NEP T.Y.B.Sc. PHYSICS

Modern Education Society's

NOWROSJEE WADIA COLLEGE
Pune-411 001

(Autonomous College Affiliated to SPPU, Pune)

Third Year B.Sc. Program in Physics
(Faculty of Science and Technology)

T.Y.B.Sc. Physics

To be implemented from the Academic Year 2025-26

The objectives of the course syllabus are:

- To constructively build theoretical as well as practical knowledge base course based on the previous FYBSc course.
- To acquire knowledge of basic concepts, theories, and processes through study of core courses in respective programs.
- To impart the understanding of mathematical terms as well as mathematical operations and their physical significance in Physics.
- To develop the ability to use practical knowledge in designing and demonstrating experiments, and the science of analysis of data generated and its interpretation.
- To work effectively in a group.
- To demonstrate oral, written and spoken skills to effectively communicate with peers and mentors.
- To develop the ability to think critically and relate learning to academic, professional and real-life problem solving.
- To acquire widespread knowledge and understanding of the subject and the ability to apply their knowledge in practice including in a multi-disciplinary setting.
- To sow the seeds of the entrepreneurship among students by exposing them to industrial importance of Physics related applications.
- To develop the self-sustained admiration towards Physics and its ability in solving social, industrial, environmental as well as research-oriented problems.

B. Sc. (Physics)

2. INDEX

3. PREAMBLE FOR THE SYLLABUS:

The syllabus has been prepared on a participatory manner, after discussion with number of faculty members in the Physics subject and after referring an existing syllabi.

In compliance with the directives from the University Grants Commission (UGC), under the autonomous status of the college, the syllabus for Physics at the undergraduate level is revised and reframed as per the National Educational Policy (NEP – 2020) curriculum framework. Nowrosjee Wadia College has decided to change the syllabi for the B.Sc. degree from June 2023 – 24 academic year, as the college has already shifted to the autonomous status from the academic year 2022 – 2023. The present syllabus is prepared by the Board of Studies in Physics, Nowrosjee Wadia College, considering the present relevance.

Considering the curricular reforms as instrumental for desired learning outcomes, department of Physics has made a rigorous attempt to revise the curriculum of undergraduate and postgraduate programmes in alignment with National Education Policy-2020 and UGC Quality Mandate for Higher Education Institutions-2021.

The process of revamping the curriculum started with the series of discussions conducted by the college authorities to orient the teachers about the key features of the Policy, enable them to revise the curriculum in sync with the NEP-2020 policy. Proper orientation of the faculty about the vision and provisions of NEP-2020 made it easier for them to incorporate the vital aspects of the Policy in the revised curriculum.

The learning outcome-based curriculum for a degree in B.Sc. (Physics) is designed to provide comprehensive foundation in the subject and to help students to develop ability to continue with further studies and research in physics. The present syllabus is prepared by the Board of Studies in Physics, Nowrosjee Wadia College, taking in to consideration the present relevance and application of the various branches of Physics. While preparing this syllabus the U.G.C. model curriculum (LOCF) and existing syllabus structure given by UGC and Savitribai Phule Pune University under NEP - 2020 is followed.

4. OBJECTIVES:

The curriculum will be taught through formal lectures with the aid of power-point presentations, audio and video tools and other teaching aids can be used as and whenever required. Emphasis will be inclined towards laboratory work for giving hands on experience to students. Students will be encouraged to accomplish semester long project in their own institute as well as in reputed institutes of National level. Aims of the Programme are as follows-

- Provide the students with a broad spectrum of Physics Courses.
- Emphasize the role of Physics in other disciplines such as (Chemical Sciences, Mathematical Sciences, Life Sciences and their applied areas)
- Develop the ability of the students to deal with physical models and formulas mathematically.
- Strengthen the student knowledge of Physics and its applications in real world.
- Provide the student with mathematical and computational tools and models to be used in solving problems.
- Equip the students with different practical, intellectual and transferable skills.
- Improve the student’s inter disciplinary skills.
- To train students in skills related to research, experiments, education, industry and market.
- To familiarize with the recent scientific and technological developments.
- To enrich knowledge through problem solving, hands on activities, study visits, research projects, etc.
- To become compatible students for research and developments in fundamental science.
- To help students to build-up a progressive and successful career in Physics and allied areas.

5. Program Outcome (PO):

The Department of Physics has outlined following 09 PO's and 10 Program Specific Outcomes (PSOs). The course syllabi and the overall curriculum have been designed to achieve these outcomes:

Program Outcome (PO)	Short title	Description: A Graduate student in Physics will be able to:
PO1	Basic Knowledge	Capable of delivering basic disciplinary knowledge gained during the programme.
PO2	In-depth Knowledge	Capable of describing advanced knowledge gained during the programme.
PO3	Critical thinking and Problem Solving abilities	Capable of analysing the results critically and applying acquired knowledge to solve the problems.
PO4	Creativity and innovation	Capable to identify, formulate, investigate and analyse the scientific problems and innovatively to design solutions to real life problems.
PO5	Research aptitude	Ability to develop a research aptitude and apply knowledge to find the solution of research problems in the concerned fields.
PO6	Holistic and multidisciplinary	Ability to gain knowledge with the holistic and multidisciplinary approach across the fields.
PO7	Skills enhancement	Learn specific sets of disciplinary or multidisciplinary skills and advanced techniques and apply them.
PO8	Ethical thinking and Social awareness	Inculcate the professional and ethical attitude and ability to relate with social problems.
PO9	lifelong learning skills	Ability to learn lifelong learning skills which are important to provide better carrier opportunities and improve quality of life.

6. PROGRAM SPECIFIC OUTCOMES (PSO):

After successful completion of Bachelor's Science degree in Physics, the student will be able to:

PSO	Short title	Description
PSO1	Fundamental Concepts	The students will acquire a scientific knowledge of the fundamental principles of Physics through study of Classical Mechanics, Electromagnetic Theory, Optics, Heat and Thermodynamics, Statistical Mechanics, Solid State Physics, Modern Physics, Quantum Mechanics and other areas of Physics
PSO2	Experimental Skills	Students should learn how to design and conduct an experiment and understand the basic physics behind it.
PSO3	Locomotive skills	Students will develop the proficiency in the handling of laboratory instruments
PSO4	Computational Techniques	The students will acquire a fair amount of computational skill using open source software packages such as Python, Numpy, Scipy, Matplotlib, SciLab etc. in both Linux and Windows platform.
PSO5	Statistical Techniques	The students will learn use of appropriate computational techniques and apply them for experimental data analysis and solving theoretical problems.
PSO6	Experimental skills	The students will learn to work independently as well as a group during laboratory sessions, projects and student seminars.
PSO7	Research attitude	Students develop aptitude of doing research through undertaking small projects and research centre visit.
PSO8	Societal Applications	Students will realize and develop an understanding of the impact of Physics on society and apply conceptual understanding of the physics in real life.
PSO9	Ethics	The student will acquainted with the recent development in the subject through of scientific literature and ethical issues related to physics.
PSO10	Communication skills	The students will learn effective communication skill to present their knowledge of physics from basic concepts to specific advanced areas in the form of preparation of laboratory note book, project work, seminar presentation, poster presentation, etc.

7. ELIGIBILITY:

- Higher secondary school certificate (10+2) (Science) or its equivalent examination with English.
- Whenever and wherever, the guidelines directed from SPPU, Pune will be followed.

8. TEACHING SCHEME:

- The course is of 3 years i.e. 6 semesters full time under graduate course.
- The course follows the NEP (National Educational Policy 2020) pattern as per Government of Maharashtra G.R(s) as follows:

सांकेतांक २०२३०४२०१९२५२६६९०८

<u>शासन निर्णय क्रमांक: एनईपी-२०२२/प्र.क्र.०९/विशि-३ शिकाना, दिनांक २० एप्रिल, २०२३</u>

- 2 Credits Theory Courses = 30 Hours (30 Lectures)
- 2 Credits Practical Course = 60 Hours (4 Hours/Week/Batch)

9. ABBREVIATIONS:

OE: Open Elective
AEC: Ability Enhancement Course
VEC: Value Education Courses
CC: Co-Curricular Courses
IKS: Indian Knowledge System
OJT: On Job Training
FP: Field Project
VS: Vocational Skill Courses
CEP: Community Engagement Project
T – Theory
P - Practical
CE - Continuous Evaluation
SEE – Semester End Examination
F.Y. – First Year
S.Y. – Second Year
T.Y. – Third Year.

10. B.Sc. Physics Course Structure:

Level	Semester	Major		Minor	OE	VSC, SEC (VSEC)	AEC, VEC, IKS	OJT, FP, CEP, CC, RP	Cum. Cr./ Sem.	Degree/ Cum. Cr.
		Mandatory	Electives							
4.5	I	4- 6 (4+2)		-	2+2	VSC:2, SEC:2	AEC:2, VEC:2,IKS:2	CC:2	20-22	UG Certificate 40-44
	II	4- 6 (4+2)		2	2+2	VSC:2, SEC:2	AEC:2, VEC:2	CC:2	20-22	
	Cum Cr.	8-12	-	2	8	4+4	4+4+2	4	40-44	
Exit option: Award of UG Certificate in Major with 40-44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor										
5.0	III	6(4+2)- 8(2*4)		4	2	VSC:2,	AEC:2	FP:2 CC:2	20-22	UG Diploma 80-88
	IV	6(4+2)- 8(2*4)		4	2	SEC:2	AEC:2	CEP: 2 CC:2	20-22	
	Cum Cr.	20-28		10	12	6+6	8+4+2	8+4	80-88	
Exit option; Award of UG Diploma in Major and Minor with 80-88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor										
5.5	V	8(2*4)-10 (2*4 +2)	4	4-6		VSC: 2-4		FP/CEP: 2	20-22	UG Degree 120-132
	VI	8(2*4)-10 (2*4 +2)	4	4				OJT :4	20-22	
	Cum Cr.	36-48	8	18-20	12	8-10 +6	8+4+2	8+6+4	120-132	
Exit option: Award of UG Degree in Major with 120-132 credits OR Continue with Major and Minor										

First Year - Semester I

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Major Mandatory (4 + 2)	Major Paper 1 (Theory)	Mechanics and Properties of Matter	2	2
	Major Paper 2 (Theory)	Physics Principles and Applications	2	2
	Major Paper (Practical)	Physics Practical - I	4	2
Major Electives				
Minor				
OE (2 + 2)		Introduction to Astronomy	2	4
		Renewable Energy Sources - I	2	
VSC (2)	Major Specific Practical I	Basic Python Programming -I	4	2
SEC (2)	Skill Paper 1 (Theory)	Basic Circuits and Network Analysis	2	2
AEC(2),	English Theory	English Communication I	2	2
VEC (2)	EVS Theory	Environment Science I	2	2
IKS (2)	Major Specific Theory	Indian Space Missions	2	2
CC (2)	CC-I Course	Physical Education / Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts Course	2	2

OE: Open Elective, AEC: Ability Enhancement Course, VEC: Value Education Courses, CC: Co-Curricular Courses, IKS: Indian Knowledge System, OJT: On Job Training, FP: Field Project, VSC: Vocational Skill Courses, CEP: Community Engagement Project.

