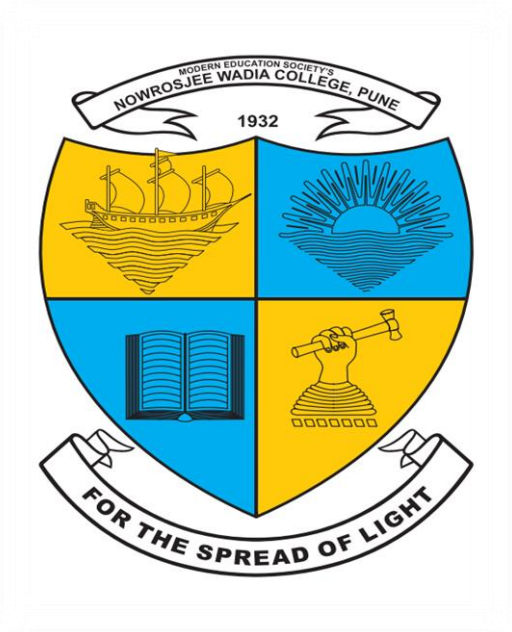
NEP 2.0 **S.Y.B.Sc.** **PHYSICS**



Modern Education Society's

NOWROSJEE WADIA COLLEGE

Pune-411 001

(Autonomous College Affiliated to SPPU, Pune)

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

S.Y.B.Sc. Physics

To be implemented from Academic Year 2025-26

B. Sc. (Physics)

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 and as per the revised guidelines provided by the S. P. Pune University, Pune on 13th March, 2024.

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 given by Savitribai Phule Pune University 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 formulate 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 follows the NEP (National Educational Policy 2020) pattern as per Government of Maharashtra G.R(s) as follows:

सांकेतांक २०२३०४२०१९२५२६६९०८

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

- 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
SEC: Skill Enhancement 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 (NEP 2.0)

Savitribai Phule Pune University, Pune
Credit Framework for Under Graduate (UG) (2024 – 25) (3 Subject)

Level / Difficulty	Sem	Subject-1				Subject-2	Subject-3	GE/OE	SEC	IKS	AEC	VEC	CC	Total
4.5 / 100	I	2 (T) + 2 (P)				2(T)+2(P)	2(T)+2 (P)	2 (T)	2 (T/P)	2 (T) (Generic)	2 (T)	2	--	22
	II	2 (T) + 2 (P)				2(T)+2(P)	2(T)+2 (P)	2 (P)	2 (T/P)	--	2 (T)	2	2	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor **Continue option**: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and another as minor and third subject will be dropped.														
Level / Difficulty	**Sem**	**Credits Related to Major**				**Minor**		**GE/OE**	**SEC**	**IKS**	**AEC**	**VEC**	**CC**	**Total**
		Major Core	**Major Elective**	**VSC**	**FP / OJT/ CEP**									
5.0 / 200	III	4 (T) + 2 (P)	--	2 (T/P)	2 (FP)	2(T)+2(P)	--	2 (T)	--	2 (T) (Subject Specific)	2 (T)	--	2	22
	IV	4 (T) + 2 (P)	--	2 (T/P)	2 (CEP)	2(T)+2(P)	--	2 (P)	2 (T/P)	--	2 (T)	--	2	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor														
5.5 /300	V	8(T) + 4(P)	2 (T) + 2 (P)	2 (T/P)	2 (FP/CEP)	2(T)	--	--	--	--	--	--	--	22
	VI	8(T) + 4(P)	2 (T) + 2 (P)	2 (T/P)	4 (OJT)	--	--	--	--	--	--	--	--	22
Total 3 Years		**44**	**8**	**8**	**10**	**18**	**8**	**8**	**6**	**4**	**8**	**4**	**6**	**132**
Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor														
6.0 /400	VII	6 (T) + 4 (P)	2 (T) + 2 (T/P)	--	--	4 (RP)	4(RM)(T)	--	--	--	--	--	--	22
	VIII	6 (T) + 4 (P)	2 (T) + 2 (T/P)	--	0	8 (RP)	0		0	0	0	0	0	22
Total 4 Years		**68**	**16**	**8**	**2**	**22**	**22**		**12**	**6**	**8**	**4**	**8**	**176**
Four Year UG Honours Degree in Major and Minor with 176 credits **OR**														
6.0 /400	VII	10(T) + 4(P)	2 (T) + 2 (T/P)	0	0	0	4 (RM)		0	0	0	0	0	22
	VIII	10(T) + 4(P)	2 (T) + 2 (T/P)	0	0	4 (OJT)	0		0	0	0	0	0	22
Total 4 Years		**76**	**16**	**8**	**2**	**14**	**22**		**12**	**6**	**8**	**4**	**8**	**176**
Four Year UG Honours with Research Degree in Major and Minor with 160-176 credits														

First Year - Semester 1

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Subject 1 (2T + 2P)	Major Paper 1 (Theory)	Fundamentals of Physics - I	2	2
	Major Paper (Practical)	Physics Practical - I	4	2
Subject 2 (2T + 2P)	Major Paper 1 (Theory)	Any other science subject - I	2	2
	Major Paper (Practical)	Any other science subject Practical - I	4	2
Subject 3 (2T + 2P)	Major Paper 1 (Theory)	Any other science subject - I	2	2
	Major Paper (Practical)	Any other science subject Practical - I	4	2
Major Electives	--	--	--	--
Minor	--	--	--	--
OE (2T)	GE/OE	Physics in Daily Life	2	2
VSC (2)				
SEC (2T)	Skill Paper 1 (Theory)	Basic Python Programming -I	2	2
AEC(2T)	English Theory	English Communication - I	2	2
VEC (2)	EVS Theory	Environment Science - I	2	2
IKS (2T) Generic				
CC (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, SEC: Skill Enhancement Courses, CEP: Community Engagement Project.

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

First Year - Semester 2

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Subject 1 (2T + 2P)	Major Paper 1 (Theory)	Fundamentals of Physics - II	2	2
	Major Paper (Practical)	Physics Practical - II	4	2
Subject 2 (2T + 2P)	Major Paper 1 (Theory)	Any other science subject - II	2	2
	Major Paper (Practical)	Any other science subject Practical - II	4	2
Subject 3 (2T + 2P)	Major Paper 1 (Theory)	Any other science subject - II	2	2
	Major Paper (Practical)	Any other science subject Practical - II	4	2
Major Electives				
Minor				
OE (2T)	GE/OE	India's Contribution to Science	2	2
VSC (2)				
SEC (2T)	Skill Paper 1 (Theory)	Basic Python Programming -II	2	2
AEC(2T)	English Theory	English Communication I	2	2
VEC (2)	EVS Theory	Environment Science I	2	2
IKS (2)	--	--	--	--
CC (2)	CC-II 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, SEC: Skill Enhancement Courses, CEP: Community Engagement Project.

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

Second Year - Semester 3

Course Type	Course	Course / Paper Title	Hours/Week	Credit
Major Core (4T + 2P)	Major Paper III (Theory)	Mathematical Methods in Physics – I	2	2
	Major Paper IV (Theory)	Electronics / Instrumentation*	2	2
	Major (Practical) on Major Paper III & IV	Physics Practical – III	4	2
Major Electives				
Minor (2T+2P)	Minor Paper I (Theory)	Elective 1: Nanoscience and Nanotechnology – Synthesis Techniques	2	2
		Elective 2: Foundation of Statistics in Physics		
	Minor (Practical) on Minor Paper I	Practicals on Nanoscience and Nanotechnology – Synthesis Techniques	4	2
		Practicals on Foundation of Statistics in Physics		
GE/OE (2T)	Theory	Physics in Sports	2	2
VSC (2P)	Major Specific Practical - I	Python Programing Practicals – III	4	2
SEC (2)				
AEC(2)	MIL	MIL-I (Hindi) / MIL-I (Marathi)	2	2
VEC (2)				
IKS (2T)	Theory	Indian Space Missions	2	2
FP/CEP/OJT (2 FP)	FP –I	Field Project - I	4	2
CC(2)	CC III	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, SEC: Skill Enhancement Courses, CEP: Community Engagement Project.

