AC – 28/03/2025
Item No. – 6.3 (N) (6ab) Sem. III & IV

As Per NEP 2020

University of Mumbai

Syllabus for Minor Vertical 2 (Scheme-II)		
Faculty of Science		
Board of Studies in Physics		
Second Year Programme in Minor (Physics)		
Semester	**III & IV**	
Title of Paper	**Sem.**	**Credits**
I) Modern Physics	**III**	**2**
II) Practical Course 3		**2**
Title of Paper		**Credits**
I) Mechanics	**IV**	**2**
II) Sound		**2**
III) Practical Course 4		**2**
From the Academic Year		**2025-26**

Sem. - III

Syllabus
B.Sc. (Physics)
(Sem.- III)
Physics Minor Course

Title of Paper: Modern Physics (2 Credits)

Sr. No.	Heading	Particulars
1.	**Description the course: (Including but not limited to)**	Introduction, relevance, Usefulness, Application, interest, connection with other courses, demand in the industry, job prospects etc.
2.	**Vertical:**	Major / **Minor** / Open Elective / Skill Enhancement / Ability Enhancement / Indian Knowledge System
3.	**Type:**	Theory
4.	**Credit:**	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5.	**Hours Allotted:**	**30 Hours**
6.	**Marks Allotted**:	**50 Marks**
7.	**Course Objectives (CO):** The students are expected to:	
	CO 1	learn De-Broglie's concept of matter waves its properties.
	CO 2	study the principle, production and transmission of ultrasonic waves and understand the working of various instruments based on ultrasonic.
	CO 3	describe qualitatively theory Black-body Radiation, de Broglie Waves and theory Heisenberg's Uncertainty principle, concept of X-ray's, Properties & Applications of x-rays.
	CO 4	enrich knowledge through problem-solving, hands-on activities, projects etc.
	CO 5	acquire knowledge of fundamental of Modern physics.
8.	**Course outcomes (OC):** After successful completion of this course students will be able to:	
	OC 1	understand concept of Matter waves and its properties
	OC 2	understand the principle, production and transmission of ultrasonic waves and understand the working of various instruments based on ultrasonic.
	OC 3	understand concept of Black-body Radiation, Wave particle Duality, de Broglie Waves Heisenberg's Uncertainty Principle and different forms of Uncertainty.
	OC 4	understand concept of X-Rays: Production, Characteristics of x-ray spectra, x-ray diffraction, Properties & Applications of x-rays.
	OC 5	demonstrate quantitative problem-solving skills in all the topics covered in the syllabus.
9.	**Modules / Units**: - There will be One module / Unit Per Credit	
	Module / Unit-I: Matter Waves and Ultrasonic	**(15 Lectures)**

	1. **Matter waves -** Introduction to matter waves, De-Broglie's concept of matter waves, Properties of matter waves. 2. **Ultrasonic -** sound waves - Introduction to sound waves, Generation of sound waves, construction and working principle, types of ultrasound generators, Ultrasound transmission modes, Ultrasound imaging and instrumentation; Phonocardiograph, Echo ophthalmoscope, Ultrasound blood flow meter.	
	Module / Unit-II: Basics of Quantum Theory (15 Lectures)	
	1. **Basics of Quantum Theory:** Black-body Radiation. Stefan-Boltzmann 'law, Wave particle Duality, Heisenberg's Uncertainty Principle, Different forms of Uncertainty principle, Applications of Uncertainty Principle. –problems. 2. **X-Rays:** Production (Coolidge tube), Continuous & Characteristics of x-ray spectra, x-ray diffraction (Laue's diffraction pattern) Bragg's Law, Properties & Applications of x-rays, problems.	
10	**Reference Books:** **1.** Concepts of Modern Physics, Arthur Beiser; Tata McGraw – Hill Edition. **2.** Arthur Beiser, Perspectives of Modern Physics: Tata McGraw Hill **3.** Modern Physics, Jeremy Bernstein, Paul M. Fish bane, Stephen Gasiorowics; Pearson Education. **4.** Quantum Mechanics, L. J. Schiff; Mc-Graw Hill International Edition. **5.** PHYSICS (Volume I & II), Resnick Halliday and Krane; Willey India 5th Edition. **6.** Atomic and Nuclear Physics – N. Subramanyam, Brijlal & Seshan	
11.	**Individual Passing in Internal and External Examination**	
12.	**Internal Continuous Assessment (40%) (20 Marks)**	**External Assessment, (60%) (30 Marks)**
	Continuous Evaluation through: Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. (at least 3)	**Evaluation:** through Exam at the End of the Semester / Term.
13.	**Duration of the Term End Examination: One Hour** **Format of Question Paper for Physics Minor Term End Examination for 30 Marks:**	
	Unit - I (15 Marks)	Q.1 A) Attempt any Two 10 Marks i) Theory ii) Theory iii) Theory iv) Theory B) Attempt any One 05 Marks i) Problem / Theory ii) Problem
	Unit – II (15 Marks)	Q.1 A) Attempt any Two 10 Marks i) Theory ii) Theory iii) Theory iv) Theory B) Attempt any One 05 Marks i) Problem / Theory ii) Problem