******Courses mentioned in grey shaded rows are not offered from Physics subject.***

First Year - Semester II

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Major Mandatory (4 + 2)	Major Paper 3 (Theory)	Heat and Thermodynamics	2	4
	Major Paper 4 (Theory)	Electricity and Magnetism	2	
	Major Paper (Practical)	Physics Practical -II	4	2
Major Electives				
Minor	Minor Paper I (Theory)	Introduction to Nanoscience and Nanotechnology	2	2
OE (2 + 2)	OE (Theory)	Medical Physics	2	4
		Renewable Energy Sources-II	2	
VSC (2)	Major Specific Practical II	Basic Python Programming -II	4	2
SEC (2)	Skill Paper 1I (Theory)	Introduction to SciLab Programming language	2	2
AEC(2),	English Theory	English Communication II	2	2
VEC (2)	EVS Theory	Environment Science II	2	2
IKS (2)				
CC (2)	CC-II Course	Physical Education / Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts Course	2	2

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Second Year - Semester III

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Major Mandatory (4 + 4)	Major Core Paper 5 (Theory)	Optics	2	4
	Major Core Paper 6 (Theory)	Electronics	2	
	Major (Practical) on Major Core Paper 5	Physics Practical -III	4	4
	Major (Practical) on Major Core Paper 6	Physics Practical -IV	4	
Major Electives				
Minor (4)	Minor Paper II (Theory)	Synthesis of Nanomaterials	2	4
	Minor (Practical) On Minor Paper II	Physics Lab-I	4	
OE (2)	Theory	Physics in daily life	2	2
VSC (2)	Major Specific Practical III	Expeyes	4	2
SEC (2)				
AEC(2)	MIL	MIL-I (Hindi) / MIL-I (Marathi)	2	2
VEC (2)				
IKS (2)				
FP/CEP (2)	FP –I		6	2
CC(2)	CC III	Physical Education / Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts Course	2	2

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Second Year Semester - IV

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Major Mandatory (4 + 4)	Major Core Paper 7 (Theory)	Mathematical Methods in Physics -I	2	4
	Major Core Paper 8 (Theory)	Oscillations, Wave and Sound	2	
	Major (Practical) on Major Core Paper 7	Physics Practical -V	4	4
	Major (Practical) on Major Core Paper 8	Physics Practical -VI	4	
Major Electives				
Minor (4)	Minor Paper III (Theory)	Characterization of nanomaterials	2	4
	Minor (Practical) on Minor paper III	Physics Lab-II	4	
OE (2)	Theory	India's contribution in Science, Indian Institutes and their opportunities	2	2
VSC (2)				
SEC (2)	Skill Paper III (Theory)	Statistical tools for data analysis	4	2
AEC(2),	MIL	MIL-II (Hindi) / MIL-II (Marathi)	2	2
VEC (2)				
IKS (2)				
CEP(2)	CEP –I		6	2
CC(2)	CC-4	Physical Education / Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts Course	2	2

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Third Year Semester - V

Course Type	Course code	Course Title	Hours/Week	Credits
Major Core (8T + 2P)	Major Paper VII (Theory)	Mathematical Methods in Physics - II	2	2
	Major Paper VIII (Theory)	Classical Mechanics	2	2
	Major Paper IX (Theory)	Solid State Physics	2	2
	Major Paper X (Theory)	Classical Electrodynamics	2	2
	Major (Practical)	Major Physics Practical - V	4	2
Major Elective (2T + 2P)	Elective I (Theory)	Nanomaterials: – Synthesis	2	2
	Elective – I (Practical)	Practical on Nanomaterials: Synthesis	4	2
	OR			
	Elective II (Theory)	Physics of Semiconductor Devices	2	2
	Elective – II (Practical)	Practical – Physics of Semiconductor Devices	4	2
Minor (2T+2P)	Minor Paper – III (Theory)	Applications of Nanomaterials	2	2
	Minor Paper – III (Practical)	Practical- Applications of Nanomaterials	4	2
VSC (2P)	Major Specific Practical - III	Introduction to R software	4	2
FP/OJT/CEP (2)	FP-II/CEP-II		4	2

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Third Year Semester - VI

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Major Core (8T + 2P)	Major Paper XI (Theory)	Quantum Mechanics	2	2
	Major Paper XII (Theory)	Thermodynamics and Statistical Mechanics	2	2
	Major Paper XIII (Theory)	Atoms, Molecules and Laser Physics	2	2
	Major Paper XIV (Theory)	Nuclear Physics	2	2
	Major (Practical)	Physics Practical -VI	4	2
Major Electives (2T + 2P)	Elective III (Theory)	Nanomaterials - Characterization	2	2
	Elective III (Practical)	Practical on Nanomaterials: Characterization	4	2
	OR			
	Elective IV (Theory)	Computational Physics	2	2
	Elective IV (Practical)	Practical – Computational Physics	4	2
Minor (4)	Minor (Theory)	Basics of Python Programming	2	2
	Minor (Practical)	Practical – Basics of Python Programming	4	2
OE (2)	--	--	--	--
VSC (2P)	--	--	--	--
SEC (2)	--	--	--	--
AEC(2)	--	--	--	--
VEC (2)	--	--	--	--
IKS (2)	--	--	--	--
FP/OJT/ CEP(2)	OJT		8	4
CC	--	--	--	--

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******Courses mentioned in grey shaded rows are not offered from Physics subject.***

11. Semester wise courses (PHYSICS) with credits & evaluation scheme

Semester - I

Course Type	Course code	Course Title	Credits		Evaluation		
			T	P	CE	SEE	Total
Major Mandatory (4 + 2)	Major Paper 1 (Theory)	Mechanics and Properties of Matter	2		15	35	50
	Major Paper 2 (Theory)	Physics Principles and Applications	2		15	35	50
	Major Paper (Practical)	Physics Practical - I		2	15	35	50
OE (2T)	OE (Theory)	Introduction to Astronomy	2		15	35	50
		Renewable Energy Sources - I	2		15	35	50
VSC (2P)	Major Specific Practical I	Basic Python Programming -I		2	15	35	50
SEC (2T)	Skill Paper 1 (Theory)	Basic Circuits and Network Analysis	2		15	35	50
IKS (2T)	Major Specific Theory	Indian Space Missions	2		15	35	50

Semester II

Course Type	Course code	Course Title	Credits		Evaluation		
			T	P	CE	SEE	Total
Major Mandatory (4 + 2)	Major Paper 3 (Theory)	Heat and Thermodynamics	2		15	35	50
	Major Paper 4 (Theory)	Electricity and Magnetism	2		15	35	50
	Major Paper (Practical)	Physics Practical -II		2	15	35	50
Minor (2T)	Minor Paper I (Theory)	Introduction to Nanoscience and Nanotechnology		2	15	35	50
OE (2T)	GE/OE	India's Contribution in Science, Indian Institutes and Their Opportunities	2		15	35	50
VSC (2P)	Major Specific Practical II	Basic Python Programming -II		2	15	35	50
SEC (2T)		Introduction to SciLab Programming language	2		15	35	50

Semester - III

Course Type	Course code	Course Title	Credits		Evaluation		
			T	P	CE	SEE	Total
Major Core (4T + 2P)	Major Paper III (Theory)	Optics	2		15	35	50
	Major Paper IV (Theory)	Electronics	2		15	35	50
	Major (Practical) on Major Core Paper – III & IV	Physics Practical - III		2	15	35	50
Minor (2T + 2P)	Minor Paper - I	Synthesis of Nanomaterials	2		15	35	50
	Minor (Practical) on Minor Paper - I	Physics Minor Lab - I		2	15	35	50
GE/OE (2T)	Theory	Physics in Daily Life	2		15	35	50
VSC (2P)	Major Specific Practical - I	Expeyes		2	15	35	50
FP/CEP/OJT (2FP)	FP-I			2	15	35	50

Semester IV

Course Type	Course code	Course Title	Credits		Evaluation		
			T	P	CE	SEE	Total
Major Core (4T + 4P)	Major Paper V (Theory)	Mathematical Methods in Physics -I	2		15	35	50
	Major Paper VI (Theory)	Oscillations, Wave and Sound	2		15	35	50
	Major (Practical) on Major Core Paper – V & VI	Physics Practical - IV		2	15	35	50
		Physics Practical - V		2	15	35	50
Minor (2T + 2P)	Minor Paper - II	Characterization of Nanomaterials	2		15	35	50
	Minor (Practical) on Minor Paper - II	Minor Physics Lab – II		2	15	35	50
OE (2T)	Theory	India’s contribution in Science, Indian Institutes and their opportunities	2		15	35	50
SEC (2T)	Theory	Statistical tools for data analysis	2		15	35	50

Semester V

Course Type	Course code	Course Title	Credits		Evaluation		
			T	P	CE	SEE	Total
Major Core (8T + 2P)	Major Paper VII (Theory)	Mathematical Methods in Physics - II	2		15	35	50
	Major Paper VIII (Theory)	Classical Mechanics	2		15	35	50
	Major Paper IX (Theory)	Solid State Physics	2		15	35	50
	Major Paper X (Theory)	Classical Electrodynamics	2		15	35	50
	Major (Practical)	Major Physics Practical - V		2	15	35	50
Major Elective (2T + 2P)	Elective I (Theory)	Nanomaterials: Synthesis	2		15	35	50
	Elective – I (Practical)	Practical – Nanomaterials: Synthesis		2	15	35	50
	OR						
	Elective II (Theory)	Physics of Semiconductor Devices	2		15	35	50
	Elective – II (Practical)	Practical – Physics of Semiconductor Devices		2	15	35	50
Minor (2T+2P)	Minor Paper – III (Theory)	Applications of Nanomaterials	2		15	35	50
	Minor Paper – III (Practical)	Practical- Applications of Nanomaterials		2	15	35	50
VSC (2P)	Major Specific Practical - III	Introduction to R software		2	15	35	50
FP/OJT/CEP (2P)	FP-II/CEP-II			2	15	35	50

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******Courses mentioned in grey shaded rows are not offered from Physics subject.***

Third Year - Semester VI

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Major Core (8T + 2P)	Major Paper XI (Theory)	Quantum Mechanics	2	2
	Major Paper XII (Theory)	Thermodynamics and Statistical Mechanics	2	2
	Major Paper XIII (Theory)	Atoms, Molecules and Laser Physics	2	2
	Major Paper XIV (Theory)	Nuclear Physics	2	2
	Major (Practical)	Physics Practical -VI	4	2
Major Electives (2T + 2P)	Elective III (Theory)	Nanomaterials: Characterization	2	4
	Elective III (Practical)	Practical – Nanomaterials: Characterization	4	
	OR			
	Elective IV (Theory)	Computational Physics	2	4
	Elective IV (Practical)	Practical – Computational Physics	4	
Minor (4)	Minor (Theory)	Basics of Python Programming	2	2
	Minor (Practical)	Practical – Basics of Python Programming	4	2
OE (2)	--	--	--	--
VSC (2P)	--	--	--	--
SEC (2)	--	--	--	--
AEC(2)	--	--	--	--
VEC (2)	--	--	--	--
IKS (2)	--	--	--	--
FP/OJT/ CEP(2)	OJT		8	4
CC	--	--	--	--

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******Courses mentioned in grey shaded rows are not offered from Physics subject.***

12. Program Articulation Matrices:

B.Sc. Physics Degree (Three-year Degree Program)

Total Credits for the Program: **120 - 132**

Discipline/Subject: PHYSICS

Starting year of implementation: 2023-2024

Program Articulation Matrix for Core Courses (Major)

Semester	Title of the Course	Theory/Practical	Credits
I	Fundamentals of Physics - I	Theory	2
	Physics Practical -I	Practical	2
II	Fundamentals of Physics – II	Theory	2
	Physics Practical -II	Practical	2
III	Optics	Theory	2
	Electronics/Instruentation	Theory	2
	Physics Practical -III	Practical	2
	Physics Practical -IV	Practical	2
IV	Mathematical Methods in Physics -I	Theory	2
	Oscillations, Waves and Sound	Theory	2
	Physics Practical – V	Practical	2
	Physics Practical - VI	Practical	2
V	Mathematical Methods in Physics - II	Theory	2
	Classical Mechanics	Theory	2
	Solid State Physics	Theory	2
	Classical Electrodynamics	Theory	2
	Physics Practical -V	Practical	2
VI	Quantum Mechanics	Theory	2
	Thermodynamics and Statistical Mechanics	Theory	2
	Solid State Physics	Theory	2
	Nuclear Physics	Theory	2
	Physics Practical – VI	Practical	2

Program Articulation Matrix for Discipline Specific Elective (DSC EL)

Semester	Title of the Course	Theory/Practical	Credits
V	Nanomaterials: Synthesis	Theory	2
	Practical – Nanomaterials: Synthesis	Practical	2
	OR		
	Physics of Semiconductor Devices	Theory	2
	Practical – Physics of Semiconductor Devices	Practical	2
VI	Nanomaterials: Characterization	Theory	2
	Practical – Nanomaterials: Characterization	Practical	2
	OR		
	Computational Physics	Theory	2
	Practical – Computational Physics	Practical	2

Program Articulation Matrix for Minor:

Semester	Title of the Course	Theory/Practical	Credits
III	Synthesis of Nanomaterials	Theory	2
	Minor Physics Lab-I	Practical	2
IV	Characterization of Nanomaterials	Theory	2
	Minor Physics Lab-II	Practical	2
V	Applications of Nanomaterials	Theory	2
	Practical on Applications of Nanomaterials	Practical	2
VI	Basics of Python Programming	Theory	2
	Practical – Basics of Python Programming	Practical	2

Program Articulation Matrix for Indian Knowledge System Courses (IKS)

Semester	Title of the Course	Theory/ Practical	Credits
III	Indian Space Missions	Theory	2

Program Articulation Matrix for Open Elective (OE)

(These will be offered by Science Faculty for Arts)

Semester	Title of the Course	Theory/ Practical	Credits
I	Physics in Daily Life	Theory	2
II	India's Contribution in Science, Indian Institutes and their Opportunities	Theory	2
III	Renewable Energy – I	Theory	2
IV	Renewable Energy – II	Theory	2

Program Articulation Matrix for Vocational Courses (VSC)

Semester	Title of the Course	Theory/Practical	Credits
III	Advanced Python Programming -I	Practical	2
IV	Advanced Python Programming -II	Practical	2
V	Introduction to R Software	Practical	2

Program Articulation Matrix for Skill Enhancement Courses (SEC)

Semester	Title of the Course	Theory/Practical	Credits
I	Basic Python Programming -I	Theory	2
II	Basic Python Programming - II	Theory	2
IV	Basic Circuits and Network Analysis	Theory	2

Program Articulation Matrix for Field Project Courses (FP)

Semester	Title of the Course	Theory/Practical	Credits
III		Practical	2
V		Practical	2