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

**** Those opting Electronics as one the major subject in FYBSc (NEP2.0)***

Second Year - Semester 4

Course Type	Course	Course / Paper Title	Hours/ Week	Credit
Major Core (4T + 2P)	Major Paper V (Theory)	Oscillations, Wave and Sound	2	2
	Major Paper VI (Theory)	Optics	2	2
	Major (Practical) on Major Paper V & VI	Physics Practical – IV	4	2
Major Electives				
Minor (2T+2P)	Minor Paper II (Theory)	Elective 1: Nanoscience and Nanotechnology - Characterization Techniques	2	2
		Elective 2: Advanced Statistical Tools in Physics		
	Minor (Practical) Minor Paper II	Practicals on Nanoscience and Nanotechnology - Characterization Techniques	4	2
		Practicals on Advanced Statistical Tools in Physics		
OE (2P)	Practical	Practicals on Basic Physics	2	2
VSC (2T/P)	Practical	Python Programing Practicals– IV	4	2
SEC (2T/P)	Skill Paper III (Theory)	Network Analysis	2	2
AEC(2)	MIL	MIL-II (Hindi) / MIL-II (Marathi)	2	2
VEC				
IKS				
FP/OJT/CEP (2CEP)	CEP – I	Community Engagement Project	6	2
CC (2)	CC-4	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, SEC: Skill Enhancement Courses, CEP: Community Engagement Project.

******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
Subject 1 (2T + 2P)	Major Paper 1 (Theory)	Fundamentals of Physics - I	2		15	35	50
	Major Paper (Practical)	Physics Practical - I		2	15	35	50
OE (2T)		Physics in Daily Life	2		15	35	50
SEC (2T)		Basic Python Programming - I	2		15	35	50

Semester - II

Course Type	Course code	Course Title	Credits		Evaluation		
			T	P	CE	SEE	Total
Subject 1 (2T + 2P)	Major Paper 2 (Theory)	Fundamentals of Physics - II	2		15	35	50
	Major Paper (Practical)	Physics Practical - II		2	15	35	50
OE (2T)		India's Contribution in Science	2		15	35	50
SEC (2T)		Basic Python Programming - II	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)	Mathematical Methods in Physics – I	2		15	35	50
	Major Paper IV (Theory)	Electronics / Instrumentation	2		15	35	50
	Practical on Major Paper III & IV	Physics Practical -III		2	15	35	50
Minor (T) (2T + 2P)	Minor Paper I (Theory)	Elective 1: Nanoscience and Nanotechnology – Synthesis Techniques Elective 2: Foundation of Statistics in Physics	2		15	35	50
	Minor (Practical) on Minor Paper I	Practical on Nanoscience and Nanotechnology – Synthesis Techniques Practical on Foundation of Statistics in Physics		2	15	35	50
GE/OE (2T)	Theory	Physics in Sports	2		15	35	50
VSC (2P)	Major Specific Practical - I	Python Programming Practicals - III		2	15	35	50
IKS (2T)	Theory	Indian Space Missions	2		15	35	50
FP/CEP/OJT (2FP)	FP-I	Field Project	2		15	35	50
CC (2)	CC III	Physical Education / Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/Performing Arts Course	2		15	35	50

Semester IV

Course Type	Course code	Course Title	Credits		Evaluation		
			T	P	CE	SEE	Total
Major Core (4T + 2P)	Major Paper V (Theory)	Oscillations, wave and Sound	2		15	35	50
	Major Paper VI (Theory)	Optics	2		15	35	50
	Practical on Major Paper V & VI	Physics Practical –IV		2	15	35	50
Minor (2T + 2P)	Minor Paper II (Theory)	Elective 1: Nanoscience and Nanotechnology - Characterization Techniques / Elective 2: Advanced Statistical Tools in Physics	2		15	35	50
	Practical on Minor Paper II	Practical on Nanoscience and Nanotechnology - Characterization Techniques / Practical on Advanced Statistical Tools in Physics		2	15	35	50
OE (2P)	Practical	Practical on Basic Physics		2	15	35	50
VSC (2P)	Practical	Python Programming Practicals - IV		2	15	35	50
SEC (2T)	Skill Paper III (Theory)	Network Analysis	2		15	35	50
FP/OJT/CEP (2CEP)	CEP - I	Community Engagement Project		2	15	35	50
CC (2)	CC - 4	Physical Education / Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts Course	2		15	35	50

12. Program Articulation Matrices:

B.Sc. (Honour's) Degree
Discipline/Subject: PHYSICS
Starting year of implementation: 2024-2025

- **Four-year UG Honour's Degree in Major and Minor with 176 credits**
- **Four-year UG Honour's with Research Degree in Major and Minor with 160-176 credits**

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	Mathematical Methods in Physics – I	Theory	2
	Electronics / Instrumentation	Theory	2
	Physics Practical -III	Practical	2
IV	Oscillations, wave and Sound	Theory	2
	Optics	Theory	2
	Physics Practical -IV	Practical	2

Program Articulation Matrix for Discipline Specific Elective (DSC EL)

Program Articulation Matrix for Minor:

Semester	Title of the Course	Theory/Practical	Credits
III	Elective 1: Nanoscience and Nanotechnology – Synthesis Techniques	Theory	2
	Elective 2: Foundation of Statistics in Physics		
	Physics Minor Lab – I	Practical	2
IV	Elective 1: Nanoscience and Nanotechnology - Characterization Techniques	Theory	2
	Elective 2: Advanced Statistical Tools in Physics		
	Physics Minor Lab-II	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 to Science	Theory	2
III	Physics in sports	Theory	2
IV	Practical on Basic Physics	Practical	2

Program Articulation Matrix for Vocational Courses (VSC)

Semester	Title of the Course	Theory/Practical	Credits
III	Python Programming Practicals - III	Practical	2
IV	Python Programming Practicals - IV	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	Network Analysis	Theory	2

Program Articulation Matrix for Field Project Courses (FP)

Semester	Title of the Course	Theory/Practical	Credits
III	Field Project-I	Practical	2

Program Articulation Matrix for Community Engagement Project (CEP)

Semester	Title of the Course	Theory/Practical	Credits
IV	Community Engagement Project	Practical	2

Title of the Course: S. Y. B. Sc. (Physics)
Structure of the Course
Semester: III

Sr. No.	Course Code	Course Subjects	Credits	Number of Lectures	Exam Pattern*
01	NPHMJ 231	Mathematical Methods in Physics – I	2	30	35+15
02	NPHMJ 232A	Electronics /	2	30	35+15
	NPHMJ 232B	Instrumentation	2	30	35+15
03	NPHMJ 233	Physics Practical – III (NPHMJ-231 & NPHMJ-232 specific practicals)	2	60	35+15
04	NPHMN-236(A)	Elective 1: Nanoscience and Nanotechnology – Synthesis Techniques	2	30	35+15
		Elective 2: Foundation of Statistics in Physics			
05	NPHMN 236 (B)	Physics Minor Lab – I (NPHMN-236A specific practicals)	2	60	35+15
06	NPHOE 237	Physics in Sports	2	30	35+15
07	NPHVSC 235	Python Programming Practicals - III (Major specific practical-I)	2	60	35+15
08	NPHIKS 236	Indian Space Missions	2	30	35+15
09	NPHFP238	Field Project	2	60	35+15

Semester: IV

Sr. No.	Course Code	Course Subjects	Credits	Number of Lectures	Exam Pattern*
01	NPHMJ 241	Oscillations, wave and Sound	2	30	35+15
02	NPHMJ 242	Optics	2	30	35+15
03	NPHMJ 243	Physics Practical – IV (NPHMJ-241 & NPHMJ-242 specific practicals)	2	60	35+15
04	NPHMN 246 (A)	Elective 1: Nanoscience and Nanotechnology - Characterization Techniques	2	30	35+15
		Elective 2: Advanced Statistical Tools in Physics			
05	NPHMN 246(B)	Minor Physics Lab-II (NPHMN-246A specific practicals)	2	60	35+15
06	NPHOE 247	Practical on Basic Physics	2	30	35+15
07	NPHVSC 245	Python Programming Practicals – IV	2	60	35+15
08	NPHSEC 244	Network Analysis	2	30	35+15
09	NPHCEP248	Community Engagement Project	2	90	35+15

*The mid-semester Examination of 15 marks and end-semester examination of 35 marks.

