:

- University Physics. FW Sears, MW Zemansky and HD Young13/e, 1986. Addison-Wesley
- Mechanics Berkeley Physics course,v.1: Charles Kittel, et. Al. 2007, Tata McGraw-Hill.
- Physics – Resnick, Halliday & Walker 9/e, 2010, Wiley
- Engineering Mechanics, Basudeb Bhattacharya, 2nd edn., 2015, Oxford University Press
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Mechanics, D.S. Mathur, S. Chand and Company Ltd.
- An Introduction to Mechanics, Kleppner, Tata Macgraw Hill.

MECHANICS LAB

Name of the Course	**PHYSICS-DSC 1A LAB: MECHANICS (Credits: -02)**
Code	PHYS 101PR
Yearly Based Examination	**20 marks (3 Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/ Skills= **4 Marks** Viva Voce = **4 Marks**, Practical Record Book= **4 Marks.**	

PHYSICS LAB: DSC 1A LAB: MECHANICS

60 Lectures

1 Measurements of length (or diameter) using vernier caliper, screw gauge and travelling microscope.

2 To determine the Height of a Building using a Sextant.

3 To determine the Moment of Inertia of a Flywheel.

4 To determine the Young's Modulus of a Wire by Optical Lever Method.

ELECTRICITY, MAGNETISM AND EMT

Name of the Course	**PHYSICS-DSC 1B: ELECTRICITY, MAGNETISM AND EMT (Credits: Theory-**

	04) Theory: 60 Lectures
Code	PHYS102TH
Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Lab**: Lab Seminar + Lab Attendance = **5+5 marks.**	

Course Outcomes (COs)

1. **CO1:** Understand and apply the concepts of vector analysis in the context of electromagnetic theory.
2. **CO2:** Analyze electrostatic phenomena using Gauss's law and its applications to various charge distributions.
3. **CO3:** Comprehend and apply the laws of magnetism, including Ampere's circuital law and the concept of magnetic fields due to moving charges.
4. **CO4:** Explain the behavior of electric and magnetic fields in matter, including the concepts of polarization, magnetization, and the relationship between electric and magnetic fields.
5. **CO5:** Understand Maxwell’s equations and their significance in describing electromagnetic wave propagation.

Program Specific Outcomes (PSOs)

1. **PSO1:** Develop a solid foundation in the principles of physics with an emphasis on classical mechanics, electromagnetism, quantum mechanics, and statistical physics.
2. **PSO2:** Cultivate problem-solving skills through practical and theoretical approaches, enabling application of physics concepts in various domains.
3. **PSO3:** Prepare students for higher education, research, and professional careers in physics and related fields.

Matrix Articulation Table for "PHYSICS-DSC 1B: ELECTRICITY, MAGNETISM AND EMT"

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO3
CO1	3	3	2	2	1	1	3	3	2
CO2	3	3	2	2	1	1	3	3	2
CO3	3	3	3	2	2	1	3	3	2
CO4	3	3	2	2	1	1	3	3	2
CO5	3	3	3	2	2	1	3	3	3

Legend:

- **3**: Strong contribution
- **2**: Moderate contribution
- **1**: Slight contribution

Instructions for Paper Setters and Candidates:

1 *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1. (Section A), will consist ofseven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*

2 *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Vector Analysis: Review of vector algebra (Scalar and Vector product), gradient, divergence, Curl and their significance, Vector Integration, Line, surface and volume integrals of Vector fields, Gauss-divergence theorem, Stokes's theorem, Green's theorem.

(5 Lectures)

Electrostatics: Significance of electrostatic force, Electrostatic Field, electric flux, Gauss's theorem of electrostatics. Applications of Gauss theorem- Electric field due to point charge, infinite line of charge, uniformly charged spherical shell and solid sphere, plane charged sheet, charged conductor, electrostatic potential, electrostatic potential energy. Electric potential due to a dipole and quadrupole, long uniformly changed wire,

charged disc. Electric potential energy. Electric field as a gradient of a scalar potential. Calculation of electric field due to a point charge and a dipole from potential. Method of Electrical Images. Poisson and Laplace equations. **(7 Lectures)**

Electric Current and Fields of Moving charges: Current and current density. Continuity equation; AJ + 6p/6t = 0. Microscopic form of Ohm's law (J α E) and conductivity. Failure of Ohms law and its explanation. Invariance of charge. **(3 Lectures)**

Unit-II

Magnetism: Ampere circuital law and its applications. Hall Effect, Expression for Hall constant and its significance. Divergence and curl of magnetic field **B**. Vector potential: Definition of vector potential **A** and derivation. **(5 Lectures)**

Field of Moving Charges: E in different frames of reference. Field of a point charge moving with constant velocity. Field of charge that starts or stops (qualitative). Interaction between moving charge and force between parallel currents. **(4 Lectures) Surface current density**: Definition. and its use in calculation of change in magnetic field at a current sheet. Transformation equations of E and B from one frame of reference to another. Dielectrics, parallel plate capacitor with a dielectric, dielectric constant, polarization and polarization vector, displacement vector **D**, molecular interpretation of Claussius - Mossotti equation, boundary conditions satisfied by **E** and **D** at the interface between two homogenous dielectrics, illustration through a simple example**.** **(6 Lectures)**

Unit-III

Electrostatic Fields in Dielectrics: Polarization of matter. Atomic and molecular dipoles, induced. Dipole moment and atomic polarizability. Electric susceptibility and polarization vector Capacity of a capacitor filled with Dielectrics. Dielectrics and Gauss's law Displacement vector- Establishment of relation $\nabla.D = \rho_{free}$. Energy stored in a dielectric medium. **(7 Lectures)**

Magnetic Fields in Matter: Behavior of various substances in magnetic fields. Definition of M and H and their relation to free and bound currents. Magnetic permeability and susceptibility and their interrelation. Orbital motion of electrons and diamagnetism. Electron spin and paramagnetic. Ferromagnetism. Domain theory of ferromagnetism, magnetization curve, hysterics loss, ferrites. **(8 Lectures)**

Unit-IV

Maxwell`s equations and Electromagnetic wave propagation: Displacement current, Maxwell's equations and its physical interpretation, EM waves and wave equation in a medium having finite permeability and permittivity but with conductivity $\sigma = 0$. Poynting vector, Poynting theorem, Impedence of a dielectric to EM waves, EM waves in conducting medium and skin depth. EM waves velocity in a conductor and anomalous dispersion. Reflection and Transmission of EM waves at a boundary of two dielectric media for normal and oblique incidence of reflection of EM waves from the surface of a conductor at normal incidence.

(15 Lectures)

Reference Books:

- Electricity and Magnetism, Edward M. Purcell, 1986, McGraw-Hill Education..
- Electricity and Magnetism, J.H. Fewkes & J. Yarwood. Vol. I, 1991, Oxford Univ. Press.
- Electricity and Magnetism, D C Tayal, 1988, Himalaya Publishing House.
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Introduction to Electrodynamics, D.J. Griffth, 3rd Edition, Prentice Hall of India.
- Electricity and Magnetism, Brij Lal and Subramanium, S. Chand & Co. Ltd.
- Electricity and Magnetism, A S Mahajan and A A Rangwala, Tata McGraw Hill Company.

ELECTRICITY, MAGNETISM AND EMT LAB

Name of the Course	**PHYSICS-DSC 1B LAB: ELECTRICITY, MAGNETISM AND EMT (Credits: -02)**
Code	PHYS 102PR
Yearly Based Examination	**20 marks (3 Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/ Skills= **4 Marks** Viva Voce = **4 Marks**, Practical Record Book= **4 Marks.**	

PHYSICS LAB- DSC 1B LAB: ELECTRICITY, MAGNETISM AND EMT

60 Lectures

1 To use a Multimeter for measuring (a) Resistances, (b) AC and DC Voltages, (c) DC Current, and (d) checking electrical fuses.

2 Ballistic Galvanometer:Measurement of charge and current sensitivity

2.i Measurement of CDR

2.ii Determine a high resistance by Leakage Method

2.iii To determine Self Inductance of a Coil by Rayleigh's Method.