13. Syllabus in detail (Sem – V)

<table>
<tr><td></td><td>MODERN EDUCATION SOCIETY’S
NOWROSJEE WADIA COLLEGE, PUNE
(AUTONOMOUS)
(NEP 1.0)</td><td>Academic Year 2025-2026</td></tr>
<tr><td colspan="3">Bachelor of Science in Physics</td></tr>
<tr><td>Year: 3rd
Semester V</td><td>Major-VII(T): Mathematical Methods in Physics-II</td><td>Credit: 2
Hours: 30</td></tr>
<tr><td colspan="3">Course specific Objectives: In this course students will learn,
➢ Curvilinear coordinates, special theory of relativity, partial differential equations, and special functions.
➢ Special functions applicable to various techniques.</td></tr>
<tr><td>Unit No.</td><td>Course Content</td><td>Lectures</td></tr>
<tr><td>1</td><td>Curvilinear Co-ordinates
1.1 Review of Cartesian, spherical and cylindrical co-ordinate, transformation equation, General Curvilinear co-ordinate system: Co-ordinate surface, co-ordinate lines, length, surfaces and volume elements in curvilinear co-ordinate system.
1.2 Orthogonal curvilinear co-ordinate system, expressions for gradient, divergence, Laplacian, and curl, special case for gradient, divergence and curl in Cartesian, spherical polar and cylindrical co-ordinate system
1.3 Problems.</td><td>10</td></tr>
<tr><td>2</td><td>Partial Differential Equations
2.1 Introduction to Partial differential equations (PDE), General methods for solving second order PDE,
2.2 Method of separation of variables in Cartesian, Spherical polar and cylindrical co-ordinate system (two-dimensional Laplace’s equation, one dimensional Wave equation), Singular points ($x = x_0$),
2.3 Solution of differential equation-Statement of Fuch’s theorem,
2.4 Frobenius method of series Solution.
2.5 Problems</td><td>12</td></tr>
<tr><td>3</td><td>Special Functions
3.1 Introduction, generating function for Legendre Polynomials: $P_n(x)$, Properties of Legendre Polynomials,
3.2 Generating function for Hermite Polynomials: $H_n(x)$, Properties of Hermite Polynomials
3.3 Bessel function of first kind: $J_n(x)$, Properties of Bessel</td><td>8</td></tr>
</table>

	function of first kind, 3.4 Problems.	
References /Resources	1. Mathematical methods for physicists, Arfken and Weber, Academic press New York, 7th Edition. 2. Mathematical physics, Rajput, Pragati prakashan-1997. 3. Mathematical methods in the physical sciences – Marry L. Boas, John Willy & Sons publication, 3rd Edition-2005. 4. Introduction to special relativity, Robert Resnick, John Wiley & Sons, Inc. - 1968. 5. Mathematical physics, B. D. Gupta, Vikas publishing house Pvt. Ltd., 4th edition-2010. 6. Mathematical physics, H. K. Dass, Dr. Rama Varma, S. Chand & Company Pvt. Ltd.,7th Edition-2014 7. The Special Theory of Relativity: A Mathematical Approach-Farook Rahaman, Springer Publication -2014.	
Learning Outcomes	Students will, ➢ Able to generate programming solution for defined problem statement. ➢ Students could able to apply numerical methods easily in required field of problem statement. ➢ Students can apply mathematical methods in physics in research as well as Industries.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
	Bachelor of Science in Physics	
Year: 3rd **Semester V**	**Major – VIII (T): Classical Mechanics**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course students will learn,

- To know the concept of constraint, degree of freedom, generalized coordinates.
- To use Langrangain and Hamiltonian to solve dynamical problem.
- To know motion under central force field. Kepler's planetary motion.

Unit No.	Course Content	Lectures
1	**Constrained Motion** 1.1 Constraints- Definition, Classification and Examples. 1.2 Constrained system, Forces of constraint and constrained motion. 1.3 Degrees of Freedom and Configuration space. 1.4 Generalized coordinates, Transformation equations and generalized notions and relations, 1.5 Principle of Virtual work and D'Alembert's principle. 1.6 Problems	6
2	**Lagrangian Formalism** 2.1 Lagrange's equation of motion derived from Newtonian formulation, Comparison of Newtonian and Lagrangian formulation 2.2 Lagrangian for conservative and non-conservative systems. 2.3 Cyclic coordinates, and Conservation laws. 2.4 Simple examples based on Lagrangian formulation – Atwood's machine, simple pendulum, motion of particle along inclined plane, SHM. 2.5 Problems	9
3	**Hamiltonian Formalism** 3.1 Hamilton's equation of motion (derivation), Comparison of Lagrangian and Hamiltonian formulation. 3.2 Phase space, Hamiltonian for conservative and non-conservative systems. Physical significance of Hamiltonian. 3.3 Hamiltonian formulation, cyclic coordinates and construction of Hamiltonian from Lagrangian. 3.4 Simple examples based on Hamiltonian formulation – Atwood's machine, particle on inclined plane, Simple Harmonic motion. 3.5 Problems	9
4	**Central Force**	6

	4.1 Definition and properties (with proof) of central force. 4.2 Equation of motion and differential equation of orbit. 4.3 Bound and unbound orbits. 4.4 Motion under inverse square law of force and derivation of Kepler's laws.	
References /Resources	1. R.G. Takwale, P.S. Puranik, "Introduction to Classical Mechanics", McGraw Hill, 2017 2. Dr. J.C. Upadhyaya, "Classical Mechanics", Himalaya Publishing House, 2019. 3. P. V.Panat, " Classical Mechanics" , Narosa , 2008 4. Herbert Goldstein, Charles P. Poole, John L. Safko, "Classical Mechanics", Pearson Education, India, 2011, 3e	
Learning Outcomes	On completion of the course, students will be able to describe: ➢ This course in Classical Mechanics serves as the foundation for further study of physics at post graduate level. ➢ Student will be able to find Lagrange of given physical system and use Lagrangain equation of motion to obtain its solution. ➢ Student will be able to obtain Hamilton and use Hamilton equation of motion. ➢ Central force helps student to understand motion of celestial objects.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year** **2025-2026**
	Bachelor of Science in Physics	
Year: 3rd **Semester V**	**Major-IX (T): Solid State Physics**	**Credit: 2** **Hours: 30**

Course Specific Objectives:

- Understanding the basics of crystal structures in crystalline solids
- Understanding the imagination of reciprocal lattice space in solids
- Understanding of X ray diffraction processes and extraction of crystalline parameters from cubic crystalline solids
- Understanding of free electron theory in case of crystalline solids and the Quantum Physics involved in the Solid State Physics

Unit No.	Course Content	Lectures
1	**Crystalline solids** 1.1 Lattice space and basis 1.2 Crystal structure and concept of periodicity 1.3 Position vectors and translational vectors in lattice space 1.4 Primitive cells and unit cells in solids 1.5 Symmetry operations on crystal lattices 1.6 Bravais Lattices (2D and 3D) 1.7 Concept of Miller Indices and crystalline plane identification 1.8 Derivation of inter-planar distance 1.9 Comparative study of properties of cubic crystal system (FCC, BCC and SC) 1.10 Special crystal structures: a. NaCl b. Diamond 1.11 Concept of reciprocal lattice space 1.12 Numerical problems	12
2	**Diffraction of X-rays by crystalline solids** 2.1 Concept of X-ray diffraction 2.2 Bragg's law of X-ray diffraction in real and reciprocal lattice space 2.3 Concept of Ewald's construction 2.4 Experimental methods for X-ray diffraction: a. Loue's method b. Rotating crystal method c. Bragg's spectrometer method d. Debye-Scherrer Powder crystal method	6

	2.5 Concept of Brillouin zones 2.6 Numerical problems	
3	**Free electron theory of metals** 3.1 Introduction and background of classical free electron theory 3.2 Drude-Lorentz classical free electron theory 3.3 Achievements and shortcomings of Drude-Lorentz classical theory 3.4 Introduction to Schodinger's wave equation 3.5 Sommerfeld's free electron theory 3.6 Quantization of electron energy 3.7 Concept of Fermi energy level 3.8 Nearly free electron theory in solid 3.9 Origin of energy band gap 3.10 Concept of Hall effect: a. Derivation of Hall Field b. Derivation of Hall Coefficient c. Mobility of charge carriers 3.11 Applications of Hall effect 3.12 Problems	12
References /Resources	1. Solid State Physics, S. O. Pillai (New Age International Publishing) 2. Introduction to Solid State Physics, Charles Kittel (John Wiley and Sons.) 3. Elementary Solid State Physics, Ali Omar (Addison-Wesley Publishing Company) 4. Solid State Physics, N. W. Ashcroft and N. D. Mermin (CBS Publishing Asia Ltd.) 5. Introductory Solid State Physics, H. P. Myers (Viva Books Pvt. Ltd.) 6. Solid State Physics, A. J. Dekkar (Prentice Hall). 7. Solid States Physics – M. A. Wahab (Narosa publishing house)	
Learning Outcomes	On completion of the course, students will be able to: ➢ Gain insights for different crystal structures of solids and calculations related to the specific crystal structures ➢ Imagine and understand reciprocal lattice space and its application the in crystalline solids ➢ Understand the X-ray diffraction process and the information it extracts from the crystalline materials ➢ Expand the notions of classical and quantum developments in understanding the interaction of electrons and ionic cores in solids and related effects they generate.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year** **2025-2026**
	Bachelor of Science in Physics	
Year: 3rd **Semester V**	**Major-X (T): Classical Electrodynamics**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course students will learn,

- To introduce concepts of Gauss law, scalar electric potential etc. from electrostatics in free space and material medium. To develop electrostatics in dielectric media and understand polarization of medium.
- To study magnetostatics and develop concepts from Ampere's law in straight wire and solenoid. Explain magnetic vector potential.
- To develop magnetostatics in matter and introduce Maxwell's equations.
- To apply the concepts of electrodynamics for electromagnetic waves and develop Poynting's theorem.

Unit No.	Course Content	Lectures
1	**Electrostatics:** **Fundamental Concepts** 1.1 Coulomb's Law: Describes the force between two point charges in terms of their magnitudes, separation distance, and the electrostatic constant. 1.2 Gauss' Law: Integral and differential forms relating electric flux to the enclosed charge distribution. 1.3 Electric Field (E): Vector field describing the force experienced per unit charge. 1.4 Electrostatic Potential (ϕ): Scalar function whose gradient gives the electric field. Potential Energy of System of Charges 1.5 Energy stored in the configuration of multiple charges in an electric field. **Boundary Value Problems in Electrostatics** 1.6 Laplace Equation in Cartesian System: Solutions in specified boundary conditions. 1.7 Method of Image Charges: Technique to simplify electrostatic problems by introducing imaginary charges. 1.8 Example 1: Point charge near an infinite grounded conducting plane. 1.9 Example 2: Point charge near a grounded conducting sphere. **Polarization and Electric Displacement**	10

	1.10 Polarization (P): Electric dipole moment per unit volume. 1.11 Electric Displacement (D): $D = \varepsilon_o E + P$. 1.12 Electric Susceptibility and Dielectric Constant. 1.13 Bound surface and volume charge densities.	
2	**Magnetostatics:** **Fundamental Concepts** 2.1 Biot-Savart Law: Relates magnetic field to current element in space. 2.2 Ampère's Law: Describes the magnetic field generated by an electric current. **Magnetic Vector Potential (A)** 2.3 Vector potential whose curl gives the magnetic field. **Magnetic Properties of Materials** 2.4 Energy Density in Magnetic Fields. 2.5 Magnetization of Matter (B, H, M). 2.6 Magnetic Susceptibility and Permeability. 2.7 Hysteresis Loss and BH Curve. 2.8 Types of Magnetic Materials: Diamagnetic, Paramagnetic, and Ferromagnetic substances.	10
3	**Electrodynamics** **Time-Varying Fields** 3.1 Faraday's Law of Induction: Induced emf in a loop due to changing magnetic flux. 3.2 Generalized Ampère's Law: Incorporates displacement current for time-varying electric fields. 3.3 Maxwell's Equations: Unified framework describing electric and magnetic fields in both differential and integral forms. **Wave Propagation** 3.4 Wave Equation: Derived from Maxwell's equations. 3.5 Plane Waves in Free Space: Characteristics and properties of propagating electromagnetic waves. **Poynting Theorem and Energy Flow** 3.6 Describes energy transfer in an electromagnetic field.	10
References /Resources	1. Introduction to Electrodynamics, David J Griffiths, 4th edition, Pearson. 2. Electricity and magnetism, Reitz, Milford and Christie, Narosa Publishing House. 3. Engineering Electrodynamics: William Hayt Jr. & John H. Buck (TMH). 4. Feynman Lecture Series, Volume II, The New Millenium Edition.	
Learning Outcomes	On completion of the course, students will be able to describe: ➢ Understand the laws of electrodynamics and be able to perform calculations using them. ➢ Understand Maxwell's electrodynamics and its relation. ➢ Understand how optical laws can be derived from electromagnetic principles.	