Equivalence of Previous Syllabus: S. Y. B. Sc. Physics (NEP 2.0)

Old Course (NEP 1.0)	New Course (NEP 2.0)	
SEM-III		
PHMJ 231 Optics	NPHMJ 231 Mathematical Methods in Physics-I	
PHMJ 232 Electronics	NPHMJ 232(A) Electronics / NPHMJ 232(B) Instrumentation	
PHMJ 233 Physics Laboratory I	NPHMJ 233 Physics Practical III	
PHMJ 234 Physics Laboratory II		
PHMN 236 (A) Synthesis of Nanomaterials	NPHMN 236 (A)	Elective 1: Nanoscience and Nanotechnology – Synthesis Techniques
		Elective 2: Foundation of Statistics in Physics
PHMN 236 Physics Laboratory III	NPHMN 236 (B) Physics Minor Lab-I	
PHOE 237: Physics in daily life	NPHOE 237 Physics in Sports	
PHVSC 235: Expeyes	NPHVSC 235 Python Programming Practicals - III	
	NPHIKS 236 Indian Space Missions	

SEM-IV

PHMJ 241 Mathematical Methods in Physics-I	NPHMJ 241 Oscillations, Wave and Sound	
PHMJ 242 Oscillations, Wave and Sound	NPHMJ 242 Optics	
PHMJ 243 Physics Laboratory I	NPHMJ 243 Physics Practical - IV	
PHMJ 244 Physics Laboratory II		
PHMN 246 (A) Characterization of Nanomaterials	NPHMN 246 (A)	Elective 1: Nanoscience and Nanotechnology - Characterization Techniques
		Elective 2: Advanced Statistical Tools in Physics
PHMN 246 Physics Laboratory III	NPHMN 246 (B)	Minor Physics Lab-II
PHOE 247 India's contribution in Science, Indian Institutes and their opportunities	NPHOE 247 Practical on Basic Physics	
	NPHVSC 245 Python Programming Practicals - IV	
PHSEC 244: Statistical Methods in Physics	NPHSEC 244 Network Analysis	
	NPHCEP 248 Community Engagement Program	

13. Syllabus in detail (Sem III)

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(Autonomous)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 2nd	**NPHMJ 231 : Mathematical Methods in Physics - I**	**Credit: 2**
Semester III		**Hours: 30**
Course specific Objectives: In this course students will learn, ➢ To impart knowledge about various mathematical tools employed to study physics problems		
Unit No.	**Course Content**	**Lectures**
1	**Complex Variables** 1.1 Introduction of complex numbers 1.2 Properties of complex conjugate, moduli, argument and geometry of complex numbers 1.3 Complex algebra (Addition, Subtraction, Multiplication, Division, Conjugate of complex number), Rectangular, polar and exponential form of complex number 1.4 Argand diagram- Graphical representation of sum, difference product and quotient of complex numbers 1.5 De-Moivres Theorem (Statement only) 1.6 Power, root and log of complex numbers, Trigonometric, hyperbolic and exponential functions 1.7 Applications of complex numbers to determine velocity and acceleration in curved motion. 1.8 Applications and Problems.	10
2	**Vector Calculus** 2.1 Physical significance of dot product and cross product of two vectors (Revision) 2.2 Define: Scalar and Vector triple product with their physical significance. 2.3 Scalar and Vector Fields 2.4 Define: Gradient of a Scalar function, Divergence of a vector function and Curl of a vector function with its physical interpretation Vector Identities 2.5 Line Integral, Surface Integral and Volume Integral (Simple Problems) 2.6 Gauss Divergence Theorem, Stroke's Theorem and Green's Theorem (Statement and Proof) 2.7 Applications and Problems	10
3	**Partial Differentiation**	

	3.1 Definition of partial differentiation 3.2 Successive differentiation 3.3 Total differentiation 3.4 Exact differential 3.5 Chain rule 3.6 Theorems of differentiation 3.7 Change of variables from Cartesian to polar co-ordinates 3.8 Conditions for maxima and minima (without proof) 3.9 Liner homogeneous partial differential equations with constant coefficients 3.10 Rules for finding the complementary function. 3.11 Applications and Problems	10
References /Resources	1. Methods of Mathematical Physics by Laud, Takwale and Gambhir 2. Calculus and Analytic Geometry by G. B. Thomas, Jr R. L. Finney (9^{th} Edition) 3. Mathematical Physics by B. D. Gupta 4. Mathematical Physics by Rajput and Gupta 5. Mathematical Methods in Physical Science by Mary and Boas 6. Vector analysis by Spiegel and Murrey 7. Mathematical Methods for Physicists by Arfken and Weber. (5th Edition) 8. Fundamentals of Mathematical Physics by A. B. Gupta 9. Vector Analysis by Seymour Lipschutz and Dennis Spellman. 10. Introduction to Electrodynamics by David J. Griffiths (Ch.1)	
Learning Outcomes	Students will have achieved the ability to ➢ The complex numbers are helpful them for the description of physical systems. ➢ Getting realization of virtually every advanced concept in physics requires the use of partial derivatives. ➢ Understand vector algebra and analysis useful in mathematics and physics. ➢ Understand the concept of singular points of differential equations. ➢ Interest to find out importance of mathematical equations with its physical significance.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(Autonomous)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 2nd	**NPHMJ 232(A): Electronics**	**Credit: 2**
Semester III		**Hours: 30**

Course specific Objectives: In this course students will learn,

- To get basic understanding of transistor.
- To learn working and applications of operational amplifiers.
- To get basic understanding of working of rectifiers.
- To design circuits using resistors and transistors.
- To study Number System and Boolean algebra.

Unit No.	Course Content	Lectures
1	**The P-N Junction** 1.1 Semiconductor: Intrinsic, Extrinsic. 1.2 P-N Junction: Formation of depletion region, Barrier Voltage. 1.3 Forward Biased P-N Junction, Forward I-V Characteristics. 1.4 Reverse Biased P-N Junction, Reverse Saturation Current, Reverse I-V Characteristics. 1.5 P-N junction Diode. 1.6 Equation of Diode Current.	6
2	**Study of Transistors: Bi-junction Transistor.** 2.1 Revision of bipolar junction transistor, types, symbol and basic action. 2.2 Configuration (common base, common emitter and common collector). 2.3 Current gain factors (α and β) and their relations. 2.4 Input, output and transfer characteristics of CE configuration. 2.5 Biasing Methods. 2.6 DC load line (CE), operating point. 2.7 Transistor as: switch, amplifier. 2.8 Problems.	8

3	**Operational Amplifiers and Applications** **a) Differential Amplifier** 3.1 Introduction 3.2 Differential input and output 3.3 Single ended output 3.4 Non-inverting input configuration 3.5 Inverting input configuration **b) Operational Amplifiers** 3.6 Ideal and Practical Characteristics 3.7 Operational Amplifiers: IC 741-Block diagram and pin diagram 3.8 Concept of virtual ground 3.9 Inverting and Non-inverting amplifiers with concept of gain 3.10 Operational Amplifier as an Adder, Subtractor, Integrator and Differentiator 3.11 Problems	10
4	**Number Systems and Logic Gates** 4.1 Number Systems: Binary, Decimal, Hexadecimal 4.2 Basic logic gates: OR, AND, NOT 4.3 Derived logic gates: NOR, NAND, EXOR, EXNOR 4.4 Boolean Algebra 4.5 De Morgan's Theorems and their verification 4.6 Problems	6
References /Resources	1. Principles of Electronics: V. K. Mehta; S. Chand & Company Ltd. Ram Nagar, New Delhi. 2. Basic Electronics: B. L. Theraja 3. Op-Amps and Linear Integrates Circuits: Ramakant Gayakwad 4. Electronic Principles: Albert Paul Malvino; Tata McGraw-Hill Publishing Company Ltd New Delhi. 5. Digital Electronic Principles and Applications: Albert Paul Malvino; Tata McGraw-Hill Publishing Company Ltd New Delhi.	
Learning Outcomes	On successful completion of this course the students will be able to ➢ Understand the parameters, characteristics and working of transistors. ➢ Understand use of rectifiers in regulated power supply. ➢ Understand the basics as well as applications of operational amplifiers. ➢ Design circuits using resistors and transistors. ➢ Use of Boolean algebra to simplify Boolean equations.	

	MODERN EDUCATION SOCIETY'S NOWROSJEE WADIA COLLEGE, PUNE (Autonomous) NEP 2.0	Academic Year 2025-2026
Bachelor of Science in Physics		
Year: 2nd	**NPHMJ 232(B): Instrumentation**	**Credit: 2**
Semester III		**Hours: 30**

Course specific Objectives: In this course students will learn,

- the concept of measurement and unit system.
- Understand the performance of measuring instruments.
- Design experiments using sensors
- Basic mechanism of transducers
- Different pressure and temperature measurement methods
- Fundamental knowledge of signal conditioning.