3 To compare capacitances using De'Sauty's bridge.

4 Measurement of field strength B and its variation in a Solenoid (Determine dB/dx).

5 To study the Characteristics of a Series RC Circuit.

6 To study the a series LCR circuit and determine its (a) Resonant Frequency, (b) Quality Factor

7 To study a parallel LCR circuit and determine its (a) Anti-resonant frequency and (b) Quality factor Q

8 To determine a Low Resistance by Carey Foster's Bridge.

9 To verify the Thevenin and Norton theorem

10 To verify the Superposition, and Maximum Power Transfer Theorem

11 To determine unknown capacitance by flashing and quenching method

12 To find frequency of ac supply using an electrical viberator.

13 To study the induced emf as a function of the velocity of the magnet (simple method).

Reference Books

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- B.Sc. Practical Physics C.L. Arora, S. Chand and company Ltd.

- To determine the Modulus of Rigidity of a Wire by Maxwell's needle.

5 To determine the Elastic Constants of a Wire by Searle's method.

6 To determine g by Bar Pendulum.

7 To determine g by Kater's Pendulum.

8 To determine g and velocity for a freely falling body using Digital Timing Technique

9 To study the Motion of a Spring and calculate (a) Spring Constant (b) Value of g

10 To find the moment of inertia of an irregular body about an axis through its C.G with the torsional pendulum.

11 To compare the moment of inertia of a solid sphere and hollow sphere or solid disc of same mass with the torsional pendulum.

12 To verify (a) the law of conservation of linear momentum and (b) law conservation of kinetic energy on case of elastic collision.

Reference Books:

- Advanced Practical Physics for students, B.L.Flint and H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers.
- Engineering Practical Physics, S.Panigrahi & B.Mallick,2015, Cengage Learning India Pvt. Ltd.
- A Text Book of Practical Physics, Indu Pra..kash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- B.Sc Practical Physics C.L. Arora, S. Chand and company Ltd.

2nd Year

STATISTICAL AND THERMAL PHYSICS

Name of the Course	**PHYSICS-DSC 1C: STATISTICAL AND THERMAL PHYSICS** **(Credits: Theory-04)** **Theory: 60 Lectures**
Code	PHYS201TH

Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Lab**: Lab Seminar + Lab Attendance = .**marks** 5+5	

Course Outcomes (COs) for PHYSICS-DSC 1C: STATISTICAL AND THERMAL PHYSICS

1. **CO1**: Understand the basic concepts of statistical physics and the significance of microstates and macrostates.
2. **CO2**: Differentiate between various statistical distributions such as Maxwell-Boltzmann, Bose-Einstein, and Fermi-Dirac distributions.
3. **CO3**: Apply the laws of thermodynamics to various physical systems, including understanding entropy and its implications.
4. **CO4**: Analyze thermodynamic potentials and derive Maxwell's thermodynamic relations and their applications.

Program Specific Outcomes (PSOs)

1. **PSO1**: Gain a deep understanding of core physics concepts and principles.
2. **PSO2**: Develop problem-solving skills and apply them in real-world scenarios.
3. **PSO3**: Acquire practical skills through laboratory experiments, enhancing the ability to conduct scientific investigations.

Matrix Articulation Table

COs \ POs/PSOs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PSO 1**	**PSO 2**	**PSO3**
CO1	3	2	1	1	1	3	2	1
CO2	3	3	2	2	1	3	3	2
CO3	3	2	3	1	2	3	2	2
CO4	3	3	2	2	3	3	3	2

Legend:

- 3 = Highly Significant
- 2 = Moderately Significant
- 1 = Low Significance

Instructions for Paper Setters and Candidates:

1 *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*

2 *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Basic Ideas of Statistical Physics: Scope of statistical physics, basic ideas about probability, distribution of four distinguishable particles in two compartments of equal sizes. Concept of macro-states, micro-states, thermodynamic probability, effect of constraints on the system.

(8 Lectures)

Distribution of Particles in Compartments: Distribution of n particles in two compartments, Deviation from the state of maximum probability. Equilibrium state of a dynamic system, distribution of n distinguishable particles in k compartments of unequal sizes.

(7 Lectures)

Unit-II

Types of Statistics in Physics: Phase space and division into elementary cells. Three kinds of statistics. The basic approach in the three statistics. M-B. Statistics applied to an ideal gas in equilibrium, experimental verification of the Maxwell Boltzmann‘s law of distribution of molecular speeds. Need for quantum statistics, h as a natural constant and its implications, indistinguishability of particles and its implications. B-E statistics, **(8 Lectures)**

Bose Einstein and Fermi Dirac Statistics: Derivation of Planck’s law of radiation, deduction of Wien’s distribution law and Stefan’s law from plank’s law. Fermi-Dirac statistics. Applications to liquid helium, free electrons gas (Fermi level and Fermi Energy), Comparison of M-B, B-E, F-D statistics. **(7 Lectures)**

Unit-III

Entropy and Laws of Thermodynamics: Application of thermodynamics to the thermoelectric effect, change of entropy along a reversible path in a p-v diagram,

entropy of a perfect gas, equation of state of ideal gas from simple statistical considerations, heat death of the universe.

(7 Lectures)

Statistical Interpretation of entropy: Statistical definition of entropy, change of entropy of system, additive nature of entropy, law of increase of entropy. Reversible and irreversible processes, example of reversible and irreversible processes. Work done in a reversible process, example of entropy in natural process, entropy and disorder.

(8 Lectures)

Unit-IV

Maxwell's Thermodynamic Relations and Their Applications: Thermodynamic Potentials: Enthalpy, Gibbs, Helmholtz and Internal Energy functions, Derivation of Maxwell's thermodynamic relations. **(7 Lectures)**

Applications of thermodynamics relations. Cooling produced by adiabatic stretching, adiabatic compression, adiabatic Stretching of a wire, stretching of thin films, change of internal energy with volume. Clausius-Clapeyron Equation, Thermo dynamical treatment of Joule- Thomson effect for liquification of Helium. Production of very low temperatures by adiabatic demagnetization, TdS equations. **(8 Lectures)**

Reference Books:

- Statistical Physics and Thermodynamics, V.S. Bhatia, Sohan Lal Nagin Chand & Co, 1986, Jalandhar.
- Statistical Mechanics, R.K. Patharia, 2nd Edition, Butterworth-Heinemann.
- Introduction to Statistical Mechanics, B. B. Laud,(1988), Macmillan India Limited
- Statistical Physics, Berkley Physics Course, Vol. 5, F. Rief, Mc-Graw Hill Book Company.
- Thermal Physics, S. Garg, R. Bansal and C. Ghosh, 1993, Tata McGraw-Hill.
- Thermodynamics, Enrico Fermi, 1956, Courier Dover Publications.
- Thermodynamics, Kinetic theory & Statistical thermodynamics, F.W.Sears & G.L.Salinger. 1988, Narosa
- University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
- Thermal and Statstical Physics, Brij Lal and Subrahmanyam, S. Chand & Co. Ltd.
- Introduction to Statistical Mechanics, B. B. Laud,(1988), Macmillan India Limited
- Statistical Physics, Berkley Physics Course, Vol. 5, F. Rief, Mc-Graw Hill Book Company.