	➢ Develop quantitative problem-solving skills.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 3rd **Semester V**	**Major (P): Physics Laboratory-V**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course,

- Students should learn how to design and conduct an experiment and understand the basic physics behind it.

Unit No.	Course Content
1	Moment of Inertia by Bifilar suspension
2	Surface tension of a liquid by Fergusson method
3	Surface tension of mercury by Quincke's method
4	Self-Inductance by Anderson bridge
5	Core losses in transformers
6	Determination of crystallite size from X-ray diffraction spectra
7	Resistivity by Four Probe Method
8	Y by Vibration of wooden scale
9	Hall Effect: To determine the Hall Coefficient
10	Energy-gap of a Semiconductor
11	To verify Stefan's fourth power law
12	Determination of Boltzmann constant
13	e/m by Thomson Method
14	To locate position of points on a sphere and calculate volume element using spherical coordinate system.
15	To locate position of points on a cylinder and find volume element using cylindrical coordinate system.
References /Resources	1. Undergraduate Physics Practical, Pragati Publication. 2. Analog Enectronics: Malvino 3. Solid State Electronic Devices, by Streetman and Banarjee, Pearson Publication. 4. Modern Physics, by A. B. Gupta, Arunabha Sen Books and Allied Publishing (P) ltd. 5. Elements of X-ray diffraction by B. D. Cullity, S. R. Stock, Pearson Publication.
Learning Outcomes	**Students can;** ➢ Students will be able to learn how to design and conduct an experiment and understand the basic physics behind it.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(Autonomous)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 3rd	**Elective-I (T): Nanomaterials: Synthesis**	**Credit: 2**
Semester V		**Hours: 30**

Course Specific Objectives - In this course students will learn,

- The basic concept of nanostructures, nanoscience and nanotechnology.
- The influence of dimensionality of the object at nanoscale on their properties.
- Size and shape controlled synthesis of nanomaterials.

Unit No.	Course Content	Lectures
1	**Introduction of Nanomaterials** 1.1 Introduction: Nanoscale, Nanoscience and Nanotechnology, 1.2 Classifications based on dimensions: 0D, 1D, 2D and 3D nanomaterials 1.3 Concept of bulk versus nanomaterials: Size, surface area to volume ratio and physical properties 1.4 Properties of nanomaterials	10
2	**Top-down approaches** 2.1 Mechanical milling method 2.2 Pulse laser deposition method 2.3 Sputtering deposition method i. Magnetron sputtering ii. RF sputtering 2.4 Thermal evaporation method	10
3	**Bottom-up approaches** 3.1 Co-precipitation method 3.2 Solvothermal/hydrothermal method 3.3 Microwave synthesis 3.4 Spray pyrolysis technique 3.5 Sol–gel method 3.6 Chemical Reduction Method 3.7 Green Synthesis	10
References /Resources	1. The Chemistry of Nanomaterials edited by C.N.R.Rao, A.Muller, A.K.Cheetham— Wiley-VCH Verlag GmbH & co. Volumes 1&2 2. WTEC Panel Report on Nanostructure Science and Technology edited by Richard Siegel, Evelin Hu7M.C.RoCo—Kluwer Academic Publishers, Boston/London. 3. Nanotechnology: Principle and Practices by Dr. Sulbha Kulkarni.	

	4. Nanoscopic Materials – Size Dependent Phenomenon, E. Roduner, RSC Publishing 2006. 5. Nanochemistry – A Chemical Approach to Nanomaterials, G. A. Ozim, A. C. Arsenault, L. Cadematiri, RSC Publishing 2009.
Learning Outcomes	On completion of the course, students will be able to describe: ➢ Learn about the basic concepts of nanoscience and different types of nanomaterials ➢ Various top-down and bottom-up approaches to synthesize the nanomaterials. ➢ Learned knowledge to develop nanomaterials. ➢ Choose appropriate synthesis technique to synthesize nanostructures of desired size, shape and surface properties. ➢ Correlate properties of nanostructures with their size, shape and surface characteristics.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2024-2025**
Bachelor of Science in Physics		
Year – 3rd	**Major Elective-I (P): Practical on Nanomaterials: Synthesis**	**Credits 2**
Semester-V		**Hours 60**

Course specific objectives -Understand

- The basic concept of nanostructures, nanoscience and nanotechnology.
- Hands on training for various physico-chemical route to synthesis of nanomaterials
- The influence of dimensionality of the object at nanoscale on their properties
- Size and shape controlled synthesis of nanomaterials

Sr. No.	**COURSE CONTENT**
1	Synthesis of metal sulphide nanoparticles by chemical co-precipitation method
2	Synthesis of metal nanoparticles using chemical reduction method
3	Synthesis of oxide nanostructures using Sol-Gel method
4	Synthesis of metal oxide nanostructures using hydrothermal method
5	Synthesis of inorganic sulphide nanostructures using solvothermal method
6	Preparation of films by dip coating / spin coating method
7	Preparation of thin film using spray pyrolysis method
8	Biosynthesis of metal oxide nanoparticles using plant extracts
9	Biosynthesis of metal nanoparticles using plant extracts
10	Extraction of protein and estimation by lowry's method
11	Scientific visit equivalent to **four experiments** with report submission by each student.
References /Resources	1. The Chemistry of Nanomaterials edited by C.N.R.Rao, A.Muller, A.K.Cheetham— Wiley-VCH Verlag GmbH & co. Volumes 1&2. 2. WTEC Panel Report on Nanostructure Science and Technology edited by Richard Siegel, Evelin Hu7M.C.RoCo—Kluwer Academic Publishers, Boston/London. 3. Nanomaterials by Dr. Sulbha Kulkarni. 4. Nanoscopic Materials – Size Dependent Phenomenon, E. Roduner, RSC Publishing 2006. 5. Nanochemistry – A Chemical Approach to Nanomaterials, G. A. Ozim, A. C. Arsenault, L. Cadematiri, RSC Publishing 2009.
Learning outcomes	Students will have achieved the ability to ➢ Various top-down, bottom-up and bio-synthesis approaches are discussed to synthesize the nanomaterials. ➢ Learned knowledge to develop nanomaterials. ➢ Choose appropriate synthesis technique to synthesize nanostructures of desired size, shape and surface properties.

	➢ Correlate properties of nanostructures with their size, shape and surface characteristics.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE (AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
	Bachelor of Science in Physics	
Year: 3rd **Semester V**	**Major Elective-II (T): Fundamentals of Semiconductor Devices**	**Credit: 2** **Hours: 30**

Course Specific Objectives:

- This course seeks to cover the basics of semiconductor devices including the physics of energy bands, doping and carrier statistics and transport leading up to the understanding of common semiconductor devices including p-n junctions and their applications, BJTs and MOSFETs.
- The course will also give a flavour of the basics of compound semiconductors and their devices, and also touch base with opto-electronic devices such as solar cells, photodetectors and LEDs.
- In parallel, the course will consistently seek to engage the audience by giving real-life examples pertaining to the content, and also seek to calibrate the content with respect to practical and commercial technologies which are all around us and which use semiconductor devices.
- Numerical on each module will understand better the basic concepts and functioning of semiconductor devices.

Unit No.	Course Content	Lectures
1	**Introduction to Semiconductors:** 1.1 Introduction to semiconductors 1.2 Concept of energy bands and its formation 1.3 Effective mass of electrons, E-k diagram, Concept of holes 1.4 Concept of Fermi level 1.5 Fermi-Dirac distribution. 1.6 Doping (extrinsic & intrinsic semiconductor) 1.7 Density of states. 1.8 **Problems**	08
2	**Transport of Carriers in Semiconductors:** 2.1 Equilibrium electron-hole concentration 2.2 temperature-dependence 2.3 Carrier scattering and mobility, velocity saturation, Drift-diffusion transport 2.4 Excess carrier decay & recombination, 2.5 charge injection 2.6 Continuity equation, quasi-Fermi level. 2.7 **Problems**	07
3	**Semiconductor Junction:**	08

	3.1 p-n junction static behaviour (depletion width, field profile) 3.2 p-n junction under forward & reverse bias, 3.3 Current equations 3.4 Generation-recombination current. 3.5 Ohmic and Schottky contacts. 3.6 **Problems**	
4	**Semiconductor Devices** 4.1 Concept and Physics behind the FET 4.2 MOSFET, MODFET 4.3 BJT, SCR 4.4 Solar Cells, LED's 4.5 **Problems**	07
References /Resources	1 B. Streetman and S. Banerjee, Solid State Electronics, Prentice Hall India, (2006). 2 S. M. Sze, Physics of Semiconductor Devices, Wiley, 1996. 3 M. S. Tyagi, Introduction to semiconductor materials and devices, John Wiley, (2000). 4 D. A. Neemen, Semiconductor Physics and Devices, TMH, 3rd Edn., 2007.	
Learning Outcomes	Students will have achieved the ability to: ➢ Gain a solid foundation in the properties and behaviours of semiconductor materials, including intrinsic and extrinsic semiconductors, doping, and charge carriers. ➢ Learn about energy bands, band gaps, and their significance in determining the electrical properties of semiconductors. ➢ Study the various carrier transport mechanisms such as drift, diffusion, and recombination processes. ➢ Understand the formation, characteristics, and operation of p-n junctions, including forward and reverse bias conditions. ➢ Explore the principles, types, and applications of diodes, including Zener diodes, LEDs, and photodiodes. ➢ Learn about the structure, operation, and characteristics of different types of transistors, including Bipolar Junction Transistors (BJTs) and Field Effect Transistors (FETs). ➢ Gain insights into the basic processes and techniques involved in semiconductor device fabrication. ➢ Understand the practical applications of semiconductor devices in various electronic systems and circuits.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE (AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 3rd **Semester V**	**Major Elective-II (P): Practical on Physics of Semiconductor Devices**	**Credit: 2** **Hours: 60**
Sr. No.	**Title of the Practical**	
1	Diode Characteristics	
2	I-V Characteristics of UJT	
3	Transfer Characteristics of JFET	
4	Temperature dependent resistance of the semiconductor	
5	Examine the I-V characteristics of LED	
6	Determine the input and output characteristics of a BJT in common-emitter configuration.	
7	Measure the carrier lifetime in a semiconductor sample	
8	Perform C-V measurements on a semiconductor device to analyse doping profiles.	
9	Study the response of a photoresistor (LDR) to varying light intensities.	
10	Study the characteristics and applications of Silicon Controlled Rectifiers (SCR).	
11	Characteristics of Solar Cell.	
12	UJT as staircase generator.	
13-15	**Semiconductor Industry/ Institute Visit.**	
References /Resources	1 B. Streetman and S. Banerjee, Solid State Electronics, Prentice Hall India, (2006). 2 S. M. Sze, Physics of Semiconductor Devices, Wiley, 1996. 3 M. S. Tyagi, Introduction to semiconductor materials and devices, John Wiley, (2000). 4 D. A. Neemen, Semiconductor Physics and Devices, TMH, 3rd Edn., 2007.	
Course Outcomes	**Students will have achieved the ability to:** ➢ Graduates will demonstrate the ability to apply foundational knowledge of semiconductor physics and engineering principles to practical experiments and real-world challenges. ➢ Students will gain expertise in using laboratory equipment and techniques for analysing the properties and functionalities of semiconductor devices, fostering a hands-on approach to learning. ➢ Graduates will be equipped to design experiments, analyse data, and evaluate results for improving semiconductor device performance or solving technological issues. ➢ The practical course will foster an attitude of continuous learning and adaptability in rapidly evolving technological fields. ➢ The course will emphasize the importance of precision, ethics, and quality in conducting experiments and reporting findings.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
	Bachelor of Science in Physics	
Year: 3rd **Semester V**	**Minor (T) : Application of Nanomaterials**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course students will learn,

- Develop critical thinking skills to evaluate the potential applications and limitations of nanomaterials.
- Learn how to design and conduct experiments to characterize and test the properties of nanomaterials.
- Familiarize yourself with the challenges and opportunities of working with nanomaterials in interdisciplinary teams.