Unit No.	Course Content	Lectures
1	**Fundamental of Measurement** 1.1 Aims of measurement 1.2 Functional elements of typical measurement system (Block diagram and its explanation). 1.3 Standards of measurement and its classification. (International, primary or national, secondary and working standards). 1.4 Static characteristics: Accuracy, Precision, Sensitivity, Linearity, Resolution, Drift and Hysteresis. 1.5 Dynamic characteristics concepts: First and Second order instruments, Examples of first order: Resistance thermometer and thermal element, Example of 2nd order: U tube Manometer. 1.6 Errors in measurement and its classifications. 1.7 Problems.	8
2	**Transducers** 2.1 Classification of Transducers and its characteristics 2.2 Displacement Transducer a) Resistive Type: Linear and Angular (Rotary) Potentiometer, Strain Gauge: Bonded and Unbonded b) Inductive Type: Self inductive: Variable number of turns, Variable Reluctance Mutual Inductive: LVDT c) Piezoelectric Type: Quartz Crystal 2.3 Force Transducer: Cantilever beam, Column type devices Temperature Measurement 2.4 Scales for temperature: Celsius, Kelvin and Fahrenheit	10

	2.5 Temperature Measurement Techniques a. Non-electrical: Liquid filled thermometer and bimetallic thermometer b. Electrical Methods: i. Platinum Resistance Thermometer ii. Thermistor: PTC and NTC with characteristics iii. Thermocouple: Seebeck effect and Peltier effect, Types of Thermocouple.	
3	**Measurement of Pressure** 3.1 Unit of pressure, Concept of vacuum, Absolute gauge and differential pressure, 3.2 Elastic Transducer- Diaphragm, Corrugated Diaphragm, Bellows, Bourdon Tube 3.3 Electric Type- LVDT, Strain gauge 3.4 Pressure Transducer- Calibration by dead weight tester Method 3.5 Problems.	6
4	**Signal Conditioning and Processing** 4.1 Current to voltage, Voltage to current convertors, buffer amplifier, S/H Amplifier and 4.2 Characteristics, Acquisition time, Aperture time, Drop rate 4.3 Filters: First order LPF and HPF with design, 4.4 Instrumentation Amplifier (Using 3 op-amp)	6
References /Resources	1. Instrumentation Device and System, Rangan,Mani and Sarma, Tata Mc Graw Hill 2. Instrumentation Measurement and Analysis, Nakra, Choudhari, Tata Mc Graw Hill New Delhi. 3. Measurement Systems: Application and Design by Doebelin. 4. Sensors and Transducers, D. Patranabis, PHI publications. 5. Op-Amps and Linear Integrated Circuits, by Ramakant A. Gayakwad, Pearson India publications. 6. Process control Instrumentation Technology, C.D. Johnson, PHI publications.	
Learning Outcomes	On successful completion of this course the students will be able to ➢ Understand fundamentals of measurement systems ➢ Gain knowledge of different transducers. ➢ Understand the working of pressure measurement methods. ➢ Understand the mechanism of LVDT. ➢ Understand the fundamentals of signal conditioning.	

	MODERN EDUCATION SOCIETY'S NOWROSJEE WADIA COLLEGE, PUNE (Autonomous) NEP 2.0	Academic Year 2025-2026
Bachelor of Science in Physics		
Year: 2nd	**NPHMJ 233: Physics Practical - III**	**Credit: 2**
Semester III		**Hours: 60**

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

- Connecting proper circuits, handling signal generator, cathode ray oscilloscope
- Studying I-V characteristics of various electronic components
- Understanding concepts of mathematical methods in physics through MS-Excel
- Plotting curves in MS-Excel
- Practical implementation of concepts from digital electronics
- Verification of various theorems related to electronics

Sr. No.	Course Content
1	Transistor characteristics (Common emitter).
2	Study of Inverting OP-AMP.
3	Study of Non-Inverting OP-AMP.
4	Verification of maximum power transfer theorem.
5	Verification of Norton's theorem.
6	To study use of OPAMP as an Adder and Subtractor
7	Verification of De-Morgan's theorem.
8	Study of NAND/NOR gate as a Universal logic gate.
9	Operations on complex numbers using MS-Excel
10	Matrix Operations using MS-Excel
11	Plotting circle, ellipse, hyperbola, parabola using parametric equation in MS-Excel
12	Numeric Derivative using MS-Excel
13	Trapezoidal Rule using MS-Excel
14	Mesh analysis using MS-Excel
15	RLC in series/parallel

References /Resources	1. Electronic Principles – Albert Paul Malvino, McGraw-Hill 2. Principles of Digital Electronics – K. Meena, PHI 3. Fundamentals of Electric Circuits – Charles Alexander, Matthew Sadiku, McGraw Hill 4. Mathematical Physics – H. K. Dass, S. Chand 5. Mathematical Methods in the Physical Sciences – Mary L. Boas, Wiley 6. Mathematical Methods for Physicists – Arfken, Weber and Harris, Elsevier
Learning Outcomes	On completion of the course, students will be able to : ➢ Analyse and interpret the behaviour of semiconductor devices in circuits ➢ Use multi-meters, oscilloscopes, function generators and power supplies for circuit testing ➢ Apply Kirchhoff's laws and Thevenin/Norton theorems for circuit analysis ➢ Solve physical problems using mathematical techniques ➢ Implement numerical differentiation and integration for physical problems ➢ Develop an analytical approach for solving complex physics problems

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(Autonomous)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 2nd	**NPHMN 236 (A): Nanoscience and Nanotechnology – Synthesis Techniques**	**Credit: 2**
Semester III		**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. 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	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 2025-2026**
Bachelor of Science in Physics		
Year: 2nd	**NPHMN 236 (A) : Foundation of Statistics in Physics**	**Credit: 2**
Semester III		**Hours: 30**

Course Specific Objectives - In this course students will learn,

- To provide students with a comprehensive understanding of statistical methods in physics.
- To equip students with the ability to analyse and interpret experimental data effectively.
- To develop skills in applying measures of central tendency and dispersion in physics problems.
- To introduce various data visualization techniques for effective presentation of scientific data.
- To enhance students' proficiency in selecting appropriate sampling methods for physics experiments.
- To foster critical thinking through the application of statistical concepts in theoretical and experimental physics.

Unit No.	Course Content	Lectures
1	**Introduction to Statistical Methods in Physics** 1.1 Role of statistics in experimental and theoretical Physics 1.2 Types of data: Qualitative vs. Quantitative, Discrete vs. Continuous 1.3 Population vs. Sample, Descriptive vs. Inferential Statistics 1.4 Data Collection Techniques in Physics Experiments 1.5 Grouped vs. Ungrouped Data 1.6 Methods of Data Classification (Tabular, Graphical, and Numerical) 1.7 Sampling Techniques (Random, Systematic, Stratified)	7
2	**Measures of Central Tendency** 2.1 Arithmetic Mean, Weighted Mean, and Geometric Mean 2.2 Median, Quartiles, and Percentiles 2.3 Mode and Bimodal Distributions 2.4 Applications of Central Tendency in Physics	8
3	**Measures of Dispersion**	8

	3.1 Range, Mean Deviation, Variance, and Standard Deviation 3.2 Coefficient of Variation 3.3 Skewness and Kurtosis 3.4 Role of Dispersion in Experimental Physics	
4	**Data Visualization Techniques** 4.1 Histograms and Frequency Distributions 4.2 Box Plots and Violin Plots 4.3 Scatter Plots and Bubble Charts 4.4 3D Data Visualization	7
References /Resources	**References Books:** 1. Fundamentals of Biostatistics- Khan and Khanum 2. Data Analysis: A Bayesian Tutorial – D.S. Sivia 3. Online Courses & Resources: MIT Open Course Ware – Statistical Physics Coursera – Statistical Data Analysis in Physics	
Learning Outcomes	**Learning Outcomes** Upon successful completion of this course, students will be able to: ➢ Understand and apply statistical methods to analyse physics data. ➢ Differentiate between types of data and choose appropriate techniques for data collection and classification. ➢ Compute and interpret measures of central tendency and dispersion to assess data trends and variability. ➢ Utilize various visualization tools such as histograms, box plots, and scatter plots to present data effectively. ➢ Apply sampling techniques to design and analyse experiments in physics. ➢ Critically evaluate experimental results and draw meaningful conclusions based on statistical insights.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2024-2025**
Bachelor of Science in Physics		
Year – 2nd	**NPHMN 236 (B): Practical on Nanoscience and Nanotechnology – Synthesis Techniques**	**Credits 2**
Semester-III		**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 sulfide 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 2.0	Academic Year 2025-2026
Bachelor of Science in Physics		
Year – 2nd	**NPHMN 236 (B): Practical on Foundation of Statistics in Physics**	**Credits 2**
Semester-III		**Hours 60**

Course specific objectives - In this course, students will:

- Develop hands-on skills in data collection, organization, and analysis relevant to physics experiments.
- Master data visualization techniques for effectively interpreting complex experimental data.
- Apply statistical methods such as mean, median, mode, and quartile calculations to analyse experimental results.
- Enhance their proficiency in Excel and Scilab for data analysis, ensuring accuracy in calculations and presentation.
- Gain practical insights into error analysis, data spread, and variability using real-world datasets.
- Strengthen their ability to identify and address anomalies such as outliers, improving data reliability.