STATISTICAL AND THERMAL PHYSICS LAB

Name of the Course	**PHYSICS-DSC 1C LAB:** **STATISTICAL AND THERMAL**

	PHYSICS **(Credits: -02)**
Code	PHYS 201PR
Yearly Based Examination	**20 marks (3 Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/ Skills= **4 Marks** Viva Voce = **4 Marks**, Practical Record Book= **4 Marks.**	

PHYSICS LAB-DSC 1C LAB: STATISTICAL AND THERMAL PHYSICS

60 Lectures

1 To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
2 Measurement of Planck's constant using black body radiation.
3 To determine Stefan's Constant.
4 To determine the coefficient of thermal conductivity of copper by Searle's Apparatus.
5 To determine the Coefficient of Thermal Conductivity of Cu by Angstrom's Method.To determine the coefficient of thermal conductivity of a bad conductor by Lee and Charlton's disc method.
6 To determine the temperature co-efficient of resistance by Platinum resistance thermometer.
7 To study the variation of thermo emf across two junctions of a thermocouple with temperature.
8 To record and analyze the cooling temperature of an hot object as a function of time using a thermocouple and suitable data acquisition system
9 To calibrate Resistance Temperature Device (RTD) using Null Method/Off-Balance Bridge
10 To prove the law of probability by using one coin, two coins and 10 or more coins.
11 To determine the coefficient of increase of volume of air at constant pressure.
12 To determine the coefficient of increase of pressure of air at constant volume.
13 To study the spectral characteristics of a photo-voltaic cell.
14 To study the current voltage, power load, areal, azimuthal and spectral characteristics of a photo voltaic cell.
15 To verify inverse square law of radiation using a photoelectric cell.

Reference Books:

- Advanced Practical Physics for students, B.L.Flint & H.T.Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.
- A Laboratory Manual of Physics for Undergraduate Classes, D.P. Khandelwal, 1985, Vani Publication.
- B.Sc. Practical Physics C.L. Arora, S. Chand and company Ltd.

2nd Year

WAVES AND OPTICS

Name of the Course	**PHYSICS-DSC 1D: WAVES AND OPTICS** **(Credits:** **Theory-04)** **Theory: 60** **Lectures**
Code	PHYS202TH
Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Lab**: Lab Seminar + Lab Attendance = **5+5 marks.**	

Course Outcomes (COs):

By the end of the course, students will be able to:

1. **CO1**: Understand and apply the concepts of simple harmonic motion, damped oscillations, and forced oscillations in physical systems.
2. **CO2**: Analyze wave motion and its applications, including impedance matching, reflection, transmission, and standing waves.
3. **CO3**: Explain the principles of interference, diffraction, and polarization in the context of wave optics.
4. **CO4**: Analyze Fraunhofer and Fresnel diffraction patterns and understand the working of diffraction gratings.
5. **CO5**: Comprehend the principles of polarization and the production of polarized light through various techniques.

Program Specific Outcomes (PSOs):

1. **PSO1**: Gain a solid foundation in classical and modern physics, with an emphasis on wave optics and its real-world applications.
2. **PSO2**: Develop proficiency in experimental techniques, particularly in optics and wave phenomena, and apply them in research or professional fields.
3. **PSO3**: Utilize mathematical and computational tools to model physical systems involving waves and optics.
4. **PSO4**: Enhance critical thinking and problem-solving skills, preparing for higher education or careers in physics and related domains.

Matrix Articulation Table for PHYSICS-DSC 1D: WAVES AND OPTICS

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	3	2	1	1	2	3	3	2	2
CO2	3	3	2	1	2	2	3	3	2	2
CO3	3	3	3	2	2	2	3	3	3	3
CO4	3	3	3	2	1	2	3	3	3	3
CO5	3	3	2	1	1	2	3	3	3	3

Legend:

- **3**: Strong contribution
- **2**: Moderate contribution
- **1**: Slight contribution

Instructions for Paper Setters and Candidates:

1 *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(UnitIV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*

2 *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Simple harmonic motion: characteristics, graphical representation of SHM, phase relation between displacement, velocity and acceleration of a particle, executing SHM, SHM oscillator (mass attached to a spring placed on horizontal frictionless surface). energy of a simple harmonic oscillator. solution of the differential equation of SHM. Average kinetic energy, average potential energy and total energy. **(7 Lectures) Damped SHM:** Damped oscillations. differential equation of motion of one dimensional damped harmonic mechanical oscillator. Types of damping. damped harmonic electric oscillator (differential equation and its solutions). Determination of the damping constants. Logarithmic decrement. Relaxation time. The quality factor, power dissipation in a damped harmonic oscillator when damping is weak. Relation between power dissipation energy and relaxation time of damped harmonic oscillator. **(8 Lectures)**

Unit-II

The Forced Oscillator: Transient and steady behaviour of forced oscillator. Displacement and velocity variation with driving force frequency. Variation of phase with frequency. Power supplied to an oscillator and its variation with frequency. Q-value and band width. Q-value as an amplification factor (Phasor treatment to be followed). **(4 Lectures)**

Coupled Oscillators: Stiffness coupled pendulums. Normal co-ordinates and normal modes of vibration. Inductance coupling of electrical oscillators. **(3 Lectures)**

Wave Motion: The type of waves. The wave equation and its solution. Characteristic impedance of a string. Impedance matching. Reflection and transmission of energy. Reflected and transmitted energy coefficients. Standing waves on a string of fixed length. Energy of a vibrating string. Wave velocity and group velocity. **(8 Lectures)**

Unit-III

Wave Optics: Electromagnetic nature of light. Definition and Properties of wave front. Huygens Principle. **(3 Lectures)**

Interference: Division of wavefront and division of amplitude. Young's Double Slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: measurement of wavelength and refractive index. Michelson's Interferometer.

(12 Lectures)

Unit-IV

Diffraction: Fraunhofer diffraction: Single slit; Double Slit. Multiple slits & Diffraction grating, Dispersive power of diffraction grating, Fresnel Diffraction: Half-period zones. Zone plate. Fresnel Diffraction pattern of a straight edge, a slit and a wire using half-period zone analysis.

(8 Lectures)

Polarization: Transverse nature of light waves. Unpolarized and plane polarized light, production of polarized light, Wire grid polarizer, Polaroid, Effect of intensity of light passing through Polaroid, Malus' law, double refraction; ordinary ray and extraordinary ray, positive and negative crystals, birefringence, Nicol Prism, quarter wave plate and half wave plate, Polarization by reflection (Brewster law), polarization by scattering,. Circular and elliptical polarization, production of elliptically polarized and circularly polarized light.

(7 Lectures)

Reference Books:

- A text book of Optics, N. Subrahmanyam, B. Lal, M.N. Avadhanulu, S. Chand & Company Ltd.
- Fundamentals of Optics, F A Jenkins and H E White, 1976, McGraw-Hill.
- Principles of Optics, B.K. Mathur, 1995, Gopal Printing.
- Fundamentals of Optics: Geometrical Physical and Quantum, D. R. Khanna, H. R. Gulati R. Chand Publication.
- Optics, Eugene Hecht, Addison-Wesley 2002.

WAVES AND OPTICS LAB

Name of the Course	**PHYSICS-DSC 1D LAB: WAVES AND OPTICS (Credits: -02)**
Code	PHYS 202PR
Yearly Based Examination	**20 marks (3 Hrs)**
Distribution of Marks: Experiment = **8 Marks**, Written/ Skills= **4 Marks** Viva Voce = **4 Marks**, Practical Record Book= **4 Marks.**	

PHYSICS LAB-DSC 1D LAB: WAVES AND OPTICS

60 Lectures

1 To investigate the motion of coupled oscillators

2 Familiarization with Schuster`s focussing; determination of angle of prism.

3 To determine the Refractive Index of the Material of a given Prism using Sodium Light.

4 To determine Dispersive Power and Resolving power of the Material of a given Prism using Mercury Light

5 To determine the value of Cauchy Constants of a material of a prism.

6 To determine the Resolving Power of a Prism.

7 To determine wavelength of sodium light using Fresnel Bi prism.

8 To determine wavelength of sodium light using Newton's Rings.To determine the wavelength of Laser light using Diffraction of Single Slit.

9 To determine wavelength of (1) Sodium & (2) spectrum of Mercury light using plane diffraction Grating

10 To determine the Resolving Power of a Plane Diffraction Grating.

11 To measure the intensity using photo sensor and laser in diffraction patterns of single and double slits.

12 To find the refractive index of glass slab using travelling microscope

13 To find the refractive index of water using travelling microscope

14 To determine the magnifying power of a telescope.

15 To determine the specific rotation of sugar using Laurent's half-shade polarimeter.

16 Plot a graph between the concentration and rotation for various strengths of sugar solution and hence find (a) the specific rotation and (b) the concentration of the given sugar solution.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practical's, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.