Syllabus
B.Sc. (Physics)
(Sem.- III)

Title of Paper: Physics Minor Practical Course 3 – USPHMNP3 (Credit - 02)

Sr. No.	Heading	Particulars
1.	**Description the course: (Including but not limited to)**	Introduction, Relevance, Usefulness, Application, Interest, Connection with other courses, Demand in the Industry, Job Prospects etc.
2.	**Vertical:**	Major / **Minor** / Open Elective / Skill Enhancement / Ability Enhancement / Indian Knowledge System
3.	**Type:**	**Practical**
4.	**Credits:**	2 Credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a Semester)
5.	**Hours**	60 Hours
6.	**Marks Allotted:**	50 Marks
7.	**Course Objectives (CO):** The students are expected to:	
	CO 1	study the skills while performing experiments.
	CO 2	know how to use the apparatus without fear & hesitation.
	CO 3	learn the concepts of physics theory concepts and their practical application.
	CO 4	learn the errors and their estimation**.**
8.	**Course outcomes (OC):** After successful completion of this course, the students will be able to:	
	OC 1	understand & practice the skills while performing experiments.
	OC 2	understand the use of apparatus and their use without fear & hesitation.
	OC 3	correlate the physics theory concepts to practical application.
	OC 4	understand the concept of errors and their estimation**.**
9.	**List of Experiments:** **1.** LCR series Resonance **2.** LCR parallel resonance **3.** Thevenin's Theorem: To verify the theorems for DC circuits **4.** Norton's Theorem: To verify the theorems for DC circuits **5.** Determination of wavelength of LASER beam Using Grating **6.** Passive Low Pass Filter **7.** Passive High Pass Filter **8.** Verification of Stefan's Law (electrical method). **9.** Determination of R.I. of liquid by laser **10.** C1/ C2 by De-Sauty's Bridge. **11.** Determination of angle of diffraction using grating (I^{st} order only) **12.** Passive band pass filter **13.** I-V Characteristics of Solar cell with different intensity of light **14.** OPAMP: Inverting amplifier with different gains (BB) **15.** CE amplifier: variation of gain with load **Skill Experiment:** **1.** Use of Bread Board **2.** PC simulations: graph, curve fitting, etc. using Origin Software	

3. To determine the resistance and capacitance using colour code / number and verify the values obtained by using the multimeter.
4. Travelling microscope (radius of capillary)
5. Optical Levelling of Spectrometer
6. Graph plotting - plotting of graphs and finding slope and intercept.

- Minimum **10 experiments** from the list of experiments and all skill experiments must be completed and reported in the journal, in the **Third Semester**. Certified Journal is a must, to be eligible to appear for the semester end practical examination.
- All the measurements and readings should be written with proper units in SI system only.
- After completing the required number of experiments in the semester and recording them in journal, student will have to get their journal certified and produce the certified journal at the time of practical examination to be eligible to appear in the Semester End Practical Examination.

General Instructions:

- For practical examinations, the learner will be examined in ONE experiment from the list of experiments.
- Evaluation in viva voce will be based on regular experiments and skill experiments.
- A candidate will be allowed to appear for the semester end practical examination only if the candidate submits a certified journal at the time of practical examination of the semester or a certificate from the Head of the Department / Institute to the effect that the candidate has completed the practical course of that semester of S.Y.B. Sc. Physics as per the minimum requirement.

Note:

- The questions on slips for the same should be framed in such a way that candidate will be able to complete the task within the specified time.
- While evaluating practical, weightage should be given to circuit / ray diagram, observations, tabular representation, experimental skills, procedure, graph, calculation and result.
- The skill of doing the experiment and understanding physics concepts should be more important than the accuracy of final result.