Sr. No.	COURSE CONTENT
1	Collect real-world experimental physics data and classify it into grouped vs. ungrouped data. [Tool: Microsoft Excel (Tables, Sorting, and Filtering)].
2	Organize experimental data into frequency tables and create a bar graph & pie chart to represent different categories. [Tool: Excel (Tables, Charts)].
3	Generate random, systematic, and stratified samples from a given dataset. [Tool: Excel (RAND () function)]
4	Compute Arithmetic Mean, Weighted Mean, and Geometric Mean for a dataset (e.g., speed of particles in an experiment). [Tool: Excel (=AVERAGE (), =MEDIAN (), =MODE.SNGL())].
5	Compute the Q1, Q2 (Median), and Q3 values along with IQR to analyse data spread. [Tool: Excel (=QUARTILE (), =PERCENTILE ())].
6	Identify bimodal distributions in physics experiments. [Tool: Excel]
7	Calculate Range, Variance, Standard Deviation, and Mean Deviation for experimental data. [Tool: Excel (=STDEV.P(), =VAR.P())].
8	Compare the spread of two different experimental datasets using Coefficient of Variation. [Tool: Excel (=STDEV.P()/AVERAGE ())].
9	Compute Skewness (Asymmetry) and Kurtosis (Peak Sharpness) of an experimental dataset. [Tool: Excel (=SKEW (), =KURT ())].
10	Impact of Outliers on Dispersion

	Introduce outliers in a dataset and observe their effect on standard deviation and variance. [Tool: Excel (Manual Data Editing, Formula Analysis)].
11	Create a histogram to analyse the frequency of experimental data (e.g., particle speed distribution). [Tool: Excel (Data Analysis Tool Pak - Histogram)].
12	Use a box plot to display quartiles and violin plot to visualize data density. [Tool: Scilab]
13	Create a scatter plot to observe trends in physics data (e.g., temperature vs. pressure). [Tool: Excel (Scatter Plot with Trendline)].
14	Visualize three variables in an experiment using a Bubble Chart (e.g., time, velocity, and force). [Tool: Excel (Insert Bubble Chart)].
15	Create 3D scatter plots to visualize motion or thermodynamic behaviour in experiments. [Tool: Scilab].
References /Resources	1. Bevington, P.R., & Robinson, D.K. (2003). Data Reduction and Error Analysis for the Physical Sciences. McGraw-Hill. 2. Taylor, J.R. (1997). An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements. University Science Books. 3. Meyer, P.L. (1975). Introductory Probability and Statistical Applications. Addison-Wesley. 4. Daniel, W.W. (2009). Biostatistics: A Foundation for Analysis in the Health Sciences. Wiley. 5. Khan, I.A. (2004). Fundamentals of Biostatistics. Ukaaz Publications.
Learning outcomes	**Learning Outcomes** Upon successful completion of this course, students will be able to: ➢ Effectively gather, classify, and analyse experimental data for physics research. ➢ Use Excel and Scilab tools proficiently for data visualization and interpretation. ➢ Apply statistical techniques to compute central tendencies, dispersion measures, and analyse data variability. ➢ Develop critical thinking skills to identify patterns, trends, and inconsistencies in experimental datasets. ➢ Conduct comprehensive error analysis and recognize the influence of outliers on scientific data. ➢ Demonstrate improved communication skills by presenting data in meaningful visual formats.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in PHYSICS		
Year – 2nd	**NPHOE 237: Physics in Sports**	**Credits 2**
Semester-III		**Hours 30**

Course specific outcomes- In this course students will learn,

- To provide students with a fundamental understanding of physics concepts as they apply to sports
- To explore the relationship between physics principles and sports performance
- To enable students to analyse and evaluate the physical aspects of sports activities

Sr. No.	COURSE CONTENT	Lectures
1	1.1 **Measurement:** Physical quantities, Standards and Units, International system of Units, Standards of time, length and mass, Precision and significant figures 1.2 **Newton's laws of motion:** Newton's first law. Force, mass. Newton's second law. Newton's third law, Mass and weight, geared bicycle, Applications of Newton's laws. 1.3 **Projectile motion:** Shooting a falling target, Physics behind Shooting, Javelin throw and Discus throw. 1.4 **Conservation laws:** Conservation of linear momentum, collisions – elastic and inelastic. Angular momentum. (Physics behind Carrom, Billiards, Racing)	12
2	2.1 **Centre of mass:** Physics behind Cycling, Rock climbing, Skating Gravitation: Origin, Newton's law of gravitation, Archimedes' principle, Buoyancy & Physics behind swimming 2.2 **Food and Nutrition:** Macro and micronutrients, Concept of balanced diet, calorie content in food & requirements, Blood pressure. Problems due to the deficiency of macro or micronutrients, BMI, Weight management, hazards of junk food 2.3 **Energy:** Different Forms of Energy 2.4 **Physical exercises:** Types of exercises, Calisthenics, Importance of warm-up, cooling down and stretching, heart rate zones, High-Intensity Interval Training (HIIT), yoga & meditation	12
3	**Implementation of Physics in sports** 3.1 Physics of Cricket	

	3.2 Physics of Hockey 3.3 Physics of Football	6
References /Resources	1. "The Physics of Sports" by Angelo Armenti Jr. 2. "Sports Physics" by Ken Laws 3. "The Physics of Football" by Timothy Gay **Websites:** 1. The Physics Classroom - Sports and Physics: www.physicsclassroom.com/class/sports 2. Sports Science Exchange: www.sportsscienceexchange.com 3. Sports Engineering Journal: www.springer.com/journal/12283	
Learning outcomes	On completion of the course, students will be able to describe: ➢ Explain and apply key physics concepts to sports activities. ➢ Analyse and evaluate the impact of physical factors on sports performance. ➢ Demonstrate an understanding of how different sports utilize physics principles. ➢ Apply physics principles to optimize performance and technique in sports. ➢ Critically evaluate the role of physics in sports research and development.	

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 2nd	**NPHVSC 235: Python Programming Practicals - III**	**Credit: 2**
Semester III		**Hours: 60**

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

- Usage of python programming to solve physics related problems
- Various topics of mathematical methods in physics using python programming
- Plotting of data using matplotlib library for visualization
- Understanding of concepts of electronics through python programming
- I-V characteristics of various electronic components in python

Sr. No.	Course Content
1	Complex numbers operations
2	Dot and Cross products
3	Numerical Derivative
4	Partial Differentiation
5	Gradient, Divergence and Curl
6	Scalar and Vector triple product
7	Series and Parallel combinations of resistors and capacitors
8	Charging and Discharging of capacitor
9	I-V characteristics of diode
10	Verification of De Morgan's Theorem
11	Binary to Decimal and Decimal to Binary Conversion
12	Op-Amp as Inverting Amplifier
13	Op-Amp as Non-Inverting Amplifier
14	DC Load Line
15	Op-Amp as Adder and Subtractor
References /Resources	1. Let us Python- Yashwant Kanetkar, BPB publications. 2. Computer oriented numerical methods – V. Rajaraman. 3. Data Analytics using Python – Bharti Motwani, Wiley 4. Numerical Python – Robert Johansson, Apress. 5. Mathematical Methods using Python – Vasilis Pagonis, Christopher W. Kulp, CRC Press. 6. Programming with C- K.R. Venugopal, S. R. Prasad, TMH. 7. Introductory methods of numerical analysis-S. Sastry, Prentice Hall
Learning	On completion of the course, students will be able to :

Outcomes	➢ 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

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 2nd Semester III	**NPHIKS 236: Indian Space Missions**	**Credit: 2 Hours: 30**

Course specific Objectives: In this course students will learn,

- About Space mission, its origin and its expansion.
- To understand Fundamental principles governing ascent mission design.
- To provide exposure to basic concept of Spacecraft orbital mechanics.

Unit No.	Course Content	Lectures
1	**Space Mission** 1.1 Introduction 1.2 History of the Indian Space Program 1.3 Current Status of Space Programs 1.4 Space Mission Configuration	6
2	**Fundamental principles** 2.1 Role of launch vehicles and Spacecraft 2.2 Ascent mission objectives, Mathematical models 2.3 Effect of drag and gravity on mission performance 2.4 Parts of launch vehicle and spacecraft	8
3	**Concept of orbit** 3.1 Introduction 3.2 Two body problem and Kepler's laws 3.3 Orbital parameters and orbit from initial condition 3.4 Types of orbits.	8
4	**Major Mission and achievements of ISRO** 4.1 Chandrayaan- 1, 2 & 3 4.2 Gaganyaan 4.3 Shukrayaan- I 4.4 GSAT-14	8
References /Resources	1. Thompson, 'Introduction to Space Dynamics', Dover Publications, New York, 1986. 2. Hale, 'Introduction to Space Flight', Prentice Hall, 1994. 3. Wiesel, 'Spaceflight Dynamics', McGraw-Hill, 1997. 4. Curtis, 'Orbital Mechanics for Engineering Students', 2nd Ed., Elsevier, 2010. 5. Walter, 'Astronautics: The Physics of Space Flight', Wiley-VCH, 2012.	
Learning Outcomes	On completion of this course, the learner will be able to: ➢ Recognize the importance and objectives of space exploration, with knowledge of the origin and evolution of the Indian Space Program.	