3rd Year

ELEMENTS OF MODERN PHYSICS

Name of the Course	**PHYSICS-DSE 1A: ELEMENTS OF MODERN PHYSICS** **(Credits:**

	Theory-04) **Theory: 60** **Lectures**
Code	PHYS301TH
Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Lab**: Lab Seminar + Lab Attendance = **5+5 marks.**	

Course Outcomes (COs)

By the end of the course, students will be able to:

1. **CO1**: Understand the foundational concepts of quantum theory, including Planck's constant, photon nature of light, and phenomena like the photoelectric effect and Compton scattering.
2. **CO2**: Apply wave-particle duality and the de Broglie hypothesis to matter waves, and comprehend the results of the Davisson-Germer experiment.
3. **CO3**: Solve problems using the Schrödinger equation for non-relativistic particles, and interpret wave functions in the context of quantum mechanics.
4. **CO4**: Analyze quantum mechanical systems such as particles in a one-dimensional potential box, quantum tunneling, and step potential problems.
5. **CO5**: Comprehend nuclear physics principles, including the structure and properties of the atomic nucleus, radioactive decay, and nuclear fission and fusion.

Program Specific Outcomes (PSOs)

For the **B.Sc. Physical Science** or **B.Sc. Physics** program, the specific outcomes are:

1. **PSO1**: Gain a solid understanding of classical, quantum, and modern physics, enabling the application of these principles in various scientific and technological contexts.
2. **PSO2**: Develop proficiency in experimental physics, data analysis, and problem-solving techniques for research and professional pursuits.
3. **PSO3**: Prepare for higher education and research in physics and related fields, cultivating critical thinking and scientific inquiry.
4. **PSO4**: Enhance computational and analytical skills to model physical systems and solve complex problems in physics.

Matrix Articulation Table

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	2	2	1	1	1	3	2	1	1
CO2	3	3	2	1	2	1	3	3	2	1
CO3	3	3	3	2	2	1	3	3	2	2
CO4	3	3	3	2	2	1	3	3	3	2
CO5	3	3	2	2	2	1	3	3	3	2

Legend:

- **3**: Strong contribution
- **2**: Moderate contribution
- **1:** Slight contribution

Instructions for Paper Setters and Candidates:

1 *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 09 marks. Question Number 1. (Section A), will consist of seven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*

2 *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and seven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

Planck’s quantum, Planck’s constant and light as a collection of photons; Photo-electric effect and Compton scattering. De Broglie wavelength and matter waves; Davisson-Germer experiment. **(10 Lectures)**

Problems with Rutherford model- instability of atoms and observation of discrete atomic spectra; Bohr's quantization rule and atomic stability; calculation of energy levels for hydrogen like atoms and their spectra. **(5 Lectures)**

Unit-II

Heisenberg uncertainty principle- impossibility trajectory; estimating minimum energy of a confined principle; Energy-time uncertainty principle. Wave-particle duality.

(4 Lectures)

Matter waves and wave amplitude; Schrodinger equation for non-relativistic particles; Momentum and Energy operators; stationary states; physical interpretation of wave

function, probabilities and normalization; Probability and probability current densities in one dimension.

(11 Lectures)

Unit-III

One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as an example; Quantum mechanical scattering and tunnelling in one dimension - across a step potential and across a rectangular potential barrier. **(10 Lectures)**

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, semi-empirical mass formula and binding energy.

(5 Lectures)

Unit-IV

Radioactivity: stability of nucleus; Law of radioactive decay; Mean life & half-life; α decay; β decay - energy released, spectrum and Pauli's prediction of neutrino; γ-ray emission.

(11 Lectures)

Fission and fusion - mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions. **(4 Lectures)**

Reference Books:

- Concepts of Modern Physics, Arthur Beiser, 2009, McGraw-Hill
- Modern Physics, John R. Taylor, Chris D. Zafiratos, Michael A.Dubson,2009, PHI Learning
- Six Ideas that Shaped Physics: Particle Behave like Waves, Thomas A. Moore, 2003,McGraw Hill
- Quantum Physics, Berkeley Physics Course Vol.4. E.H. Wichman, 2008, Tata McGraw-Hill Co.
- Modern Physics, R.A. Serway, C.J. Moses, and C.A.Moyer, 2005, Cengage Learning
- Modern Physics, G. Kaur and G.R. Pickrell, 2014, McGraw Hill

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ELEMENTS OF MODERN PHYSICS LAB

Name of the Course	**PHYSICS-DSE 1A LAB: ELEMENTS OF MODERN PHYSICS (Credits: -02)**
Code	PHYS301PR
Yearly Based Examination	**20 marks (3 Hrs)**

Distribution of Marks: Experiment = **8 Marks**, Written/ Skills= **4 Marks** Viva Voce = **4 Marks**, Practical Record Book= **4 Marks.**

PRACTICALS – DSE 1A LAB: ELEMENTS OF MODERN PHYSICS

60 Lectures

1 To determine value of Boltzmann constant using V-I characteristic of PN diode.
2 To determine work function of material of filament of directly heated vacuum diode.
3 To determine value of Planck's constant using LEDs of at least 4 different colours.
4 To determine the ionization potential of mercury.
5 To determine the wavelength of H-alpha emission line of Hydrogen atom.
6 To determine the absorption lines in the rotational spectrum of Iodine vapour.
7 To study the diffraction patterns of single and double slits using laser source and measure its intensity variation using Photosensor and compare with incoherent source – Na light.
8 Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
9 To determine the value of e/m by magnetic focusing.
10 To setup the Millikan oil drop apparatus and determine the charge of an electron.
11 To verify the inverse square law by using photovoltaic cell.
12 To measure the DC voltage by using CRO
13 To display the action of junction Diode as (a) Half wave rectifier and (b) Full wave rectifier using CRO
14 To determine e/m by magnetron method or small solenoid method.

Reference Books:

- Advanced Practical Physics for students, B.L. Flint & H.T. Worsnop, 1971, Asia Publishing House.
- Advanced level Physics Practicals, Michael Nelson and Jon M. Ogborn, 4th Edition, reprinted 1985, Heinemann Educational Publishers
- A Text Book of Practical Physics, Indu Prakash and Ramakrishna, 11th Edition, 2011, Kitab Mahal, New Delhi.3rd Year

NUCLEAR AND PARTICLE PHYSICS

Name of the Course	**PHYSICS-DSE 1B: NUCLEAR AND PARTICLE PHYSICS** **(Credits: Theory-05, Tutorials-01)** **Theory: 72 Lectures**
Code	PHYS304TH
Yearly Based Examination	**70 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**

CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory**: Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Tutorial**: Tutorial + Tutorial Attendance = **5+5 marks.**

Course Outcomes (COs)

By the end of the course, students will be able to:

1. **CO1**: Understand the fundamental properties of atomic nuclei, including their size, mass, charge, binding energy, and models describing nuclear structure.
2. **CO2**: Analyze different types of radioactive decays (alpha, beta, gamma) and understand nuclear reactions, conservation laws, and reaction dynamics.
3. **CO3**: Explore the working principles of various nuclear detectors and accelerators, and explain their role in detecting nuclear radiation.
4. **CO4**: Gain insight into elementary particle physics, particle classifications, conservation laws, and symmetries, along with an understanding of the quark model and cosmic rays.
5. **CO5**: Apply concepts of nuclear and particle physics to solve complex problems related to nuclear reactions, particle interactions, and cosmic phenomena.

Program Specific Outcomes (PSOs)

For the **B.Sc. Physical Science** or **B.Sc. Physics** program, the specific outcomes are:

1. **PSO1**: Acquire a comprehensive understanding of nuclear structure, particle physics, and their applications in experimental and theoretical contexts.
2. **PSO2**: Develop practical skills in the operation of nuclear detectors, particle accelerators, and understanding the behavior of elementary particles.
3. **PSO3**: Demonstrate proficiency in analyzing nuclear reactions, radioactive decay processes, and cosmic rays through theoretical models and empirical data.
4. **PSO4**: Prepare for advanced research or professional work in nuclear physics, particle physics, and related fields.