10. **Passing standards for Practical:**

- Individual Passing in Internal and External Examination

11. **cheme of Examination:**

emester End Practical Examination:

- The duration of **Each** Experiment in Semester End External Practical Examination will be of **Two hours**.
- The Semester End External Practical Examination will be for **30 marks** as per the marking scheme given below:

Sr. No.	Activity	Total 30 Marks
1	One Experiment	20 Marks
2	Certified Journal	05 Marks
3	Viva	05 Marks

ternal Practical Examination:

- The duration of Internal Practical Examination per experiment will be of **Two hours**.

- The Internal Practical Examination Pattern for **20 marks (During the Semester)**, will be as per the marking scheme given below:

Sr. No.	**Activity**	**Total 20 Marks**
1	Skill testing related to One Experiment	10 Marks
2	Overall performance	05 Marks
3	Viva-Voce	05 Marks

Sem. - IV

Syllabus
B.Sc. (Physics)
(Sem.- IV)
Physics Minor Course

Title of Paper: Mechanics (2 Credits)

Sr. No.	Heading	Particulars
1.	**Description the course: (Including but not limited to**)	Introduction, relevance, Usefulness, Application, interest, connection with other courses, demand in the industry, job prospects etc.
2.	**Vertical:**	Major / **Minor** / Open Elective / Skill Enhancement / Ability Enhancement / Indian Knowledge System
3.	**Type:**	Theory
4.	**Credit**:	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5.	**Hours Allotted:**	**30 Hours**
6.	**Marks Allotted**:	**50 Marks**
7.	**Course Objectives**: The students are expected to:	
	CO 1	learn work and kinetic energy theorem, conservative and non - conservative forces and to solve problems using them.
	CO 2	study the Collision (Elastic and Inelastic collision), Gravitational potential energy and to solve problems using them.
	CO 3	demonstrate quantitative problem-solving skills in all the topics covered in the syllabus.
8.	**Course Outcomes**: On successful completion of this course students will be able to:	
	OC 1	understand the concepts of mechanics & properties of matter & to apply them to solve problems.
	OC 2	comprehend work and energy equivalence and its applications through suitable numerical.
	OC 3	demonstrate quantitative problem-solving skills in all the topics covered
9.	**Modules / Units**: - There will be One module / Unit Per Credit	
	Module / Unit - I: Work and Energy (15 Lectures)	
	i) Kinetic Energy, Work and Work-energy theorem, calculation of work done, Work-energy theorem for a system of particles, potential energy, conservative and non - conservative forces, Definition of potential energy and conservation of mechanical energy, change in the potential energy in a rigid – body motion, Different forms of Energy: Mass Energy Equivalence. ii) Equivalence of Shear strain to compression and extension strains, Relations between elastic constants, Energy stored in a strained body, couple for twist in cylinder.	
	Module / Unit-II: Centre of mass, Collisions, Elasticity & Gravitation (15 Lectures)	
	i) Many particles system, Centre of mass of solid objects, Conservation of momentum in a system of particle, Angular momentum of a particle and system of particle, conservation of angular momentum.	

<table>
<tr><td></td><td colspan="3">ii) Collision, Elastic Collision in one Dimension and inelastic collision in one Dimension.

iii) Gravitational potential energy, gravitational potential, calculation of gravitational potential, calculation of gravitational field, inertial and gravitational mass.</td></tr>
<tr><td>10.</td><td colspan="3">Reference Books:
1. HCV: H.C. Verma, Concepts of Physics-Part I (Second Reprint of 2020) Bharati Bhavan Publishers and Distributers
2. HP: H. S. Hans and S. P. Puri, Mechanics, 2nd ed, Tata McGraw Hill.
3. RH: Resnick, Halliday and Krane, Physics – I, 5th Edition

Additional Reference Books:
1. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.
2. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
3. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000</td></tr>
<tr><td>11.</td><td colspan="3">Individual Passing in Internal and External Examination</td></tr>
<tr><td rowspan="2">12.</td><td colspan="2">Internal Continuous Assessment (40%)
(20 Marks)</td><td>External Assessment, (60%)
(30 Marks)</td></tr>
<tr><td colspan="2">Continuous Evaluation through:
Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. (at least 3)</td><td>Evaluation: through Exam at the End of the Semester / Term.</td></tr>
<tr><td rowspan="3">13.</td><td colspan="3">Format of Question Paper for Physics Minor Term End Examination for 30 Marks:
Duration of the Term End Examination: One Hour</td></tr>
<tr><td>Unit - I (15 Marks)</td><td colspan="2">Q.1 A) Attempt any Two 10 Marks
i) Theory
ii) Theory
iii) Theory
iv) Theory
B) Attempt any One 05 Marks
i) Problem / Theory
ii) Problem</td></tr>
<tr><td>Unit – II (15 Marks)</td><td colspan="2">Q.2 A) Attempt any Two 10 Marks
i) Theory
ii) Theory
iii) Theory
iv) Theory
B) Attempt any One 05 Marks
i) Problem / Theory
ii) Problem</td></tr>
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Syllabus
B.Sc. (Physics)
(Sem.- IV)
Physics Minor Course