	➢ Learn about ongoing space missions and their objectives. ➢ Understand the mission planning, satellite components, and launch vehicles. ➢ Explore the role of ISRO (Indian Space Research Organisation) in advancing space technology and exploration.

13. Syllabus in detail (Sem IV)

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year: 2nd Semester IV	**NPHMJ 241: Oscillations, Wave and Sound**	**Credit: 2 Hours: 30**

Course specific Objectives: On completion of this course, the learner will be able:

- To study underlying principles of oscillations and its scope in development.
- To understand and solve the equations / graphical representations of motion for simple harmonic, damped, forced oscillators and waves.
- To explain oscillations in terms of energy exchange with various practical applications.
- To solve numerical problems related to undamped, damped, forced oscillations and superposition of oscillations.
- To study characteristics of sound, decibel scales and applications.

Unit No.	Course Content	Lectures
1	**Undamped Free Oscillations** 1.1 Concept: Equilibria (stable and unstable) and Simple Harmonic Motion (S.H.M.) 1.2 Differential equation for linear S.H.M. and its solution 1.3 Composition of two perpendicular linear S.H.Ms. for frequency ratio 1:1 and 2:1 (analytical method) 1.4 Lissajous figures, their demonstration (optical and electrical method) and applications 1.5 Problems	6
2	**Damped Oscillations** 2.1 Differential equation for damped harmonic oscillator and its solution, discussion of different cases 2.2 Logarithmic decrement 2.3 Average energy of damped harmonic oscillator 2.4 Quality factor 2.5 Application: LCR series circuit 2.6 Problems	5
3	**Forced Oscillations** 3.1 Differential equation for forced oscillations and its solution 3.2 Resonance: mechanical, acoustic and electrical	8

	3.3 Velocity and Amplitude resonance 3.4 Sharpness of resonance and half width 3.5 Average energy of forced oscillator 3.6 Quality factor of forced oscillator 3.7 Relation between quality factor and bandwidth 3.8 Application of forced oscillations- LCR series circuit 3.9 Problems	
4	**Wave Motion** 4.1 Introduction 4.2 Equation for longitudinal waves and its solution (one dimension only) 4.3 Equation for transverse waves and its solution (one dimension only) 4.4 Energy density and intensity of a wave 4.5 Qualitative discussion of seismic waves and gravitational waves (Discussion). 4.6 Problems	5
5	**Sound and Doppler Effect** 5.1 Define: Sound Intensity, Loudness, Pitch, Quality and timbre 5.2 Reverberation time and reverberation of hall 5.3 Sabine's formula (without derivation) 5.4 Doppler Effect in sound, Expression for apparent frequency in different cases 5.5 Asymmetric nature of Doppler Effect in sound 5.6 Doppler Effect in light, Symmetric nature of Doppler Effect in light 5.7 Applications: Radar, Speed of distant star, Rotational speed of binary star, Red Shift and Width of spectral line 5.8 Problems	6
References /Resources	1. Waves and Oscillations - Stephenson. 2. The Physics of Waves and Oscillations - N. K. Bajaj, Tata McGraw- Hill, publication. 3. Fundamentals of Vibrations and Waves - S. P. Puri, Tata McGraw-Hill publication. 4. A Text Book of Sound - Subramanyam and Brijlal, Vikas Prakashan. 5. Sound - Mee, Heinmann Edition, London. 6. Waves and Oscillations - R.N. Chaudhari, New Age International (p) ltd. 7. A Textbook on Oscillations, Waves and Acoustics - M. Ghosh, and D. Bhattacharya, S. Chand and Company Ltd.	
Learning	On completion of this course, the learner will be able:	

Outcomes	➢ To study underlying principles of oscillations and its scope in development. ➢ To understand and solve the equations / graphical representations of motion for simple harmonic, damped, forced oscillators and waves. ➢ To explain oscillations in terms of energy exchange with various practical applications. ➢ To solve numerical problems related to undamped, damped, forced oscillations and superposition of oscillations. ➢ To study characteristics of sound, decibel scales and applications.

	MODERN EDUCATION SOCIETY'S NOWROSJEE WADIA COLLEGE, PUNE (AUTONOMOUS) NEP 2.0	Academic Year 2025-2026
Bachelor of Science in Physics		
Year: 2nd	NPHMJ 242: Optics	Credit: 2
Semester IV		Hours: 30

Course specific Objectives: In this course students will learn,

- To acquire skills allowing the student to identify and apply formulae of optics and wave physics using course content.
- To be able to identify the aberrations occurred in optical instruments/lens system and try to overcome it with the help of fundamentals given in lens aberration.
- To be able to learn the fundamentals of optical instruments and interpret the location and type of image.
- To acquire the knowledge of interference, diffraction and polarization concepts and use it in the optical experiments and optical characterization techniques.

Unit No.	Course Content	Lectures
1	**Geometrical optics and Lens Aberrations** **a) Geometrical optics** 1.1 Introduction to lenses and sign conventions 1.2 Thin lenses: Lens equation for single convex lens 1.3 Lens maker equation 1.4 Concept of magnification, deviation and power of a thin lens 1.5 Equivalent focal length of two thin lens system 1.6 Concept of cardinal points 1.7 Problems **b) Lens Aberrations** 1.8 Introduction to Aberration 1.9 Types of aberration: Monochromatic and Chromatic Aberration (Only discussion)	7
2	**Optical Instruments** 2.1 Introduction to optical instruments 2.2 Types of optical instruments: Simple Microscope, Compound Microscope and Astronomical telescope (only construction and working) 2.3 Eyepiece: Ramsden's eye piece (Expression), Huygens eye piece and Gauss's eyepiece (only qualitative discussion) 2.4 Problems.	7
3	**Interference and Diffraction**	

	a) Interference 3.1 Introduction to interference 3.2 Types of Interference (only discussion) 3.3 Phase change on reflection (Stokes treatment) 3.4 Interference due to wedge shaped thin film 3.5 Newton's rings (to determine wavelength) 3.6 Problems. **b) Diffraction** 3.7 Introduction to diffraction 3.8 Types of diffraction (only discussion) 3.9 Fraunhoffer diffraction due to single and double slits (qualitative) 3.10 Plane transmission grating and grating equation (only principal maxima) 3.11 Rayleigh criterion for resolution (only qualitative discussion) 3.12 Problems.	10
4	**Polarization** 4.1 Introduction to polarization 4.2 Brewster's law 4.3 Malus's Law 4.4 Polarization by double refraction 4.5 Nicol Prism 4.6 Application of polarization 4.7 Problems.	6
References /Resources	1. A Textbook of Optics - N. Subhramanyam, Brij Lal, M. N. Avadhanulu, S. Chand & comp Ltd, New Delhi. 2. Physical Optics - A. K. Ghatak, Tata McMillan-Hill Publishing Comp. Ltd, New Delhi	
Learning Outcomes	On successful completion of this course the students will be able to; ➢ Acquire the basic concept of Geometrical optics. ➢ Explain why a light beam spread out after passing through an aperture. ➢ Understand the operation of many modern optical devices using Geometrical optics. ➢ Describe how light can constructively and destructively interfere. ➢ Understand optical phenomenon such as diffraction, interference polarization in terms of the wave model.	

	MODERN EDUCATION SOCIETY'S NOWROSJEE WADIA COLLEGE, PUNE (AUTONOMOUS) NEP 2.0	Academic Year 2025-2026
Bachelor of Science in Physics		
Year – 2nd	**NPHMJ 243: Physics Practical - IV**	**Credits 2**
Semester-IV		**Hours 60**

Course specific objectives -In this course students will be able to;

- Learn the practical skills in oscillations, wave, sound and optics.
- Understand the principles of oscillations and basic phenomenon of geometrical optics
- Learn to handle the optical equipment's with care
- Get an idea of optical systems used in day today life

Sr. No.	COURSE CONTENT
1	Logarithmic decrement (in air and water).
2	Coupled oscillations
3	Spring constant using series or parallel combination
4	'g' by bar pendulum.
5	Study of Lissajous's figures to determine of unknown frequency.
6	Velocity of sound by Phase shift method.
7	The velocity of sound in air at room temperature with Kundt's Tube.
8	Dispersive power of prism
9	Double refracting prism
10	Newton's ring
11	Refractive index of glass slab and Total internal reflection of prism
12	Cauchy's constant
13	Unknown wavelength using prism
14	Dispersive power of diffraction grating
15	Cardinal points for a system of lenses