Matrix Articulation Table

COs \ POs/PSOs	**PO 1**	**PO 2**	**PO 3**	**PO 4**	**PO 5**	**PO 6**	**PSO 1**	**PSO 2**	**PSO 3**	**PSO4**
CO1	3	2	2	1	1	1	3	2	2	2
CO2	3	3	3	2	2	1	3	3	3	2
CO3	3	3	3	2	2	1	3	3	3	3
CO4	3	3	3	2	2	1	3	3	3	3

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO4
CO5	3	3	2	2	2	1	3	3	3	3

Legend:

- **3**: Strong contribution
- **2**: Moderate contribution
- **1:** Slight contribution

Instructions for Paper Setters and Candidates:

1 *The question paper will consist of five sections: Section A(compulsory, covering syllabus from all the units),section B(Unit I), section C(Unit II),section D(Unit III) and section E(Unit IV). Examiner will set nine questions in all, question number 1 (One) will be compulsory and selecting two questions each from Units I, II, III and IV respectively. Each question from section B, C, D and E will carry 12 marks. Question Number 1. (Section A), will consist of eleven sub-questions each of 2 marks of types: Multiple Choice Questions (MCQ)/fill in the blanks and/or short answer type questions.*

2 *The candidate will be required to attempt five questions in all i.e. selecting one question from each sections B, C, D and E and eleven sub-questions from section A (Compulsory question number 1). The duration of the examination will be 3 hours.*

Unit-I

General Properties of Nuclei: Constituents of nucleus and their Intrinsic properties, quantitative facts about size, mass, charge density (matter energy), binding energy, average binding energy and its variation with mass number, main features of binding energy versus mass number curve, N/A plot, angular momentum, parity, magnetic moment, electric moments, nuclear excites states.

Nuclear Models: Liquid drop model approach, semi empirical mass formula and significance of various terms, condition of nuclear stability. Two nucleon separation energies, Fermi gas model (degenerate fermion gas, nuclear symmetry potential in Fermi gas), evidence for nuclear shell structure, nuclear magic numbers, basic assumption of shell model, concept of mean field, residual interaction, concept of nuclear force.

(20 Lectures) Unit-II

Radioactivity decay:(a) Alphaα decay: basics of -decay processes, theory of α-emission, Gamowα factor, Geiger Nuttall law, -decay spectroscopy. (b) β-decay: energy kinematics for β- decay, positron emission, electron capture, neutrino hypothesis. (c) Gamma decay: Gamma rays emission & kinematics, internal conversion.

Nuclear Reactions: Types of Reactions, Conservation Laws, kinematics of reactions, Q-value, reaction rate, reaction cross section, Concept of compound and direct reaction,

resonance reaction, Coulomb scattering (Rutherford scattering). **(18 Lectures)**

Unit-III

Nuclear Detectors and Accelerators: Interaction of nuclear radiation with matter: Energy loss due to ionization (Bethe-Block formula), energy loss of electrons, Cerenkov radiation, Detector for Nuclear Radiations: Gas detectors, estimation of electric field, mobility of particle, for ionization chamber and GM Counter. Basic principle of Scintillation Detectors and construction of photo-multiplier tube (PMT). Semiconductor Detectors (Si & Ge) for charge particle and photon detection (concept of charge carrier and mobility). Accelerator facility available in India: Van-de Graaff generator (Tandem accelerator), Linear accelerator, Cyclotron, Synchrotrons.

(18 Lectures)

Unit-IV

Particle Physics: Particle interactions; basic features. Classification of elementary particles and its families. Conservation Laws: energy and momentum, angular momentum, parity, Baryon number, Lepton number, Isospin, Strangeness, Gell-Mann-Nishijima Scheme, CPT theorem, parity violation in weak interactions. Particle Symmetries. Quarks Model, quantum number of quarks and gluons. Quark Model of Hadrons: Quark structure of non strange and strange hadrons, Mesons and baryons containing charm and bottom quarks, explanation of their quantum numbers in terms of their constituents quarks, Quark wave function of Mesons and nucleons, need of color quantum number. Cosmic Rays; origin of cosmic rays. primary and secondary cosmic rays, hard component and soft component, the altitude effect, the latitude effect, East–west asymmetry, cosmic rays showers. **(18 Lectures)**

Reference Books:

- Introductory Nuclear Physics by Kenneth S. Krane (Wiley India Pvt. Ltd., 2008).
- Concepts of Nuclear Physics by Bernard L. Cohen. (Tata Mcgraw Hill, 1998).
- Introduction to the physics of nuclei & particles, R.A. Dunlap. (Thomson Asia, 2004)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.
- Quarks and Leptons, F. Halzen and A.D. Martin, Wiley India, New Delhi
- Basic ideas and concepts in Nuclear Physics - An Introductory Approach by K. Heyde (IOP-Institute of Physics Publishing, 2004).
- Radiation detection and measurement, G.F. Knoll (John Wiley & Sons, 2000).
- Theoretical Nuclear Physics, J.M. Blatt & V.F. Weisskopf (Dover Pub.Inc., 1991)
- Nuclear Physics, D.C. Tayal, Himalaya Publishing House.
- Introduction to Nuclear and Particle Physics, V.K. Mittal, R.C. Verma, S.C.Gupta, Prentice Hall of India (N.Delhi)
- Introduction to Particle Physics, M.P. Khanna, Prentice Hall of India (N.Delhi)
- Introduction to Elementary Particles, D. Griffith, John Wiley & Sons.

2nd Year

Part A - COMPUTATIONAL PHYSICS - SEC1

Name of the Course	**PHYSICS –SEC1: COMPUTATIONAL PHYSICS** **(Credits: Theory-03)** **Theory: 30 Lectures**
Code	PHYS204TH
Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory:** Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Skill**: Project File or Dissertation Record + Seminar = **5+5 marks.**	

Part B - COMPUTATIONAL PHYSICS SKILL EXAM - SEC1

Name of the Course	**PHYSICS-SEC1: COMPUTATIONAL PHYSICS SKILL EXAM** **(Credits: -01)**
Maintain Project file or Dissertation to check Analytic skill/Problem solving in skill exam.	
Code	PHYS204SE
Yearly Based Skill Examination	**20 marks (3 Hrs)**
Distribution of Marks: Hands on Skill Test = **15 Marks**, Viva Voce = **5 Marks**.	

PHYSICS-SEC1: COMPUTATIONAL PHYSICS SKILL EXAM

- **Skill based Project or Dissertation work on any topic of syllabus mentioned under Computational Physics (PHYS204TH) for Analytical skill/ Problem solving.**

Course Outcomes (COs)

By the end of the course, students will be able to:

1. **CO1**: Develop and implement algorithms and flowcharts to solve basic computational problems in physics.
2. **CO2**: Apply programming concepts in FORTRAN or C++ for solving physics-related problems using Linux commands and software environments.
3. **CO3**: Utilize scientific word processing tools like LaTeX for preparing documents, reports, and creating complex mathematical equations and structures.
4. **CO4**: Demonstrate the use of electronic spreadsheets for data analysis, calculations, and plotting.
5. **CO5**: Use Gnuplot and other visualization tools to graphically represent computational data and solve physics problems through visual outputs.
6. **CO6**: Conduct hands-on problem-solving through programming exercises, file handling, and plotting of physical trajectories and models.

Program Specific Outcomes (PSOs)

For the **B.Sc. Physical Science** or **B.Sc. Physics** program, the specific outcomes are:

1. **PSO1**: Acquire computational skills in programming languages and tools essential for solving physics-related problems.
2. **PSO2**: Develop a solid foundation in the use of computer algorithms, flowcharts, and scientific programming for physics research and problem-solving.
3. **PSO3**: Use data visualization techniques and tools like Gnuplot for representing and analyzing computational data in physics.
4. **PSO4**: Master numerical methods, algorithm development, and scientific computation for advanced study in physics and related fields.