Unit No.	Course Content	Lectures
1	**Nanomaterials for Photocatalysis** 1.1 Introduction of Photocatalyst 1.2 Mechanism of photocatalysis 1.3 Design nanomaterials toward enhanced photocatalytic activity 1.4 Environmental Remediation 1.4.1 Water Purification 1.4.2 Air Purification 1.5 Energy Applications 1.5.1 Hydrogen Production: Photoelectrochemical (PEC) and Water splitting 1.5.2 Carbon Dioxide Reduction 1.6 Challenges and future direction in photocatalysis	10
2	**Nanomaterials for Energy applications** 2.1 Introduction of Energy need 2.2 Energy storage 2.2.1 Battery 2.2.2 Supercapacitors 2.3 Energy Conversion 2.3.1 Solar cell 2.3.2 Fuel Cell 2.4 Challenges and future direction in field of energy	10
3	**Nanomaterials for Biological applications** 3.1 Introduction of Nanobiomaterials 3.2 Introduction of Antibacterial activity 3.2.1 Bacterial cell structure 3.2.2 Mechanisms of bacterial growth 3.2.3 Antibiotic resistance	10

	3.2.4 Antibacterial agents 3.3 Antibacterial mechanism of Nanoparticles 3.3.1 Membrane disruption 3.3.2 Oxidative stress generation 3.3.3 Metal ion release 3.3.4 DNA damage 3.4 Methods to study Antibacterial activity 3.5 Factors influencing Antibacterial activity 3.6 Challenges and future direction in biomedical field.	
References /Resources	1. Nanomaterials: Synthesis, Properties, and Applications" by Ashutosh Tiwari, Mikael Syväjärvi, and Rajeev Ahuja (CRC Press, 2014) 2. Photocatalysis: Fundamentals and Applications" by Noboru Yamamoto (Springer, 2019). 3. Nanomaterials for Energy Storage and Conversion by Yat Li, Zhong Lin Wang, and Wei Chen (CRC Press, 2016). 4. Nanomaterials for Solar Energy Conversion by Xiaojing Hao, Martin 5. A. Green, and Gavin Conibeer (Wiley, 2018). 6. Nanomaterials for Biomedical Applications" by Ashutosh Tiwari, Mikael Syväjärvi, and Rajeev Ahuja (CRC Press, 2017).	
Learning Outcomes	On completion of the course, students will be able to describe: ➢ Learn about the use of nanomaterials in energy storage and conversion, including batteries, supercapacitors, and solar cells. ➢ Familiarize yourself with the applications of nanomaterials in environmental remediation, including water treatment and air purification. ➢ Understand the importance of scaling up nanomaterials synthesis for industrial applications. ➢ Learn about the best practices for handling and disposing of nanomaterials.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 3rd **Semester V**	**Minor (P): Practical on Application of Nanomaterials**	**Credit: 2** **Hours: 60**

Course Specific Objectives - In this course students will learn,

- Develop critical thinking skills to evaluate the potential applications and limitations of nanomaterials.
- Learn how to design and conduct experiments to characterize and test the properties of nanomaterials.
- Familiarize yourself with the challenges and opportunities of working with nanomaterials in interdisciplinary teams.

Sr. No.	Title of Practical
1	To study visible light photocatalytic degradation of various dyes using metal sulphides/oxides.
2	To study the degradation of pollutants using TiO2/ ZnO/ Fe2O3 nanomaterials.
3	Carbon-based nanomaterials (e.g., graphene, carbon nanotubes) for photo-catalytic hydrogen generation.
4	Study the detection of biomolecules using nanoparticles (e.g., metal nanoparticles, quantum dots).
5	Study the energy storage properties of nanostructures materials (e.g. lithium-ion batteries, supercapacitors).
6	Study of I-V measurement of thin film.
7	I-V characteristics of heterolayer memristor device.
8	To study the behaviour of thermochromic glass.
9	To estimate core losses in the transformers
10	Hall Effect: To determine the Hall Coefficient
11	Energy-gap of a Semiconductor
12	Work function of given metal using photocell.
13	Study tour to research institute/ industry for applicability of nanomaterials (which is equivalent to 4 practical's)
14	
15	

References /Resources

1. Carbon-Based Nanomaterials for Photocatalytic Applications" by Rajender Boddula and S. B. Jonnalagadda (Wiley, 2020).
2. Metal Oxide Nanomaterials for Photocatalytic Applications" by Yat Li, Zhong Lin Wang, and Wei Chen (CRC Press, 2017).
3. Nanomaterials for Photocatalytic Degradation of Pollutants" by Ashutosh Tiwari, Mikael Syväjärvi, and Rajeev Ahuja (CRC Press, 2019).
4. Photocatalysis: Fundamentals and Applications" by Noboru Yamamoto (Springer, 2019).

	5. Nanomaterials for Energy Storage and Conversion by Yat Li, Zhong Lin Wang, and Wei Chen (CRC Press, 2016). 6. Nanomaterials for Solar Energy Conversion by Xiaojing Hao, Martin A. Green, and Gavin Conibeer (Wiley, 2018). 7. Nanomaterials for Biomedical Applications" by Ashutosh Tiwari, Mikael Syväjärvi, and Rajeev Ahuja (CRC Press, 2017).
Learning Outcomes	On completion of the course, students will be able to describe: ➢ Learn about the use of nanomaterials in energy storage and conversion, including batteries, supercapacitors, and solar cells. ➢ Familiarize yourself with the applications of nanomaterials in environmental remediation, including water treatment and air purification. ➢ Understand the importance of scaling up nanomaterials synthesis for industrial applications. ➢ Learn about the best practices for handling and disposing of nanomaterials.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
	Bachelor of Science in Physics	
Year: 3rd **Semester V**	**VSC (P): Practical's in R language**	**Credit: 2** **Hours: 60**

Course Specific Outcome:

- Understand the fundamental concepts of R programming, including syntax, data types, and basic functions.
- Recognize the importance of R in statistical analysis, data visualization, and data science.
- Apply R programming skills to import, clean, and manipulate datasets of Physics experiments.
- Analyse complex datasets using advanced R functions and packages.
- Create and interpret various types of data visualizations, including scatter plots, histograms, and box plots.

Practical No.	Name of the Practical
1	Arithmetic operations in R
2	Use of data vectors in calculations
3	Matrix multiplication
4	Verify the Logical and Relational operations
5	Data handling using R software
6	Use of conditional loops in numerical methods
7	Study the different Sequences in R software
8	Use of list operation in R
9	Strings operations in R
10	Identify the missing data in R
11	Calculations of statistical functions using R
12	Graph plotting using R
13	Plotting of histogram using R
14	Actual bank data handling using R-1
15	Data from Neutron Stars data analysis using R

References /Resources

1. R for Data Science by Hadley Wickham and Garrett Grolemund, O'Reilly Media, Inc, 2nd Edition 2023.
2. The Book of R: A First Course in Programming and Statistics by Tilman M. Davies, No Starch Press, 1st Edition, 2016.
3. R for Dummies by Andrie de Vries and Joris Meys, 2nd Edition, Wiley, 2016.
4. The Art of R Programming: A Tour of Statistical Software Design by Norman Matloff, No Starch Press, 1st Edition, 2011
5. R for Everyone: Advanced Analytics and Graphics by Jared P. Lander, Pearson Education India, 1st Edition, 2014.

Learning	**Students will be able to learn;**

Outcomes	➢ Gain a comprehensive understanding of the R programming environment, including installation, workspace management, and basic commands. ➢ Efficiently import, clean, and manipulate data from various sources using R. ➢ Understand data structures in R, such as vectors, matrices, data frames, and lists. ➢ Perform basic and advanced statistical analyses, including descriptive statistics, hypothesis testing, regression analysis, and more. ➢ Write and debug R scripts and functions to automate repetitive tasks and streamline data analysis workflows. ➢ Develop logical thinking and problem-solving skills through hands-on coding exercises. ➢ Apply R skills to real-world datasets and problems, demonstrating the ability to analyze and interpret data accurately. ➢ Design, implement, and present a comprehensive data analysis project using R, showcasing the practical application of the skills learned. ➢ Collaborate effectively in teams to develop and deliver project results.

13. Syllabus in detail (Sem – VI)

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 3rd **Semester VI**	**Major-XI (T): Quantum Mechanics**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course students will learn,
- A systematic introduction of quantum mechanics.
- To introduce the brief history of Quantum Mechanics.
- To introduce the Quantum Mechanical concepts of measurements for physical systems.
- To introduce the role of Schrodinger equation for solving quantum mechanical systems.
- To introduce the application of Schrodinger equation to simple problems in quantum mechanics.
- To introduce various operators in quantum mechanics.

Unit No.	Course Content	Lectures
1	**Origin of Quantum Mechanics** 1.1 Historical Background: Black body radiation, photoelectric effects. 1.2 Matter waves - De Broglie hypothesis. Davisson and Germer experiment. 1.3 Wave particle duality 1.4 Concept of wave function, wave packet, phase velocity, group velocity and relation between them 1.5 Heisenberg's uncertainty principle with Electron diffraction experiment, different forms of uncertainty. 1.6 Different fields of applications of quantum mechanics 1.7 Problems.	10
2	**The Schrodinger equation** 2.1 Physical interpretation of wave function 2.2 Schrodinger time dependent equation. 2.3 Schrodinger time independent equation. (Steady state equation). 2.4 Requirements of wave function. 2.5 Probability current density, equation of continuity, and its physical significance. 2.6 An operator in Quantum mechanics, Eigen function and Eigen values. 2.7 Expectation value, Ehrenfest's theorem (Only statements). 2.8 Problems.	5
3	**Applications of Schrodinger Steady state equation** 3.1 Free particle.	

	3.2 Step potential. 3.3 Potential barrier. (Qualitative discussion). Barrier penetration and tunnelling effect. 3.4 Particle in infinitely deep potential well (one - dimension). 3.5 Schrodinger's equation in spherical polar co-ordinate system. 3.6 Rigid rotator (free axis). 3.7 Problems.	10
4	**Operators in Quantum Mechanics** 4.1 Hermitian operator. 4.2 Position, Momentum operator, angular momentum operator, and total energy operator (Hamiltonian). 4.3 Commutator brackets- Simultaneous Eigen functions. 4.4 Commutator Algebra 4.5 Commutator bracket using position, momentum and angular momentum operator 4.6 Concept of parity according to quantum mechanics, parity operator and its Eigen values. 4.7 Problems	5
References /Resources	1. Eisberg, Robert M., and Robert Resnick. Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles. Wiley, 1985. ISBN: 9780471873730. 2. Liboff, Richard L. Introductory Quantum Mechanics. Addison Wesley, 2002. ISBN: 9780805387148. 3. Griffiths, David J. Introduction to Quantum Mechanics. Upper Saddle River, Pearson Prentice Hall, 2005. ISBN: 9780131118928. 4. Feynman, Richard P., Robert B. Leighton, and Matthew L. Sands. The Feynman Lectures on Physics. Addison Wesley, 1989. ISBN: 9780201500646. 5. P M Mathews and K Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw Hill publication, ISBN. : 9780070146174. 6. N. Zettili, Quantum Mechanics- Concepts and applications, Wiley publication, ISBN: 978-0-470-02679-3. 7. Ajoy Ghatak, S. Lokanathan, Quantum Mechanics: Theory and Applications, Springer Publication, ISBN 978-1-4020-2130-5. 8. G Aruldhas, Quantum Mechanics, Phi Learning Private Ltd., ISBN : 97881203363. 9. Shankar, Ramamurti. Principles of Quantum Mechanics. Springer, 2008. ISBN: 9780306447907. 10. Gupta, Kumar & Sharma, Quantum Mechanics, Jai Prakash Nath Publications.	
Learning Outcomes	On completion of the course, students will be able to describe: ➢ Failure of classical physics at the microscopic level. ➢ Basic non-relativistic Quantum Mechanics.	

	➢ Matrix representation of Quantum Mechanics. ➢ They will have skills to do the following: ➢ Apply principles of Quantum Mechanics to calculate observables for given wave functions ➢ Solve Schrodinger equation for simple systems. ➢ Understand Hermitian operators and solve problems.

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	Bachelor of Science in Physics	
Year: 3rd **Semester VI**	**Major-XII (T): Thermodynamics and Statistical Physics**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course students will learn,

- Basics concept of various thermodynamic potential
- Basic idea of probability.
- Binomial and Gaussian probability distribution
- Basic concepts used in developing statistical mechanics such as microstate and macro state, phase space.
- idea of ensemble and types of ensemble
- Introductory Quantum statistics.

Unit No.	Course Content	Lectures
1	**Thermodynamic Functions and Maxwell's relations** 1.1 Thermodynamic functions: Internal Energy, Enthalpy, Helmholtz function, Gibb's function, 1.2 Derivation of Maxwell Relations, 1.3 Specific heat and latent heat equations, 1.4 Problems	05
2	**Elementary Concepts of Statistics** 2.1 Probability, distribution functions, 2.2 Random Walk and Binomial distribution, Simple random walk problem, 2.3 Calculation of mean values, Probability distribution for large-scale N, 2.4 Gaussian probability distributions, 2.5 Problems	09
3	**Statistical Distribution of System of Particles and Ensembles** 3.1 Specification of state of system, Statistical ensembles, 3.2 Basic Postulates, Probability calculations, Behaviours of density of states, 3.3 Thermal, Mechanical and general interactions 3.4 Micro canonical Ensemble (Isolated System), Canonical ensembles, simple application of canonical ensemble, 3.5 Molecules in Ideal gas, Calculation of mean values in canonical ensemble. 3.6 Problems	09
4	**Introduction to Quantum Statistics**	07

	4.1 Quantum distribution function(derivation)- Maxwell-Boltzmann's statistics, 4.2 Bose-Einstein Statistics, 4.3 Fermi-Dirac Statistics, 4.4 Comparison of the distributions. 4.5 Problems	
References /Resources	1. Lokanathan, R.S. Gambhir, Statistical and Thermal physics 2. F. Reif, Fundamentals of statistical and thermal physics 3. A. Beiser, Perspectives of modern physics 4. B.B. Laud, Fundamental of Statistical Mechanics 5. R.B. Singh, A primer of Statistical Mechanics.	
Learning Outcomes	**On completion of the course, students will be able to describe:** ➢ After taking this course students are able to determine the probability of any type of events. ➢ They are able to interpret different types of events. ➢ The student is able to apply Binomial and Gaussian distribution to real life problem and interpret the result ➢ They can easily distinguish between different types of particles and statistics and can easily distribute bosons, fermions and classical particles among energy levels.	