References /Resources	1. Waves and Oscillations - Stephenson. 2. The Physics of Waves and Oscillations - N. K. Bajaj, Tata McGraw- Hill, publication. 3. Fundamentals of Vibrations and Waves - S. P. Puri, Tata McGraw-Hill publication. 4. A Text Book of Sound - Subramanyam and Brijlal, Vikas Prakashan. 5. Sound - Mee, Heinmann Edition, London. 6. A Textbook on Oscillations, Waves and Acoustics - M. Ghosh, and D. Bhattacharya, S. Chand and Company Ltd. 7. Optics by A. R. Ganesan, 4th edition, Pearson Education, 8. A Textbook of Optics by N. Subramanyam, Brijlal, M. N. Avadhanulu, S. Chand Publication 9. Physical Optics by A. K. Ghatak, McMillion, New Delhi. 10. Fundamental Optics by F. A. Jenkins, H. E. White, Mc Graw Hill International edition
Learning Outcome	After completion of this course students will be able to, ➢ Study underlying principles of oscillations and its scope in development. ➢ Understand and solve the equations / graphical representations of motion for simple harmonic, damped, forced oscillators and waves. ➢ Explain oscillations in terms of energy exchange with various practical applications. ➢ Solve numerical problems related to undamped, damped, forced oscillations and superposition of oscillations. ➢ Calculation of focal lengths of any lens system ➢ Handle the spectrometer and optical bench. Calculate refractive index of any transparent material

	MODERN EDUCATION SOCIETY'S NOWROSJEE WADIA COLLEGE, PUNE (AUTONOMOUS) NEP 2.0	Academic Year 2025-2026
	Bachelor of Science in Physics	
Year: 2nd	**PHMN 246(A) : Nanoscience and Nanotechnology - Characterization Techniques**	**Credit: 2**
Semester IV		**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: 2nd	**NPHMN 246 (B): Advanced Statistical Tools in Physics**	**Credit: 2**
Semester IV		**Hours: 30**

Course Specific Objectives In this course, students will learn to:

- Understand and analyse errors in physics experiments, distinguishing between systematic and random errors.
- Develop proficiency in error propagation techniques and estimation of measurement uncertainty.
- Apply regression models and correlation analysis to interpret experimental data accurately.
- Utilize hypothesis testing methods to validate experimental results.
- Implement Monte Carlo simulations for modelling complex physical systems and estimating errors.
- Enhance critical thinking skills for analysing experimental uncertainties and improving measurement accuracy.

Unit No.	Course Content	Lectures
1	**Error Analysis and Uncertainty in Physics Experiments** 1.1 Systematic vs. Random Errors 1.2 Error Propagation and Significant Figures 1.3 Confidence Intervals and Measurement Uncertainty 1.4 Chi-Square Test for Error Analysis	5
2	**Regression Analysis and Correlation in Physics** 2.1 Linear and Nonlinear Regression Models 2.2 Pearson and Spearman Correlation Coefficients 2.3 Polynomial and Exponential Curve Fitting 2.4 Least Squares Method for Experimental Data	10
3	**Hypothesis Testing and Statistical Inference** 3.1 Null and Alternative Hypotheses 3.2 t-Tests (One-Sample, Two-Sample, Paired) 3.3 Goodness-of-Fit Tests (Chi-Square, Kolmogorov-Smirnov)	10
4	**Monte Carlo Simulations in Physics** 4.1 Introduction to Monte Carlo Methods 4.2 Random Number Generation Techniques 4.3 Applications in Nuclear Physics, Thermodynamics, and Quantum Mechanics 4.4 Error Estimation using Monte Carlo Methods	5

References /Resources	**References Books:** 1. "Data Analysis for Scientists and Engineers" – Edward L. Robinson (Covers error analysis, regression, and Monte Carlo simulations). 2. "Statistical Methods for Physicists" – Barlow (Focuses on hypothesis testing, confidence intervals, and chi-square tests). 3. "Monte Carlo Methods in Statistical Physics" – K. Binder (Excellent for Monte Carlo simulations). 4. Online Courses & Resources: MIT Open Courseware – Statistical Physics Coursera – Statistical Data Analysis in Physics
Learning Outcomes	Upon successful completion of this course, students will be able to: ➢ Accurately analyse experimental data by applying advanced error analysis techniques and identifying sources of uncertainty. ➢ Demonstrate proficiency in linear and nonlinear regression models to interpret scientific data effectively. ➢ Perform complex statistical inference, including hypothesis testing and goodness-of-fit tests, to validate experimental results. ➢ Utilize Monte Carlo simulations to model complex physical systems and assess uncertainty in experimental outcomes. ➢ Apply statistical tools in diverse physics applications such as thermodynamics, quantum mechanics, and nuclear physics. ➢ Develop clear and well-organized reports detailing data analysis processes and scientific conclusions.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year – 2nd	**NPHMN 246 (P): Practical on Nanoscience and Nanotechnology - Characterization Techniques**	**Credits 2**
Semester IV		**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.
12-15	Examine the surface roughness and microstructure of nanomaterials through analysis of Atomic Force Microscopy (AFM) data.

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	**NPHMN 246 (P) - Practical on Advanced Statistical Tools in Physics**	**Credit: 2**
Semester IV		**Hours: 60**

Course Objectives: In this course, students will:

- Develop proficiency in error analysis techniques to differentiate between systematic and random errors.
- Master confidence interval estimation methods for accurate data interpretation.
- Apply regression and correlation tools for analysing experimental data trends.
- Utilize hypothesis testing techniques for validating theoretical models in physics.
- Implement Monte Carlo simulations for modelling physical systems and estimating uncertainties.

Unit No.	Course Content
1	Compute mean, standard deviation, and error margins. [Tool: Excel (=STDEV.P(), =AVERAGE ())].
2	Calculate uncertainty in Ohm's Law (V = IR) using error propagation. [Tool: Excel (Formula-Based Calculations)].
3	Compute confidence intervals (95%, 99%) for a given physics experiment. [Tool: Excel (=CONFIDENCE.NORM(), =CONFIDENCE.T())].
4	Determine if two data sets differ significantly using p-values. [Tool: Excel (=T.TEST ())].
5	Perform linear regression on a dataset (e.g., Hooke's Law: Force vs. Extension). [Tool: Excel (Trendline, =LINEST ())].
6	Fit a quadratic or cubic polynomial to experimental data (e.g., projectile motion). [Tool: Excel (Trendline - Polynomial)].
7	Analyse correlation between two variables (e.g., pressure vs. temperature in gases). [Tool: Excel (=CORREL (), =PEARSON ())].
8	8.1 Compute Pearson (linear) and Spearman (rank-based) correlation coefficients for a dataset. 8.2 Relationship between temperature and resistance in semiconductors. [Tool: Excel (=CORREL (), =PEARSON ())].
9	Fit a dataset using the least squares method and calculate errors. [Tool: Scilab]
10	Test if a dataset follows a theoretical probability distribution (e.g., radioactive decay follows a Poisson distribution). [Tool: Excel (Data Analysis Tool Pak -> Chi-Square Test)].
11	11.1 Compare means of one dataset vs. a known value (one sample t-test). 11.2 Compare means of two independent datasets (unpaired t-test). [Tool: Excel (=T.TEST ())].

12	Compare pre- and post-experiment data (e.g., change in resistance before and after heating). [Tool: Excel (=T.TEST ())].
13	Simulate a normal distribution using random numbers. [Tool: Scilab]
14	Simulate random movement of particles due to Brownian motion. [Tool: Scilab]
15	Use random sampling to estimate uncertainty in an experiment (e.g., radioactive decay). [Tool: Scilab]
References /Resources	1. Bevington, P.R., & Robinson, D.K. (2003). *Data Reduction and Error Analysis for the Physical Sciences*. McGraw-Hill. 2. Taylor, J.R. (1997). *An Introduction to Error Analysis: The Study of Uncertainties in Physical Measurements*. University Science Books. 3. Press, W.H., Teukolsky, S.A., Vetterling, W.T., & Flannery, B.P. (2007). *Numerical Recipes: The Art of Scientific Computing*. Cambridge University Press. 4. Cowan, G. (1998). *Statistical Data Analysis*. Oxford University Press. 5. James, F. (2006). *Statistical Methods in Experimental Physics*. World Scientific. 6. Barlow, R. (1989). *Statistics: A Guide to the Use of Statistical Methods in the Physical Sciences*. Wiley. 7. Metropolis, N., & Ulam, S. (1949). *The Monte Carlo Method*. Journal of the American Statistical Association.
Learning Outcomes	Upon completion of this course, students will be able to: ➢ Accurately measure and analyze experimental errors and uncertainties. ➢ Apply regression models to interpret experimental data trends. ➢ Perform hypothesis testing to confirm theoretical predictions. ➢ Utilize Monte Carlo simulations to model complex physical phenomena. ➢ Develop practical skills in Excel and Scilab for statistical analysis in physics.