Matrix Articulation Table

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	3	2	2	2	1	3	3	2	3
CO2	3	3	3	2	2	1	3	3	3	3
CO3	2	2	3	3	2	1	3	2	2	2
CO4	3	3	3	2	2	1	3	3	3	2
CO5	3	3	3	2	3	1	3	3	3	3
CO6	3	3	3	2	2	1	3	3	3	3

Legend:

- **3**: Strong contribution
- **2**: Moderate contribution
- **1:** Slight contribution

Instructions for Paper Setters and Candidates:

1 Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,
2 The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.

The aim of this course is not just to teach computer programming and numerical analysis but to emphasize its role in solving problems in Physics.

- *Highlights the use of computational methods to solve physical problems*
- *Use of computer language as a tool in solving physics problems (applications)*
- *Course will consist of hands on training on the Problem solving on Computers.*

Introduction: Importance of computers in Physics, paradigm for solving physics problems for solution**.** Usage of linux as an Editor. **Algorithms and Flowcharts:** Algorithm: Definition, properties and development. Flowchart: Concept of flowchart, symbols, guidelines, types. Examples: Cartesian to Spherical Polar Coordinates, Roots of Quadratic Equation, Sum of two matrices, Sum and Product of a finite series, calculation of sin (x) as a series, algorithm for plotting (1) lissajous figures and (2) trajectory of a projectile thrown at an angle with the horizontal. **(4 Lectures)**

Scientific Programming: Some fundamental Linux Commands (Internal and External commands). Development of FORTRAN, Basic elements of FORTRAN: Character Set, Constants and their types, Variables and their types, Keywords, Variable Declaration and concept of instruction and program. Operators: Arithmetic, Relational, Logical and Assignment Operators. Expressions: Arithmetic, Relational, Logical, Character and Assignment Expressions. Fortran Statements: I/O Statements (unformatted/formatted), Executable and Non-Executable Statements, Layout of Fortran Program, Format of writing Program and concept of coding, Initialization and Replacement Logic. Examples from physics problems.

(4 Lectures)

Control Statements: Types of Logic (Sequential, Selection, Repetition), Branching Statements (Logical **IF**, Arithmetic IF, Block IF, Nested Block IF, SELECT CASE and ELSE IF Ladder statements), Looping Statements (DO-CONTINUE, DO-ENDDO, DO-WHILE, Implied and Nested DO Loops), Jumping Statements (Unconditional GOTO, Computed GOTO, Assigned GOTO) Subscripted Variables (Arrays: Types of Arrays, DIMENSION Statement, Reading and Writing Arrays), Functions and Subroutines (Arithmetic Statement Function, Function Subprogram and Subroutine), RETURN, CALL, COMMON and EQUIVALENCE Statements), Structure, Disk I/O Statements, open a file, writing in a file, reading from a file. Examples from physics problems.

Programming:

1 Exercises on syntax on usage of Object oriented C++/FORTRAN
2 Usage of GUI Windows, Linux Commands, familiarity with DOS commands and working in an editor to write sources codes in FORTRAN.

3 To print out all natural even/ odd numbers between given limits.
4 To find maximum, minimum and range of a given set of numbers.
5 Calculating Euler number using exp(x) series evaluated at x=1 **(4 Lectures)**

Scientific word processing: Introduction to LaTeX: TeX/LaTeX word processor, preparing a basic LaTeX file, Document classes, preparing an input file for LaTeX, Compiling LaTeX File, LaTeX tags for creating different environments, Defining LaTeX commands and environments, Changing the type style, Symbols from other languages. **Equation representation:** Formulae and equations, Figures and other floating bodies, Lining in columns- Tabbing and tabular environment, Generating table of contents, bibliography and citation, Making an index and glossary, List making environments, Fonts, Picture environment and colors, errors.

(4 Lectures)

Introduction to electronic spreadsheet: Brief history and applications, Features of MS Excel, Organization of spreadsheet, Building a spreadsheet, Entering data: Text data, numeric data, formulae, entering different functions (Mathematical, Statistical, Trigonometric, Logical, Text and Financial); Types of operators (Arithmetic, Comparison, Text Concatenation and Reference), Syntax and nesting of functions, Cell Addressing/Referencing (Absolute, Relative and Mixed). Charting using spreadsheets (4 Lectures)

Visualization: Introduction to graphical analysis and its limitations. Introduction to Gnuplot. importance of visualization of computational and computational data, basic Gnuplot commands: simple plots, plotting data from a file, saving and exporting, multiple data sets per file, physics with Gnuplot (equations, building functions, user defined variables and functions), Understanding data with Gnuplot. **(4 Lectures)**

Hands on exercises:

1 To compile a frequency distribution and evaluate mean, standard deviation etc.
2 To evaluate sum of finite series and the area under a curve.
3 To find the product of two matrices
4 To find a set of prime numbers and Fibonacci series.
5 To write program to open a file and generate data for plotting using Gnuplot.
6 Plotting trajectory of a projectile projected horizontally.
7 Plotting trajectory of a projectile projected making an angle with the horizontally.
8 Creating an input Gnuplot file for plotting a data and saving the output for seeing on the screen. Saving it as an eps file and as a pdf file.

9 To find the roots of a quadratic equation.
10 Motion of a projectile using simulation and plot the output for visualization.
11 Numerical solution of equation of motion of simple harmonic oscillator and plot the outputs for visualization.
12 Motion of particle in a central force field and plot the output for visualization.

(6 Lectures)

Reference Books:

- Introduction to Numerical Analysis, S.S. Sastry, 5th Edn., 2012, PHI Learning Pvt. Ltd.
- Computer Programming in Fortran 77". V. Rajaraman (Publisher:PHI).
- LaTeX–A Document Preparation System", Leslie Lamport (Second Edition, Addison-Wesley, 1994).
- Gnuplot in action: understanding data with graphs, Philip K Janert, (Manning 2010)
- Schaum's Outline of Theory and Problems of Programming with Fortran, S Lipsdutz and A Poe, 1986Mc-Graw Hill Book Co.
- Computational Physics: An Introduction, R. C. Verma, et al. New Age International Publishers, New Delhi(1999)
- A first course in Numerical Methods, U.M. Ascher and C. Greif, 2012, PHI Learning
- Elementary Numerical Analysis, K.E. Atkinson, 3rd Edn., 2007, Wiley India Edition.

2nd Year

Part A - ELECTRICAL CIRCUITS AND NETWORK SKILLS – SEC1/SEC2

Name of the Course	**PHYSICS-SEC1/ SEC2: ELECTRICAL CIRCUITS AND NETWORK SKILLS**

	(Credits: Theory-03) Theory: 30 Lectures
Code	PHYS205TH
Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory:** Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Skill**: Project File or Dissertation Record + Seminar = **5+5 marks.**	

Part B - ELECTRICAL CIRCUITS AND NETWORK SKILLS EXAM – SEC1/SEC2

Name of the Course	**PHYSICS-SEC1/SEC2: ELECTRICAL CIRCUITS AND NETWORK SKILLS EXAM (Credits: -01)**
Maintain Project file or Dissertation to check Analytic skill/Problem solving in skill exam.	
Code	PHYS205SE
Yearly Based Skill Examination	**20 marks (3 Hrs)**
Distribution of Marks: Hands on Skill Test = **15 Marks**, Viva Voce = **5 Marks**.	