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	Bachelor of Science in Physics	
Year: 3rd **Semester VI**	**Major-XIII (T): Atoms, Molecules and Laser Physics**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course,

- Students will learn about the structure of atoms and molecules, including electronic, vibrational, and rotational energy levels.
- Students will understand how radiation interacts with matter, including concepts like absorption, spontaneous emission, and stimulated emission.
- Students will grasp the principles behind laser action, Laser Oscillator and Line shape broadening.
- Students will develop hands-on skills in using lasers and conducting experiments related to atomic and molecular physics.

Unit No.	Course Content	Lectures
1	**Atomic and Molecular Structure:** **1.1 Introduction:** Evolution of atomic structure, electronic configuration, Pauli's exclusion principle, Hund's rule, Hydrogen spectra. **1.2 Vector Atom Model:** Space quantization, Spin of electron, Quantum numbers **1.3 Quantum State:** Term symbol. **Problems**	06
2	**One and Two Valence Electron System:** **2.**1 Spin-orbit interaction: Derivation of electron spin-orbit interaction energy, 2.2 One valence electron system: Sodium atom spectra, selection rules, Sodium doublet. 2.3 Two valence electron system: Spectral terms, LS and JJ coupling schemes, Lande's interval rule, Spectra of Helium. 2.4 Zeeman Effect, Paschen-Back Effect and Stark Effect: Basic Concept & its Application. Problems	08
3	**Molecular Structure and Spectroscopy:** **3.1 Introduction:** Types of bonding, classification of molecules (Linear, symmetric tops, spherical tops, asymmetric tops), types of molecular spectra, Franck Condon principle. **3.2 Rotational Spectra:** Rotational energy levels and its spectral features.	08

	3.3 Vibrational Spectra: Vibrational energy levels and its spectra features. **3.4 Electronic Spectra:** Electronic energy levels and its spectral features. **Problems**	
4	**Lasers** 4.1 Introduction: Energy levels, Boltzmann distribution, Stimulated Absorption, Spontaneous Emission and Stimulated Emission, Einstein's Coefficients, Einstein's relations. Characteristics of Lasers. **4.2** Laser Action: Condition for light amplification, gain coefficient, Active medium, metastable states, Population inversion, pumping schemes: three level and four level **4.3** Laser Output: Line-shape broadening: Lifetime broadening, Collision broadening **4.4** Problems	08
References /Resources	1. R. Eisberg and R. Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei, and Particles, II Edition, John Wiley, 1985. 2. C. N. Banwell, Fundamentals of Molecular Spectroscopy, III Edition, Tata-McGraw Hill, 1972. 3. J. Wilson and J. F. B. Hawkes, Optoelectronics- An Introduction, Prentice Hall, 1983. 4. J. B. Rajam, Atomic Physics, S. Chand & Publication Company Ltd., 2008. 5. O. Svelto, Principles of Lasers, Springer, 5th Edition, 1998. 6. W. Demtröder, Atoms, Molecules and Photons, Springer, 2005.	
Learning Outcomes	**Students can;** ➢ Demonstrate an understanding of atomic and molecular structures, including electronic configurations and energy levels. ➢ Analyse the principles of electronic, vibrational, and rotational spectra of atoms and molecules. ➢ Describe the mechanisms of light absorption, emission, and scattering by atoms and molecules. ➢ Gain hands-on experience in using laser equipment and conducting experiments related to atomic and molecular spectroscopy. ➢ Understand the Lasing action, oscillators and laser output beam analysis. ➢ Interpret experimental data and draw conclusions based on theoretical models. ➢ Apply quantum mechanical principles to solve problems in atomic and molecular physics. ➢ Conduct quantitative analysis and simulations to predict the behaviour of atomic and molecular systems under various conditions.	

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Bachelor of Science in Physics		
Year: 3rd **Semester VI**	**Major-XIV (T): Nuclear Physics**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course students will learn,

- An introduction to the basic concept of nucleus, radioactivity, particle accelerators and radiation detectors, nuclear forces and models, nuclear reactions and reactor theory.
- The principles, methodologies and applications of various nuclear techniques.

Unit No.	Course Content	Lectures
1	**Nuclear Structure, Properties and Radioactivity:** **a) Basic Concept of Nucleus:** 1.1 Composition, charge, size, density of nucleus(Revision 1.2 Nuclear Angular momentum, 1.3 Nuclear magnetic dipole moment 1.4 Electric quadrupole moment, Parity & symmetry, 1.5 Mass defect and Binding energy, packing fraction, 1.6 Classification of nuclei, 1.7 Stability of nuclei (N Vs Z Curve) and problems. **b) Radioactivity:** 1.8 Radioactivity disintegration (concept of natural and artificial radioactivity, Properties of α, β, γ-rays, Laws of radioactive decay, half-life, mean life, Specific activity and its units (Revision) 1.9 Successive disintegration and equilibriums and radioisotopes. 1.10 Problems Ref.(1) Ch.(2,3), Ref.(3) Ch.(3, 6)	10
2	**Particle Accelerator and Radiation Detectors:** **(a)Particle Accelerators** 2.1 Introduction and Classification 2.2 Linear Accelerator (electron/proton LINAC) 2.3 Cyclic Accelerator (Cyclotron) **(b) Nuclear Detector:** 2.4 Classification of Nuclear Detectors 2.5 Gas filled Detectors (G. M. counter) 2.6 Problems: Ref.(2) Ch.(4), Ref.(3) Ch.(7, 15)	5
3	**Nuclear forces and Nuclear Models:**	10

	a) Nuclear Forces: 3.1 Classification of Nuclear Forces 3.2 Meson theory of nuclear forces, 3.3 Properties Of nuclear forces, properties of deuteron system 3.4 Elementary particles **b) Nuclear models:** 3.5 Quarks model for elementary particles 3.6 Semi-empirical B.E. formula 3.7 Problems: Ref.(1) Ch.(9, 17, 18), Ref.(3) Ch.(18)	
4	**Nuclear Reactions and Reactor Theory:** **(a) Introduction to Nuclear reactions:** 4.1 Nuclear Reaction, Conservation laws (Revision) 4.2 The Q-value equation, Exothermic and Endothermic reaction 4.3 Compound nucleus 4.4 Threshold energy 4.5 Nuclear cross-section b**) Reactor Theory** 4.6 Nuclear fission , nuclear fusion, chain reaction and critical mass 4.7 Problems. Ref.(1) Ch.(14, 15), Ref.(3) Ch.(11, 13, 14)	5
References /Resources	1. Dr. S. N. Ghoshal, Nuclear Physics, Revised Edition, S. Chand Publication, 2014 2. D. C. Tayal, Nuclear Physics, Revised Enlarged Edition, Himalaya Publishing House. 3. K.S. Krane, Introductory Nuclear Physics, Wiley, India, 1988 4. B. L. Cohen, Concepts of Nuclear Physics, Tata McGraw Hill 5. I. Kaplan, Nuclear Physics, 2nd Edition, Narosa, New Delhi, 1989. 6. S.B. Patel, Nuclear Physics: An Introduction, New Age International, 1991	
Learning Outcomes	On completion of the course, students will be able to describe: ➢ Understand nuclear structure, properties of radioactivity, particle accelerators, radiation detectors, nuclear forces and models, nuclear reactions and reactor theory. ➢ Study of atomic nuclei, their properties, interactions, and the forces that govern them. It explores the fundamental structure and behaviour of atomic nuclei, as well as the processes of nuclear reactions and applications of nuclear phenomenon. ➢ Exposure to current research topics, emerging technologies and recent developments in nuclear physics through lectures, literature reviews or discussions.	

	➢ Apply the knowledge of nuclear physics can be valuable for pursuing advanced research or specialized careers in Nuclear Physics.

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Bachelor of Science in Physics		
Year: 3rd **Semester VI**	**Major-VI (P): Physics Laboratory-VI**	**Credit: 2** **Hours: 60**

Course Specific Objectives - In this course,

- Students should learn how to design and conduct an experiment and understand the basic physics behind it.

Unit No.	Course Content
1	Study of Diffraction using a Transmission/Reflection Grating (Metal Ruler)
2	Determination of diameter of a thin wire using a laser beam.
3	Verification of Dulon and Petit's law ($C_p - C_v = R$)
4	Thermal Conductivity by Forbes Method.
5	Characteristics of G.M. Tube
6	Thermal conductivity of Rubber Tubing.
7	Statistical probability distribution (Gaussian/Binomial)
8	Llyod's mirror
9	Determination of Resolving Power of grating
10	Photoelectric effect (Photocell)
11	To draw fine structure diagram of two valence electron system
12	Frank-Hertz Experiment
13	Work function of given metal using photocell.
14	Determination of resistance of Platinum wire using Anderson-Griffith bridge
15	To determine velocity of sound using Quick's method.
References /Resources	1. Undergraduate Physics Practical, Pragati Publication. 2. Analog Enectronics: Malvino 3. Solid State Electronic Devices, by Streetman and Banarjee, Pearson Publication. 4. Modern Physics, by A. B. Gupta, Arunabha Sen Books and Allied Publishing (P) ltd. 5. Elements of X-ray diffraction by B. D. Cullity, S. R. Stock, Pearson Publication.
Learning Outcomes	**Students can;** ➢ Students will be able to learn how to design and conduct an experiment and understand the basic physics behind it.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 3rd **Semester VI**	**Elective-III (T): Nanomaterials: Characterization**	**Credit: 2** **Hours: 30**
Course specific Objectives: In this course students will, ➢ Learn determination of phase identification, vibrational modes, crystallite size, lattice parameters, crystallite size distribution of the nanomaterials ➢ Understand the method of optical absorption, energy band gap, chemical bond properties of the nanomaterials. ➢ Find the surface morphology of the nanomaterials. ➢ Get to know charge storage capacity, elemental composition, and magnetic properties of nanomaterials.		
Unit No.	**Course Content**	**Lectures**
1	**Structural Characterization** 1.1 X-ray diffraction 1.2 Raman Spectroscopy 1.3 Transmission Electron Microscopy (TEM)	10
2	**Optical Characterization** 2.1 UV-Vis – NIR Spectroscopy, 2.2 Fourier Transformed Infrared Spectroscopy (FTIR) 2.3 Photoluminescence (PL) Spectroscopy	10
3	**Microscopy** 3.1 Scanning electron microscopy (SEM) 3.2 Atomic Force Microscopy (AFM) 3.3 Scanning Tunnelling Microscopy (STM)	10
References /Resources	1. Characterization of Materials, by J. B. Watchman, Butterworth-Heinemann Ltd. 2. Instrumental Methods of Analysis, by H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, CBS Publishers and Distributors, 7th Edition. 3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell, McGraw Hill Book Company, 3rd Edition. 4. Nanotechnology: Principles and Practices by S. K. Kulkarni, Springer Publication, 2015.	
Learning Outcomes	After completion of this course students will, ➢ Learn to sample preparation for different characterizations. ➢ Understand the principle, working and applications of different instrument techniques. ➢ Actually, see the instruments physically and learn its process of execution. ➢ Prepare the base for material research.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year – 3rd	**Elective-III (P): Practical on Nanomaterials: Characterization**	**Credits 2**
Semester VI		**Hours 60**

Course specific objectives - In this course students will,

- Be able to see the instruments which will be used for characterizations.
- Learn the sample preparation for various characterization.
- Learn the working of each instrument.
- Understand the data analysis of each technique.

Sr. No.	COURSE CONTENT
1	Application of various software tools (such as OriginLab, fityk, Crystal 3.0, ImageJ, etc.) in data analysis.
2	Plot the XRD data to identify whether the material is polycrystalline or single crystalline.
3	Determine the full width at half maximum (FWHM) of peaks and calculate crystallite size using the Scherrer method.
4	Determination of lattice parameters and strain using X-ray diffraction data by the Williamson-Hall plot method.
5	Analysis of molecular structure and vibrational modes using Raman Spectroscopic data.
6	Plot the UV-visible spectrum and give its optical interpretation.
7	Determine the optical band gap of a semiconductor material from UV-visible spectroscopic data and verify whether it has a direct or indirect band gap.
8	Determine the emission peaks and their intensities from photoluminescence spectroscopic data. Investigating optical properties of materials.
9	Study of chemical composition and bonding using Fourier Transform Infra-Red (FTIR) spectroscopy data.
10	Study of particle size and shape of nanomaterials through ImageJ software using Scanning Electron Microscopy (SEM) data.
11	Analyze the nanoscale structure and morphology of nanomaterials utilizing Transmission Electron Microscopy (TEM) data.
12	Examine the surface roughness and microstructure of nanomaterials through analysis of Atomic Force Microscopy (AFM) data.
13	Application of various software tools (such as OriginLab, fityk, Crystal 3.0, ImageJ, etc.) in data analysis.
14	Plot the XRD data to identify whether the material is polycrystalline or single crystalline.