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year – 2nd	**NPHOE 247: Practical on Basic Physics**	**Credits 2**
Semester-IV		**Hours 60**

Course specific objectives - In this course students will learn,

- To provide students with a fundamental understanding of physics concepts as they apply to sports
- To explore the relationship between physics principles and sports performance
- To enable students to analyse and evaluate the physical aspects of sports activities.

Sr. No.	**COURSE CONTENT**
1	Know your Physics laboratory, use of scientific calculator and interpretation of graph.
2	Use of digital multimeter, ammeter, voltmeter
3	Measurement of Height, length and breadth by using vernier caliper
4	Measurement of radius of wire by micrometer screw gauge.
5	Measurement of resistance value by color code
6	Measurement of resistance value by digital multimeter
7	Measurement of specific resistance by voltmeter ammeter method.
8	Determine the AC mains frequency using vibrating sonometer.
9	Study of simple pendulum
10	Study of diode testing by digital multimeter
11	Study of Total Internal Reflection (TIR) and determine critical angle of incidence.
12	Study of current affects heat production
13	Study the projectile motion of a javelin throw.
14	Elastic and Inelastic Collisions using Carrom/Billiards
15	Measure the energy content in food by burning it and heating water
16	Verification of Ohms law
17	Calculating Calories Burned During Exercise
References /Resources	1. "Physics Practical" by S. Chand and Company 2. "Practical Physics" by Dhanpat Rai Publishing Company 3. "Physics Laboratory Manual" by H. C. Verma
Learning outcomes	Students will have achieved the ability to, ➢ To explain and apply key physics concepts to sports activities. ➢ To analyse and evaluate the impact of physical factors on sports performance. ➢ To demonstrate an understanding of how different sports utilize physics principles.

	➢ To apply physics principles to optimize performance and technique in sports. ➢ To critically evaluate the role of physics in sports research and development.

	MODERN EDUCATION SOCIETY'S NOWROSJEE WADIA COLLEGE, PUNE (AUTONOMOUS) NEP 2.0	Academic Year 2025-2026
Bachelor of Science in Physics		
Year: 2nd	**NPHVSC 248 : Python Programming Practicals - IV**	**Credit: 2**
Semester IV		**Hours: 60**

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

- Understanding python programming fundamentals and libraries relevant to physics
- Implement mathematical functions and data structures for wave analysis
- Visualization of wave motion and interference using matplotlib library in python
- Understanding of optics phenomenon through python programming
- Plotting intensity graphs for interference and diffraction of waves

Sr. No.	Course Content
1	Focal length calculations using Lens equation
2	Intensity graph for diffraction through a single slit
3	Newton's Ring
4	Snell's Law
5	Interference due to transmitted light
6	Interference due to reflected light
7	Lissajous figures
8	Determination of type of Damped oscillation
9	Displacement, velocity and acceleration graph in undamped oscillation
10	Logarithmic Decrement
11	Variation of amplitude with frequency of forced oscillation
12	Determination of red and blue shift using Doppler Effect in light
13	Addition of two sound waves (Beats)
14	Interference of two water waves
15	Intensity of sound

References /Resources	1. Let us Python - Yashwant Kanetkar, BPB publications. 2. Computer oriented numerical methods – V. Rajaraman. 3. Data Analytics using Python – Bharti Motwani, Wiley 4. Physics of Oscillations and Waves – Arnt Inge Vistnes, Springer 5. Understanding Optics with Python – Vasudevan Lashminarayanan, Hassen Ghalia, Ahmed Ammar, CRC Press 6. Mathematical Methods using Python – Vasilis Pagonis, Christopher W. Kulp, CRC Press. 7. Numerical Python – Robert Johansson, Apress.
Learning Outcomes	On completion of the course, students will be able to : ➢ Develop python scripts to model and analyse wave phenomena ➢ Create 2D and 3D visualizations of wave motion and optical phenomena ➢ 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

	MODERN EDUCATION SOCIETY'S **NOWROSJEE WADIA COLLEGE, PUNE** **(AUTONOMOUS)** **NEP 2.0**	**Academic Year 2025-2026**
Bachelor of Science in Physics		
Year – 2nd	**NPHSEC 245: Network Analysis**	**Credits 2**
Semester- IV		**Hours 30**

Course Objectives:

- To get knowledge about shorts and open in a circuit.
- To get basic understanding of circuit analysis.
- To study circuit theorems and laws to simplify the electrical circuits.
- To design and analyse the circuits using Resistors, Voltage sources and Current sources.

Sr. No.	COURSE CONTENT / SYLLABUS	Hours
1	**Types of Network** 1.1 Linear Network, Non-linear Network, Bilateral Network, Unilateral Network, Active Network, Passive Network, Lumped Network, Distributed Network. 1.2 Ideal Voltage Source, Practical Voltage Source, Ideal Current Source, Practical Current Source. 1.3 Ohm's Law. 1.4 Voltage Divider Circuits. 1.5 Current Divider Circuits. 1.6 Voltage Source to Current Source transformation, Current Source to Voltage Source transformation. 1.7 Combining Voltage Sources, Combining Current sources. 1.8 Analyzing Series Parallel Circuits. 1.9 Problems.	8
2	**Kirchhoff's Laws, Mesh and Nodal Analysis.** 2.1 Kirchhoff's Current law. 2.2 Nodal Analysis. 2.3 Kirchhoff's Voltage Law. 2.4 Mesh or Loop Analysis. 2.5 Network analysis using KCL and KVL. 2.6 Problems.	6
3	**Network Theorems** 3.1 Thevenin's Theorem 3.2 Norton's Theorem 3.3 Superposition Theorem 3.4 Maximum Power Transfer Theorem	16

	3.5 Reciprocity Theorem 3.6 Millman Theorem 3.7 Demonstrations/Problems	
References /Resources	1. Principles of Electronics, V. K. Mehta, S. Chand Publication. 2. Essentials of Circuit Analysis, Robert L. Boylestad, Pearson Education. 3. Fundamentals of Electric Circuits, Alexander and M. Sadiku, McGrow Hill. 4. Electronics Principles, Malvino, 7^{th} Edition, Tata McGrow Hill.	
Learning outcomes	On successful completion of this course the students will be able to ➢ Analyse the series and parallel circuits. ➢ Understand shorts and open in a circuit. ➢ Design circuits using resistors, Voltage Sources and Current Sources. ➢ Apply the Network Theorems to simplify the electronic circuits.	

Suggested Activities on Network Analysis: [15 Hours]

Sr.No.	Practical Demonstrations/Activities/Hands on
1	Use of multimeter for checking components.
2	Verification of a network composed of resistors in series and parallel configuration.
3	Verification of Ohm's law.
4	Verification of relation between Resistance, length, cross-sectional area and resistivity of a conductor.
5	Design and verify of Voltage Divider Circuit.
6	Design and verify of Current Divider Circuit.
7	Verification of short and open in a circuit.
8	Verification of Kirchhoff's Current law.
9	Verification of Kirchhoff's Voltage law.
10	Determine current through any branch of electric network by applying mesh analysis.
11	Determine voltage at a particular node and current through any branch of electric network by applying nodal analysis.
12	Verification of Thevenin's Theorem.
13	Verification of Norton's Theorem.
14	Verification of Superposition Theorem.
15	Verification of Maximum Power Transfer Theorem.

14. 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

15.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

(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.

16. PROCEDURE FOR CONTINUOUS EVALUATION

CE type	02 Credits course
Written test	10 marks
Assignment	3 marks
Seminar/ attendance	2 marks
Total marks (CE)	**15 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.

17. 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

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

(1) 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**	Each questions contains two or three sub questions	Attempt any 3 questions from Q. 2 to Q. 5
Q. 3.	**10**		
Q. 4.	**10**		
Q. 5	**10**	Attempt any 4 out of 6	

19. 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.

20. 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	$90 \leq$ Marks ≤ 100
2.	A+ (Excellent	9	$80 \leq$ Marks ≤ 89
3.	A (Very Good)	8	$70 \leq$ Marks ≤ 79
4.	B+ (Good)	7	$55 \leq$ Marks ≤ 69
5.	B (Above Average)	6	$50 \leq$ Marks ≤ 54
6.	C (Average)	5	$45 \leq$ Marks ≤ 49
7.	D (Pass)	4	$40 \leq$ 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	$20 \times \text{CGPA} - 100$
A+	$10 \times \text{CGPA} - 5$
A	$10 \times \text{CGPA} - 5$
B+	$12 \times \text{CGPA} - 20$
B	$5 \times \text{CGPA} + 23.75$
C	$10 \times \text{CGPA} - 2.50$
D	$6.6 \times \text{CGPA} + 13.6$