PHYSICS-SEC1/SEC2: ELECTRICAL CIRCUITS AND NETWORK SKILLS EXAM

- **Skill based Project or Dissertation work on any topic of syllabus mentioned under Electrical Circuits and Network Skills (PHYS205TH) for Analytical skill/ Problem solving.**

Course Outcomes (COs)

By the end of the course, students will be able to:

1. **CO1**: Understand and apply basic principles of electricity such as voltage, current, resistance, power, and Ohm's law in analyzing circuits.
2. **CO2**: Analyze and troubleshoot AC and DC electrical circuits, understanding the behavior of electrical components in series, parallel, and mixed combinations.
3. **CO3**: Interpret electrical drawings, symbols, and schematics for various circuit designs, including power and control circuits.
4. **CO4**: Understand the operation of electrical machines such as generators, transformers, and motors, including AC/DC generators and single/three-phase motors.
5. **CO5**: Comprehend the functioning of solid-state devices like resistors, inductors, capacitors, diodes, and rectifiers, and their response to AC/DC sources.

6. **CO6**: Apply knowledge of electrical protection systems, including relays, fuses, circuit breakers, and grounding methods, to ensure safe operation of electrical circuits and networks.
7. **CO7**: Develop practical skills in electrical wiring, conductors, cable systems, and the preparation of extension boards, understanding different wiring configurations and voltage drop across cables.

Program Specific Outcomes (PSOs)

For the **B.Sc. Physical Science** or **B.Sc. Physics** program, the specific outcomes are:

1. **PSO1**: Acquire practical skills in designing and troubleshooting electrical circuits and systems.
2. **PSO2**: Develop the ability to read and interpret electrical drawings, symbols, and schematics for various electrical appliances and networks.
3. **PSO3**: Understand the functioning of electrical machines and protection systems for safe operation in real-world scenarios.
4. **PSO4**: Gain hands-on experience with electrical wiring, motor control, and circuit protection in various residential and industrial settings.

Matrix Articulation Table

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	3	2	2	2	1	3	2	2	2
CO2	3	3	3	2	2	1	3	3	3	2
CO3	3	2	3	2	3	1	3	3	3	3
CO4	3	3	3	2	2	1	3	3	3	2
CO5	2	2	2	3	2	1	3	2	2	2
CO6	3	3	3	3	3	1	3	3	3	3
CO7	3	3	3	2	2	1	3	3	3	3

Legend:

- **3**: Strong contribution
- **2**: Moderate contribution
- **1:** Slight contribution

Instructions for Paper Setters and Candidates:

1 Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,

2 The candidate will be required to attempt five questions in all . The duration of the examination will be 3 hours.

The aim of this course is to enable the students to design and trouble shoots the electrical circuits, networks and appliances through hands-on mode

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. (3 Lectures)

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. **(4 Lectures)**

Electrical Drawing and Symbols: 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.

(4 Lectures)

Generators and Transformers: DC Power sources. AC/DC generators. Inductance, capacitance, and impedance. Operation of transformers.

(3 Lectures)

Electric Motors: Single-phase, three-phase & DC motors. Basic design. Interfacing DC or AC sources to control heaters & motors. Speed & power of ac motor.

(4 Lectures)

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

(3 Lectures)

Electrical Protection: Relays. Fuses and disconnect switches. Circuit breakers. Overload devices. Ground-fault protection. Grounding and isolating. Phase reversal. Surge protection. Interfacing DC or AC sources to control elements (relay protection device)

(4 Lectures)

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.

(5 Lectures)

Reference Books:

- A text book in Electrical Technology - B L Theraja - S Chand & Co.
- A text book of Electrical Technology - A K Theraja
- Performance and design of AC machines - M G Say ELBS Edn.

3rd Year

Part A - RADIATION SAFETY – SEC3

Name of the Course	**PHYSICS-SEC3: RADIATION SAFETY** **(Credits:** **Theory-03)** **Theory: 30** **Lectures**
Code	PHYS307TH
Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory:** Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Skill**: Project File or Dissertation Record + Seminar = **5+5 marks.**	

Part B - RADIATION SAFETY SKILL EXAM – SEC3

Name of the Course	**PHYSICS-SEC3: RADIATION SAFETY SKILL EXAM** **(Credits: -01)**
Maintain Project file or Dissertation to check Analytic skill/Problem solving in skill **exam.**	
Code	PHYS307SE
Yearly Based Skill Examination	**20 marks (3 Hrs)**
Distribution of Marks: Hands on Skill Test = **15 Marks**, Viva Voce = **5 Marks**.	

PHYSICS-SEC3: RADIATION SAFETY SKILL EXAM

- **Skill based Project or Dissertation work on any topic of syllabus mentioned underRadiation Safety (PHYS307TH) for Analytical skill/ Problem solving.**

Course Outcomes (COs)

By the end of the course, students will be able to:

1. **CO1**: Explain the fundamental concepts of atomic and nuclear physics, including atomic structure, radioactive decay, and nuclear reactions.
2. **CO2**: Describe the interaction of various types of radiation (alpha, beta, gamma, neutron) with matter, including their sources and the associated physical processes.
3. **CO3**: Understand and apply the principles of radiation detection and measurement using different types of detectors and dosimeters.
4. **CO4**: Implement effective radiation safety management practices, including biological effects, safety standards, and waste management.
5. **CO5**: Apply nuclear techniques in various fields such as medicine, industry, and archaeology, demonstrating an understanding of their practical applications and benefits.

Program Specific Outcomes (PSOs)

For the **B.Sc. Physical Science** or **B.Sc. Physics** program, the specific outcomes are:

1. **PSO1**: Develop proficiency in identifying and mitigating radiation hazards in various settings.
2. **PSO2**: Gain hands-on experience in using radiation detection and measurement tools effectively.
3. **PSO3**: Understand and apply safety standards and regulations related to radiation protection.
4. **PSO4**: Utilize nuclear techniques in practical applications across medical, industrial, and scientific fields.

Matrix Articulation Table

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	2	2	2	2	2	2	2	2
CO2	3	3	2	2	2	3	2	2	2
CO3	2	3	3	2	2	2	3	2	2
CO4	3	2	3	3	3	2	2	3	2
CO5	2	2	2	2	3	2	2	2	3

Legend:

- **3**: Strong contribution
- **2**: Moderate contribution
- **1:** Slight contribution

Instructions for Paper Setters and Candidates:

.1 Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,

.2 The candidate will be required to attempt five questions in all. The duration of the examination will be 3 hours.

The aim of this course is for awareness and understanding regarding radiation hazards and safety. The list of laboratory skills and experiments listed below the course are to be done in continuation of the topics

Basics of Atomic and Nuclear Physics: Basic concept of atomic structure; X rays characteristic and production; concept of bremsstrahlung and auger electron, The composition of nucleus and its properties, mass number, isotopes of element, spin, binding energy, stable and unstable isotopes, law of radioactive decay, Mean life and half life, basic concept of alpha, beta and gamma decay, concept of cross section and kinematics of nuclear reactions, types of nuclear reaction, Fusion, fission. **(6 Lectures) Interaction of Radiation with matter: Types of Radiation:** Alpha, Beta, Gamma and

Neutron and their sources, sealed and unsealed sources, **Interaction of Photons** - Photo-electric effect, Compton Scattering, Pair Production, Linear and Mass Attenuation Coefficients, **Interaction of Charged Particles:** Heavy charged particles - Beth-Bloch Formula, Scaling laws, Mass Stopping Power, Range, Straggling, Channeling and Cherenkov radiation. Beta Particles- Collision and Radiation loss (Bremsstrahlung), **Interaction of Neutrons**- Collision, slowing down and Moderation. **(7 Lectures)**

Radiation detection and monitoring devices: Radiation Quantities and Units: Basic idea of different units of activity, KERMA, exposure, absorbed dose, equivalent dose, effective dose, collective equivalent dose, Annual Limit of Intake (ALI) and derived Air Concentration (DAC). **Radiation detection:** Basic concept and working principle of gas detectors (Ionization Chambers, Proportional Counter, Multi-Wire Proportional Counters (MWPC) and Gieger Muller Counter), Scintillation Detectors **(**Inorganic and Organic Scintillators), Solid States Detectors and Neutron Detectors, Thermo luminescent Dosimetry.