15	Determine the full width at half maximum (FWHM) of peaks and calculate crystallite size using the Scherrer method.
References /Resources	1. Characterization of Materials, by J. B. Watchman, Butterworth-Heinemann Ltd. 2. Instrumental Methods of Analysis, by H. H. Willard, L. L. Merritt, J. A. Dean, F. A. Settle, CBS Publishers and Distributors, 7th Edition. 3. Fundamentals of Molecular Spectroscopy, by C. N. Banwell, McGraw Hill Book Company, 3rd Edition. 4. Nanotechnology: Principles and Practices by S. K. Kulkarni, Springer Publication, 2015.
Learning outcomes	On successful completion of this course students will, ➢ Demonstrate conceptual understanding of nanomaterials and its properties. ➢ Understand the nature of sample and its images or graphical nature

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
	Bachelor of Science in Physics	
Year: 3rd **Semester VI**	**Elective-IV (T): Fundamentals of Semiconductor Devices**	**Credit: 2** **Hours: 30**

Course Specific Objectives:

- This course seeks to cover the basics of semiconductor devices including the physics of energy bands, doping and carrier statistics and transport leading up to the understanding of common semiconductor devices including p-n junctions and their applications, BJTs and MOSFETs.
- The course will also give a flavour of the basics of compound semiconductors and their devices, and also touch base with opto-electronic devices such as solar cells, photodetectors and LEDs.
- In parallel, the course will consistently seek to engage the audience by giving real-life examples pertaining to the content, and also seek to calibrate the content with respect to practical and commercial technologies which are all around us and which use semiconductor devices.
- Numerical on each module will understand better the basic concepts and functioning of semiconductor devices.

Unit No.	Course Content	Lectures
1	**Introduction to Semiconductors:** 1.1 Introduction to semiconductors 1.2 concept of energy bands and its formation 1.3 Effective mass of electrons 1.4 E-k diagram 1.5 Concept of holes 1.6 Concept of Fermi level 1.7 Fermi-Dirac distribution. 1.8 Doping (extrinsic & intrinsic semiconductor), density of states. 1.9 Problems	08
2	**Transport of Carriers in Semiconductors:** 2.1 Equilibrium electron-hole concentration 2.2 temperature-dependence 2.3 Carrier scattering and mobility 2.4 Velocity saturation, Drift-diffusion transport, Excess carrier decay & recombination 2.5 Charge injection, continuity equation, quasi-Fermi level. 2.6 Problems	07
	Semiconductor Junction:	08

3	3.1 p-n junction static behaviour (depletion width, field profile) 3.2 p-n junction under forward & reverse bias 3.3 current equations 3.4 Generation-recombination current. 3.5 Ohmic and Schottky contacts. 3.6 Problems	
4	**Semiconductor Devices** 4.1 Concept and Physics behind the FET 4.2 MOSFET 4.3 MODFET 4.4 BJT 4.5 SCR 4.6 Solar Cells 4.7 LED's 4.8 Problems	07
References /Resources	1. B. Streetman and S. Banerjee, Solid State Electronics, Prentice Hall India, (2006). 2. S. M. Sze, Physics of Semiconductor Devices, Wiley, 1996. 3. M. S. Tyagi, Introduction to semiconductor materials and devices, John Wiley, (2000). 4. D. A. Neemen, Semiconductor Physics and Devices, TMH, 3rd Edn., 2007.	
Learning Outcomes	➢ Gain a solid foundation in the properties and behaviours of semiconductor materials, including intrinsic and extrinsic semiconductors, doping, and charge carriers. ➢ Learn about energy bands, band gaps, and their significance in determining the electrical properties of semiconductors. ➢ Study the various carrier transport mechanisms such as drift, diffusion, and recombination processes. ➢ Understand the formation, characteristics, and operation of p-n junctions, including forward and reverse bias conditions. ➢ Explore the principles, types, and applications of diodes, including Zener diodes, LEDs, and photodiodes. ➢ Learn about the structure, operation, and characteristics of different types of transistors, including Bipolar Junction Transistors (BJTs) and Field Effect Transistors (FETs). ➢ Gain insights into the basic processes and techniques involved in semiconductor device fabrication. ➢ Understand the practical applications of semiconductor devices in various electronic systems and circuits.	

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Bachelor of Science in Physics		
Year: 3rd **Semester VI**	**Elective-IV (P): Practical on Physics of Semiconductor Devices**	**Credit: 2** **Hours: 30**
Sr. No.	**Title of the Practical**	
1	Diode Characteristics	
2	I-V Characteristics of UJT	
3	Transfer Characteristics of JFET	
4	Temperature dependent resistance of the semiconductor	
5	Examine the I-V characteristics of LED	
6	Determine the input and output characteristics of a BJT in common-emitter configuration.	
7	Measure the carrier lifetime in a semiconductor sample	
8	Perform C-V measurements on a semiconductor device to analyse doping profiles.	
9	Study the response of a photoresistor (LDR) to varying light intensities.	
10	Study the characteristics and applications of Silicon Controlled Rectifiers (SCR).	
11	Characteristics of Solar Cell.	
12	UJT as staircase generator.	
13	**Semiconductor Industry/ Institute Visit.**	
14		
15		
References /Resources	1. B. Streetman and S. Banerjee, Solid State Electronics, Prentice Hall India, (2006). 2. S. M. Sze, Physics of Semiconductor Devices, Wiley, 1996. 3. M. S. Tyagi, Introduction to semiconductor materials and devices, John Wiley, (2000). 4. D. A. Neemen, Semiconductor Physics and Devices, TMH, 3rd Edn., 2007.	
Learning Outcomes	➢ Gain a solid foundation in the properties and behaviours of semiconductor materials, including intrinsic and extrinsic semiconductors, doping, and charge carriers. ➢ Learn about energy bands, band gaps, and their significance in determining the electrical properties of semiconductors. ➢ Study the various carrier transport mechanisms such as drift, diffusion, and recombination processes. ➢ Understand the formation, characteristics, and operation of p-n junctions, including forward and reverse bias conditions. ➢ Explore the principles, types, and applications of diodes, including Zener diodes, LEDs, and photodiodes.	

	➢ Learn about the structure, operation, and characteristics of different types of transistors, including Bipolar Junction Transistors (BJTs) and Field Effect Transistors (FETs). ➢ Gain insights into the basic processes and techniques involved in semiconductor device fabrication. ➢ Understand the practical applications of semiconductor devices in various electronic systems and circuits.

<table>
<tr><td rowspan="1"></td><td>MODERN EDUCATION SOCIETY'S
NOWROSJEE WADIA COLLEGE, PUNE
(AUTONOMOUS)
(NEP 1.0)</td><td>Academic Year
2025-2026</td></tr>
<tr><td colspan="3">Bachelor of Science in Physics</td></tr>
<tr><td>Year: 3rd
Semester VI</td><td>Elective-IV (T): Computational Physics</td><td>Credit: 2
Hours: 30</td></tr>
<tr><td colspan="3">Course Specific Objectives - In this course students will learn,
➢ Brief understanding of algorithms and flowcharts with their necessity and applications
➢ Various aspects of C language including data types, operators, conditional statements, iterative statements, control statements and functions
➢ Complete walkthrough graphics library of C-language with illustrative examples
➢ In depth understanding of numerical methods using C-programming</td></tr>
<tr><td>Unit No.</td><td>Course Content</td><td>Lectures</td></tr>
<tr><td>1</td><td>Concepts of Programming and Introduction to C-programming:
1.1 Definition and properties of algorithms, algorithm development.
1.2 Flowcharts symbols and simple flowcharts.
1.3 Introduction and structure of C program.
1.4 Variable names, keywords, data types, symbolic constants and their declarations.
1.5 Input/output functions: scanf(), printf(), getchar(), getch(), putchar(), gets(), puts().
1.6 Operators and expressions: Arithmetic, Relational, Logical, Assignment, Conditional operator.
1.7 Conditional statements: if, if-else, nested if, switch.
1.8 Iterative statements: for, while, do-while, nested loops.
1.9 Control statements: continue, break, exit(), goto.</td><td>10</td></tr>
<tr><td>2</td><td>Arrays, Pointers and user defined function in C-Language:
2.1 Arrays: 1-D, 2-D: Arranging numbers in descending and ascending order, Sum of matrices, multiplication of matrices.
2.2 Concept of pointers with suitable illustrative examples.
2.3 User defined functions: Definition and declaration of function, function prototype, passing arguments (Call by value and Call by reference). Simple illustrative examples.</td><td>08</td></tr>
<tr><td>3</td><td>Graphics in C-Language:
3.1 Concepts of graphics in C.</td><td>03</td></tr>
</table>

	3.2 Some simple graphic commands- Point, Line, Circle, Arc, Ellipse, Bar with suitable illustrative examples.	
4	**Computational Physics:** 4.1 Numerical methods to solve Physics problems. 4.2 Iterative methods: Bisection method and Newton-Raphson method, algorithm, flowchart and writing C program for finding the roots of the equation, problems. 4.3 Integration: Trapezoidal rule, Simpson's 1/3rd rule – Algorithm, Flowchart and C-program, problems	09
References /Resources	1. Programming in C- (Schaum's series), Gottfreid, TMH 2. Programming in C- Balgurusami, Prentice Hall publications 3. Let us C- Yashwant Kanetkar, BPB publications 4. Programming with C- K.R. Venugopal, S. R. Prasad, TMH. 5. Introductory methods of numerical analysis-S. Sastry, Prentice Hall Computer oriented numerical methods – V. Rajaraman.	
Learning Outcomes	On completion of the course, students will be able to describe: ➢ Students could able to apply numerical methods easily in required filed of problem statement. ➢ Students can write and understand algorithms and flowcharts ➢ Students could able to generate programming solution for defined problem statement ➢ Using graphics library students could plot two dimensional diagrams and can visualize the problem statement or various aspect of science	

MODERN EDUCATION SOCIETY'S

NOWROSJEE WADIA COLLEGE, PUNE (AUTONOMOUS) (NEP 1.0)

Academic Year 2025-2026

Bachelor of Science in Physics

Year: 3rd **Semester VI**	**Major Elective-IV (P): Computational Physics Practical**	**Credit: 2** **Hours: 60**

Course Specific Objectives - In this practical course students will learn,

- Iterative methods for finding a root of a function with hands-on coding practice
- Numerical integration methods to find the integration of a function
- Operations on matrix using C programming
- Graph plotting and physics simulations using C-graphics library

Sr. No.	Course Content
1	Factorial of a given number
2	Fibonacci series
3	Monte Carlo method to generate random number
4	Matrix multiplication of 3x3 matrices
5	Newton-Raphson method
6	Trapezoidal Rule
7	Bisection method
8	Simson's 1/3rd Rule
9	Runge Kutta method
10	Series Expansion(sinθ/cosθ/exp(θ))
11	Projectile Motion
12	Simple Harmonic Motion
13	Miller indices of SC/BCC structure
14	Particle in one dimensional box
15	Bouncing ball simulation

References /Resources

1. Computer oriented numerical methods – V. Rajaraman.
2. Let us C- Yashwant Kanetkar, BPB publications
3. Programming with C- K.R. Venugopal, S. R. Prasad, TMH.
4. Introductory methods of numerical analysis-S. Sastry, Prentice Hall

Learning Outcomes

On completion of the course, students will be able to describe:

- Creating algorithm and flowchart for a given problem statement
- Applying numerical methods for solving various Physics problems
- Simulate the problems using C graphics library

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **(NEP 1.0)**	**Academic Year 2025-2026**
	Bachelor of Science in Physics	
Year: 3rd **Semester VI**	**Minor-IV (T): Basics of Python Programming**	**Credit: 2** **Hours: 30**

Course Specific Objectives - In this course students will learn,

- To understand why Python Programming is one of the most useful and efficient computer languages for developers
- To learn the algorithm of programming
- To learn and apply different data types and operators in Python
- To make simple numerical calculation codes in Python
- To learn how to write loops and decision statements in Python
- To learn how to build and use different Python modules for reusability
- To understand and encounter different errors in Python Programming and their sources

Unit No.	Course Content	Lectures
1	**Basics of Python Programming** 1.1 Introduction to Python Programming Language a. Features of Python Programming b. Real life uses cases 1.2 IDLE and IDE of Python 1.3 Built-in functions of Python 1.4 Concept of variables in Python 1.5 Python data types a. Numeric: Integer, Float, Complex number b. Dictionary c. Boolean d. Sequence: Strings, List and Tuple 1.6 Operators in Python a. Arithmetic operators b. Comparison operator c. Logical operators d. Membership operator e. Identity operator f. Walrus operator 1.7 Problems	12
2	**Conditional statements and loops in Python** 2.7 Introduction to algorithm of decision making 2.8 If statements and concept of indentation	10

	2.9 If-else statement 2.10 Nested if statements and multiple if statements 2.11 Introduction to loops and iterations 2.12 For loops and range function 2.13 While loops with Boolean expressions 2.14 Break statements in loops 2.15 Problems	
3	**Modules in Python Programming** 3.1 Introduction to modules 3.2 Conditions for using modules in Python codes 3.3 Built in modules with examples 3.4 Third-party modules with examples 3.5 Custom modules with examples 3.6 Problems	08
References /Resources	1. Python Programming: Using problem solving approach, Reema Thareja 2. Let us Python by Aditya Kanetkar 3. Think Python by Allen Downey	
Learning Outcomes	On completion of the course, students will be able to describe: ➢ Do the independent Python Programming for calculations and coding ➢ Understand the importance of the modules and functions in Python and their reusability ➢ Think and express the algorithms involved in the programming codes ➢ Develop the interest in coding using Python and look at this field as one of the sure job opportunities in the near future.	