Title of Paper: Sound (2 Credits)

Sr. No.	Heading	Particulars
1.	**Description the course: (Including but not limited to)**	Introduction, relevance, Usefulness, Application, interest, connection with other courses, demand in the industry, job prospects etc.
2.	**Vertical:**	Major / **Minor** / Open Elective / Skill Enhancement / Ability Enhancement / Indian Knowledge System
3.	**Type:**	Theory
4.	**Credit**:	2 credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a semester)
5.	**Hours Allotted:**	**30 Hours**
6.	**Marks Allotted**:	**50 Marks**
7.	**Course Objectives:** The students are expected to:	
	CO 1	gain knowledge of basic concepts in sound
	CO 2	to understand the fundamental principles of sound
	CO 3	to develop practical knowledge of sound measurement and analysis.
8.	**Course Outcomes**: After successful completion of the course, the students will be able to:	
	OC 1	understand basic concept of sound
	OC 2	understand the basic concept how sound is produced
	OC 3	apply knowledge to develop sound modulations
9.	**Modules / Units**: - There will be One module / Unit Per Credit	
	Module / Unit I: Wave Motion **(15 Hours)**	
	Wave motion, characteristic of wave motion, transverse wave, longitudinal wave, relation between frequency and wavelength, equation of Simple Harmonic Wave, particle velocity and wave velocity, energy of a progressive wave. **Velocity of Sound**: Velocity of longitudinal waves in gases, newton's formula for velocity of sound, effect of temperature, effect of pressure, velocity of sound in water, velocity of sound in air.	
	Module / Unit II: Phenomena of Sound **(15 Hours)**	
	Stationary waves, properties of stationary longitudinal waves, energy of stationary wave, Interference of sound waves, special cases, Conditions for Interference of sound waves, Introduction to beats. Velocity of transverse waves along a stretched string, laws of transverse wave, verification of the law transverse vibration of strings, Kundts tube, Musical sound and noise, characteristic of musical sound. Acoustics of building: reverberation, explanation of Sabine's formula and importance of Sabine's formula, absorption coefficient, Acoustics of building, factors affecting acoustics of building, sound distribution in an auditorium.	

<table>
<tr><td>10.</td><td colspan="3">Reference Books:
1. SB: Waves and Oscillations by Subramanian and Brijlal second revised edition
2. RK: Properties of Matter and Acoustics. R Murugesham and K Shivaprasath.S
3. RS: Fundamentals of Physics by Resnick and Halliday</td></tr>
<tr><td>11.</td><td colspan="3">Individual Passing in Internal and External Examination</td></tr>
<tr><td rowspan="2">12.</td><td colspan="2">Internal Continuous Assessment: 40%
(20 Marks)</td><td>External, Semester End Examination:60%
(30 Marks)</td></tr>
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Quizzes, Class Tests, presentation, project, role play, creative writing, assignment etc. (at least 3)</td><td>Evaluation: through Exam at the End of the Semester / Term.</td></tr>
<tr><td rowspan="3">13.</td><td colspan="3">Format of Question Paper for Physics Minor Term End Examination for 30 Marks:
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<tr><td>Unit - I (15 Marks)</td><td colspan="2">Q.1 A) Attempt any Two 10 Marks
i) Theory
ii) Theory
iii) Theory
iv) Theory
B) Attempt any One 05 Marks
i) Problem / Theory
ii) Problem</td></tr>
<tr><td>Unit – II (15 Marks)</td><td colspan="2">Q.2 A) Attempt any Two 10 Marks
i) Theory
ii) Theory
iii) Theory
iv) Theory
B) Attempt any One 05 Marks
i) Problem / Theory
ii) Problem</td></tr>
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Syllabus
B.Sc. (Physics)
(Sem.- IV)

Title of Paper: Physics Minor Practical Course 4 – USPHMNP4 (Credit - 02)