(7 Lectures)

Radiation safety management: Biological effects of ionizing radiation, Operational limits and basics of radiation hazards evaluation and control: radiation protection standards, International Commission on Radiological Protection (ICRP) principles, justification, optimization, limitation, introduction of safety and risk management of radiation. Nuclear waste and disposal management. Brief idea about Accelerator driven Sub-critical system (ADS) for waste management. **(5 Lectures)**

Application of nuclear techniques: Application in medical science (e.g., MRI, PET, Projection Imaging Gamma Camera, radiation therapy), Archaeology, Art, Crime

detection, Mining and oil. Industrial Uses*:* Tracing, Gauging, Material Modification, Sterization, Food preservation. **(5 Lectures)**

Experiments: Study the background radiation levels using Radiation meter
Characteristics of Geiger Muller (GM) Counter:

1 Study of characteristics of GM tube and determination of operating voltage and plateau length using background radiation as source (without commercial source).
2 Study of counting statistics using background radiation using GM counter.Study of radiation in various materials (e.g. KSO4 etc.). Investigation of possible radiation in different routine materials by operating GM at operating voltage.
3 Study of absorption of beta particles in Aluminum using GM counter.
4 Detection of α-particles using reference source & determining its half life using spark counter
5 Gamma spectrum of Gas Light mantle (Source of Thorium)

Reference Books:

1 W.E. Burcham and M. Jobes – Nuclear and Particle Physics – Longman (1995)
2 G.F.Knoll, Radiation detection and measurements
3 Thermoluninescense Dosimetry, Mcknlay, A.F., Bristol, Adam Hilger (Medical Physics Handbook 5)
4 W.J. Meredith and J.B. Massey, “Fundamental Physics of Radiology”. John Wright and Sons, UK, 1989.
5 J.R. Greening, “Fundamentals of Radiation Dosimetry”, Medical Physics Hand Book Series, No.6, Adam Hilger Ltd., Bristol 1981.
6 Practical Applications of Radioactivity and Nuclear Radiations, G.C. Lowental and P.L. Airey, Cambridge University Press, U.K., 2001
7 A. Martin and S.A. Harbisor, An Introduction to Radiation Protection, John Willey & Sons, Inc. New York, 1981.
8 NCRP, ICRP, ICRU, IAEA, AERB Publications.
9 W.R. Hendee, “Medical Radiation Physics”, Year Book – Medical Publishers Inc. London, 1981

3rd Year

Part A - RENEWABLE ENERGY AND ENERGY HARVESTING - SEC4

Name of the Course	**PHYSICS-SEC4: RENEWABLE ENERGY AND ENERGY HARVESTING** **(Credits: Theory-03)** **Theory: 30 Lectures**
Code	PHYS310TH
Yearly Based Examination	**50 marks (3 Hrs)**
Continuous Comprehensive Assessment (CCA)	**30 marks**
CCA: Based on Midterm Exam, Class Test/Seminar/Assignments/Quiz and Attendance: **CCA Theory:** Midterm Exam = **10 marks,** Class Test/Seminar/Assignments/Quiz = **05 marks,** Attendance Theory **= 05 marks. CCA Skill**: Project File or Dissertation Record + Seminar = **5+5 marks.**	

Part B - RENEWABLE ENERGY AND ENERGY HARVESTING SKILL EXAM – SEC4

Name of the Course	**PHYSICS-SEC4: RENEWABLE ENERGY AND ENERGY HARVESTING SKILL EXAM (Credits: -01)**
Maintain Project file or Dissertation to check Analytic skill/Problem solving in skill exam.	
Code	PHYS310SE
Yearly Based Skill Examination	**20 marks (3 Hrs)**
Distribution of Marks: Hands on Skill Test = **15 Marks**, Viva Voce = **5 Marks**.	

PHYSICS-SEC4: RENEWABLE ENERGY AND ENERGY HARVESTING SKILL EXAM

- **Skill based Project or Dissertation work on any topic of syllabus mentioned under Renewable Energy and Energy Harvesting (PHYS310TH) for Analytical skill/ Problem solving.**

Course Outcomes (COs)

By the end of the course, students will be able to:

1. **CO1**: Understand the limitations of fossil fuels and nuclear energy, and recognize the need for and types of renewable energy sources.
2. **CO2**: Explain the principles, technologies, and applications of solar energy, including photovoltaic systems and solar thermal technologies.
3. **CO3**: Analyze wind energy fundamentals, turbine technologies, and their integration with power grids.
4. **CO4**: Assess ocean energy potentials, including wave, tidal, and ocean thermal energy, and their technological developments.
5. **CO5**: Describe geothermal energy resources and technologies, and their role in renewable energy.
6. **CO6**: Explore piezoelectric and electromagnetic energy harvesting techniques, including their principles, applications, and environmental implications.

Program Specific Outcomes (PSOs)

For the **B.Sc. Physical Science** or **B.Sc. Physics** program, the specific outcomes are:

1. **PSO1**: Gain a comprehensive understanding of various renewable energy technologies and their practical applications.
2. **PSO2**: Develop hands-on skills in energy harvesting technologies through experimental demonstrations and projects.
3. **PSO3**: Evaluate the efficiency and sustainability of different renewable energy sources and systems.
4. **PSO4**: Apply theoretical knowledge to practical scenarios in renewable energy systems and energy harvesting techniques.

Matrix Articulation Table

COs \ POs/PSOs	PO 1	PO 2	PO 3	PO 4	PO 5	PSO 1	PSO 2	PSO 3	PSO4
CO1	3	2	3	2	2	3	2	2	2
CO2	3	3	3	2	2	3	3	2	2
CO3	2	3	2	2	2	2	2	2	2
CO4	3	2	3	2	2	3	2	3	2
CO5	2	2	2	2	3	2	2	2	3
CO6	3	2	3	3	3	2	3	3	2

Legend:

- **3**: Strong contribution
- **2**: Moderate contribution

- **1:** Slight contribution

Instructions for Paper Setters and Candidates:

1 Examiner will set seven questions in all covering the entire syllabus each of 10 marks ,

2 The candidate will be required to attempt five questions in all. The duration of the examination will be 3 hours.

The aim of this course is not just to impart theoretical knowledge to the students but to provide them with exposure and hands-on learning wherever possible

Fossil fuels and Alternate Sources of energy: Fossil fuels and Nuclear Energy, their limitation, 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.

(3 Lectures)

Solar energy: Solar energy, its importance, storage of solar energy, solar pond, non convective solar pond, applications of solar pond and solar energy, solar water heater, flat plate collector, solar distillation, solar cooker, solar green houses, solar cell, absorption air conditioning. Need and characteristics of photovoltaic (PV) systems, PV models and equivalent circuits, and sun tracking systems.

(6 Lectures)

Wind Energy harvesting: Fundamentals of Wind energy, Wind Turbines and different electrical machines in wind turbines, Power electronic interfaces, and grid interconnection topologies.

3Lectures)

Ocean Energy: Ocean Energy Potential against Wind and Solar, Wave Characteristics and Statistics, Wave Energy Devices. Tide characteristics and Statistics, Tide Energy Technologies, Ocean Thermal Energy, Osmotic Power, Ocean Bio-mass.
Geothermal Energy: Geothermal Resources, Geothermal Technologies.

(7 Lectures)

Hydro Energy: Hydropower resources, hydropower technologies, environmental impact of hydro power sources.

(2 Lectures)

Piezoelectric Energy harvesting: Introduction, Physics and characteristics of piezoelectric effect, materials and mathematical description of piezoelectricity, Piezoelectric parameters and modeling piezoelectric generators, Piezoelectric energy harvesting applications, Human power

(4 Lectures)

Electromagnetic Energy Harvesting: Linear generators, physics mathematical models, recent applications, Carbon captured technologies, cell, batteries, power consumption, Environmental issues and Renewable sources of energy, sustainability.

(5 Lectures)

Demonstrations and Experiments

1 Demonstration of Training modules on Solar energy, wind energy, etc.
2 Conversion of vibration to voltage using piezoelectric materials
3 Conversion of thermal energy into voltage using thermoelectric modules.

Reference Books:

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