<table>
<tr><td rowspan="1"></td><td>MODERN EDUCATION SOCIETY'S
NOWROSJEE WADIA COLLEGE, PUNE
(AUTONOMOUS)
(NEP 1.0)</td><td>Academic Year
2025-2026</td></tr>
<tr><td colspan="3">Bachelor of Science</td></tr>
<tr><td rowspan="2">Year: 3rd
Semester VI</td><td rowspan="2">Name of Paper: Basic Python Programming-I</td><td>Credits 2</td></tr>
<tr><td>Hours 30</td></tr>
</table>

<u>Course specific outcomes</u>:

- Understanding the basics of Python programming along with the development of the logic that lies within
- Writing the Python codes independently for the numerical/arithmetical/complex mathematical operations on the given data sets
- Generating the ability to transfer the Physics equations into codes for better understating of the important variables and scientific parameters present in that equations
- Understanding and using of the different loops, data types and functions in the Python coding and applying them to find solutions to the Physics problems
- Defining own Python functions for arguments and operations on the given data sets

Sr. No.	COURSE CONTENT / SYLLABUS

1. Step by step installation of Python's latest version (3.11) from online Python Installer (or Pydroid 3 app on the smart phone)
2. Installation of the IDE (Jupyter/Spyder/PyCharm) on the personal computer or in the smart phone
3. Writing of Physics Equations in Python Programming:
3.1. Newton's Laws of Motion
3.2. Laws of Thermodynamics
3.3. Bohr's Postulates from Atomic Model
4. Basic mathematic and arithmetic operations in Python Programming:
4.1. Addition, Subtraction, Multiplication, Division, Modulo-division, Exponent, Truncation
4.2. Logical operators and Comparison operators
5. As per the concepts from the atomic models, calculate:
5.1. The fraction of volume occupied by a proton (V_p) within the volume of that nucleus (V_N)
5.2. The fraction of volume occupied by that nucleus (V_N) within the volume occupied by that atom (V_A)
5.3. In order to visualise above fraction in the real world, consider the nucleus to be 1 *foot* and calculate the total size of the atom in *feet* or *km*
6. Error analysis calculations: Values of length (l), breadth (b), and height (h) of a glass block readings are given. Also been provided standard readings of the same glass block by the manufacturing company. Then using Python programming, find the % error in readings for:
6.1. Average length (l_A)
6.2. Average breadth (b_A)

6.3. Average height (h_A)
6.4. Average volume of the glass block (AV_g)
6.5. Standard Deviation (σ_s) for each of the above
7. Conversion of units: By writing a Python code convert the following values as per the suggested units:
7.1. Consider the weight 10,000 *mg*, convert this value into *μgm gm* and *kg* as output value
7.2. The wavelength of the sodium lamp is 5890 A^0. Convert this wavelength into *nm*, *mm*, *cm*, and *m*
7.3. Convert input temperature value from Fahrenheit scale to the Degree Celsius scale
8. Conversion of clock hour time: By using a Python code, convert any given time in seconds into the following format:
8.1. Hour(s), Minute(s), Second(s)
8.2. Hr : Min : Sec
9. Understand the range of electromagnetic radiations: Using the conditionals and looping in the Python programming, create a Python code to differentiate different wavelength/frequency dependent electromagnetic range that should include:
9.1. γ-rays
9.2. X-rays
9.3. Ultra-Violet
9.4. Visible
9.5. NIR-IR-FIR
9.6. Microwaves
9.7. Radio waves
10. Using the conditionals and looping in the Python programming, create a Python code to calculate the wavelength (λ) of the electromagnetic radiations in the visible range where the energy (E) of that radiation is used as input value (from 2 eV to 2.75 eV). The output of wavelength (λ) value should accompany with the colour of the radiation such as: Violet, Indigo, Blue, Cyan, Green, Yellow, Orange, Red
11. Using the conditional statements in the Python programming, create a Python code to determine the given flow of a fluid is laminar or turbulent as a function of Reynold's Number (R)
12. Using the conditional statements in the Python programming, create a Python code to differentiate whether the material is hydrophobic or hydrophilic in nature as a function of contact angle (Θ)
13. Using iteration methods and looping in the Python programming, calculate the pressure at different depth levels below sea surface using P_2-$P_1 = h\rho g$
14. As a function of input principal quantum number (n), calculate:
14.1. Radius of Bohr's orbit (r_n)
14.2. Velocity (v_n) of that orbiting electron
14.3. Energy (E_n) of the electron
15. Distinguish the standard emission series of a hydrogen atom (take value of *n* up to 8 and value of *p* up to 5) as function of output wavelength (λ). Discuss comparatively:
15.1. Name the standard emission series (from Lyman to Pfund) as a function of output wavelength (λ) The origin of H_α, H_β, H_γ and H_δ lines in Balmer series.

References /Resources	1. Python Programming: Using Problem Solving Approach. By Reema Thareja (1st Edition) 2. Let Us Python By Aditya Kanetkar (3rd Edition) 3. Learning To Program With Python by Richard Halterman (Online Book) 4. Python The Ultimate Beginner's Guide by Andrew Johansen (Online Book) 5. Learn Python Pro (Mobile App) 6. Python X (Mobile App) 7. Pydroid 3 (Mobile App)
Learning Outcomes	On completion of the course, students will be able to : ➢ Understand python syntax, data structures and libraries relevant to physics ➢ Write and execute python scripts for numerical and symbolic computations ➢ Manipulate algebraic expressions and solve equations symbolically ➢ Create plots of mathematical functions and experimental data using matplotlib ➢ Work with boolean and complex data type in python.

3. EVALUATION PATTERN :

(i) Each course shall be evaluated with Continuous Evaluation (CE) and Semester-end Examination (SEE) mechanism.

(ii) Distribution of marks CE and SEE for theory and practical courses:

Theory Courses			
Credits	**CE (marks)**	**SEE (marks)**	**Total (Marks)**
04	30	70	100
02	15	35	50
Practical Courses			
02	15	35	50

4. PASSING MARKS:

(i) Passing marks will be 40 % in each paper of continuous evaluation and semester end exam separately.

Course Credits	Passing marks CE (a)	Total marks CE (b)	Passing marks SEE (c)	Total Marks SEE (d)	Total Passing marks (a+c)	Total marks (b+d)
02	06	15	14	35	20	50
04	12	30	28	70	40	100

(i) To pass a course of 2 credits, a student has to earn minimum 20 marks out of 50, provided that he/she should earn minimum 6 marks in Continuous Evaluation (out of 15) and minimum 14 marks (out of 35) in End-Semester Examination. That is passing criterion is minimum 40% marks in the examination.

(ii) For 4 credit course, a student has to earn minimum 40 marks out of 100, provided that he/she should earn minimum 12 marks in Continuous Evaluation (out of 30) and minimum 28 marks (out of 70) in End-Semester Examination. That is passing criterion is minimum 40% marks in the examination.

5. PROCEDURE FOR CONTINUOUS EVALUATION

CE type	02 Credits course	04 Credits course
Written test	10 marks	20 marks
Assignment	3 marks	5 Marks
Seminar/ attendance	2 marks	5 Marks
Total marks (CE)	**15 marks**	**30 marks**

(i) For Continuous Evaluation 2 credit course, (out of 15 marks), there has to be one written test of 10 marks (Mid-Semester Examination). The remaining 5 marks shall be based on the continuous evaluation consisting of tutorial, viva, seminars, home-assignments, mini project, survey, group discussion etc. (on approval of Head of the Department) and performance and attendance in the lectures and labs.

(ii) For Continuous Evaluation 4 credit course, (out of 30 marks), there has to be one written test of 20 marks (Mid-Semester Examination). The remaining 10 marks shall be based on the continuous evaluation consisting of tutorial, viva, seminars, home-assignments, mini project, survey, group discussion etc. (on approval of Head of the Department) and performance and attendance in the lectures and labs.

6. PATTERN OF THE QUESTION PAPER (CE THEORY PAPERS)

(1) As a part of Internal Evaluation, there shall be written test (Mid-Semester Examination). Pattern of the question paper is as follows.

(2) Continuous Evaluation for 2 credits courses (Mid-Semester Examination of 10 marks, Duration: 45 min)

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	5	Solve any 5 out of 7 questions	Short answer / objective type of questions. Each question carries 1 mark
Q. 2.	5	Solve any 1 out of 2 questions	Each question carries 5 marks

(3) Continuous Evaluation for 4 credits courses (Mid-Semester Examination of 20 marks, Duration: 1 hour)

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	**10**	Solve any 5 out of 7 questions	Short answer / objective type of questions. Each question carries 2 marks
Q. 2.	**10**	Solve any 2 out of 4 questions	Each question carries 5 marks

7. PATTERN OF THE QUESTION PAPER (SEE THEORY PAPERS)

(4) Semester-End Examination for courses, out of 35 marks, shall be of 2 hours duration. The pattern of the question paper shall be as follows:

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	**5**	Solve any 5 out of 7	Short answer / objective type of questions. Each question carries 1 mark
Q. 2.	**10**	Solve any 5 out of 7	Each question carries 2 marks
Q. 3.	**10**	Solve any 2 out of 3	Each question carries 5 marks
Q. 4.	**10**	Solve any 4 out of 6	Each question carries 2.5 marks

(5) Semester-End Examination for courses, out of 70 marks, shall be of 2:30 hours duration. The pattern of the question paper shall be as follows:

Question No.	Total Marks	No. Of questions	Remarks
Q. 1.	**16**	Solve any 8 out of 10	Short answer / objective type of questions. Each question carries 2 marks
Q. 2.	**18**	Solve any 3 out of 4	Each question carries 6 marks
Q. 3.	**16**	Solve any 2 out of 3	Each question carries 8 marks
Q. 4.	**20**	Solve any 2 out of 2	Question carries 20 marks, long – answer questions

8. REVALUATION

There shall be revaluation of the answer scripts of End-Semester Examination (out of 35 marks) of theory papers only, but not of internal assessment papers and practical papers as per Ordinance No. 134 A and B.

9. AWARD OF GRADES AND GRADE POINTS

The mapping of percentage to l**e**tter grade and grade point (for each course) is given in the following Table.

Sr. No.	Grade Letter	Grade Point	Marks
1.	O (Outstanding)	10	90 ≤ Marks ≤ 100
2.	A+ (Excellent	9	80≤ Marks ≤ 89
3.	A (Very Good)	8	70 ≤ Marks ≤ 79
4.	B+ (Good)	7	55 ≤ Marks ≤ 69
5.	B (Above Average)	6	50 ≤ Marks ≤ 54
6.	C (Average)	5	45 ≤ Marks ≤ 49
7.	D (Pass)	4	40 ≤ Marks ≤ 44
8.	F (Fail)	0	Marks < 40
9.	Ab (Absent)	0	

CGPA: The CGPA is the weighted average of the grade points obtained in all courses (theory and Practicals) by a student in all the courses in 6 semesters.

Based on the performance of the student in the Semester Examinations, Nowrosjee Wadia College will declare the results and issue the Semester Grade sheets. Also, the College will declare the results and issue the Grade sheets at the end of the course. The class will be awarded to a student on the basis of CGPA. The award of the class shall be as per the following table:

Sr. No.	CGPA	Class of the degree awarded
1	9.50 or more than 9.50	OUTSTANDING (O)
2	8.50 or more but less than 9.50	EXCELLENT (A+)
3	7.50 or more but less than 8.50	VERY GOOD (A)
4	6.25 or more but less than 7.50	GOOD (B+)
5	5.25 or more but less than 6.25	ABOVE AVERAGE (B)
6	4.75 or more but less than 5.25	AVERAGE (C)
7	4.00 or more but less than 4.75	PASS (D)

Percentage of marks corresponding to CGPA is calculated by the formulae which are given in the following Table

GRADE	**Formula for the percentage of marks**
O	$20 \times CGPA - 100$
A+	$10 \times CGPA - 5$
A	$10 \times CGPA - 5$
B+	$12\times CGPA - 20$
B	$5\times CGPA + 23.75$
C	$10 \times CGPA -2.50$
D	$6.6\times CGPA + 13.6$