Sr. No.	Heading	Particulars
1.	**Description the course: (Including but not limited to)**	Introduction, Relevance, Usefulness, Application, Interest, Connection with other courses, Demand in the Industry, Job Prospects etc.
2.	**Vertical:**	Major / **Minor** / Open Elective / Skill Enhancement / Ability Enhancement / Indian Knowledge System
3.	**Type:**	**Practical**
4.	**Credits:**	2 Credits (1 credit = 15 Hours for Theory or 30 Hours of Practical work in a Semester)
5.	**Hours**	60 Hours
6.	**Marks Allotted:**	50 Marks
7.	**Course Objectives (CO):** The students are expected to:	
	CO 1	study the skills while performing experiments.
	CO 2	know how to use the apparatus without fear & hesitation.
	CO 3	learn the concepts of physics theory concepts and their practical application.
	CO 4	learn the errors and their estimation**.**
8.	**Course outcomes (OC):** After successful completion of this course, the students will be able to:	
	OC 1	understand & practice the skills while performing experiments.
	OC 2	understand the use of apparatus and their use without fear & hesitation.
	OC 3	correlate the physics theory concepts to practical application.
	OC 4	understand the concept of errors and their estimation**.**
9.	**List of Experiments:** 1. Y by Bending 2. Resonance Pendulum 3. Brewster's Law: Determination of μ. 4. Modulus of Rigidity using Flat Spiral Spring 5. Young's Modulus using Flat Spiral Spring 6. Optical lever 7. OPAMP as Integrator (BB) 8. Coupled Pendulum 9. CE Amplifier – determination of Band Width 10. Colpitt's Oscillator 11. Helmholtz Resonator 12. Op-Amp as Non - Inverting Amplifier and Voltage follower 13. OPAMP as Differentiator (BB) ~~14.~~ Log Decrement using Simple pendulum 15. MOD 5 & MOD 10 counter using IC7490 (BB) **Demonstration Experiment:** **1.** Building Electronic Circuits using Breadboard. **2.** Slew rate of OP-AMP **3.** Faraday's Induction Experiment **4.** Concepts of Beats	

5. Measurement of Phase shift using CRO.
6. Wave form generation using Op-Amp

- Minimum **10 experiments** from the list of experiments and all Demonstration experiments must be completed and reported in the journal, in the **Fourth Semester**. Certified Journal is a must, to be eligible to appear for the semester end practical examination.
- All the measurements and readings should be written with proper units in SI system only.
- After completing the required number of experiments in the semester and recording them in journal, student will have to get their journal certified and produce the certified journal at the time of practical examination to be eligible to appear in the Semester End Practical Examination.

General Instructions:

- For practical examinations, the learner will be examined in ONE experiment from the list of experiments.
- Evaluation in viva voce will be based on regular experiments and demonstration experiments.
- A candidate will be allowed to appear for the semester end practical examination only if the candidate submits a certified journal at the time of practical examination of the semester or a certificate from the Head of the Department / Institute to the effect that the candidate has completed the practical course of that semester of S.Y.B. Sc. Physics as per the minimum requirement.

Note:

- The questions on slips for the same should be framed in such a way that candidate will be able to complete the task within the specified time.
- While evaluating practical, weightage should be given to circuit / ray diagram, observations, tabular representation, experimental skills, procedure, graph, calculation and result.
- The skill of doing the experiment and understanding physics concepts should be more important than the accuracy of final result.

10. **Passing standards for Practical:**

- Individual Passing in Internal and External Examination

11. **Scheme of Examination:**

Semester End Practical Examination:

- The duration of **Each** Experiment in Semester End External Practical Examination will be of **Two hours**.
- The Semester End External Practical Examination will be for **30 marks** as per the marking scheme given below:

Sr. No.	Activity	Total 30 Marks
1	One Experiment	20 Marks
2	Certified Journal	05 Marks
3	Viva	05 Marks

Internal Practical Examination:

- The duration of Internal Practical Examination per experiment will be of **Two hours**.
- The Internal Practical Examination Pattern for **20 marks (During the Semester)**, will be as per the marking scheme given below:

Sr. No.	Activity	Total 20 Marks
1	Skill testing related to One Experiment	10 Marks
2	Overall performance	05 Marks
3	Viva-Voce	05 Marks

Sd/- **Sd/-** **Sd/-**

Sign of the BOS Chairman
Dr. T.N. Ghorude
Board of Studies in Physics

Sign of the
Offg. Associate Dean
Dr. Madhav R. Rajwade
Faculty of Science & Technology

Sign of the
Offg. Dean
Prof. Shivram S. Garje
Faculty of Science & Technology