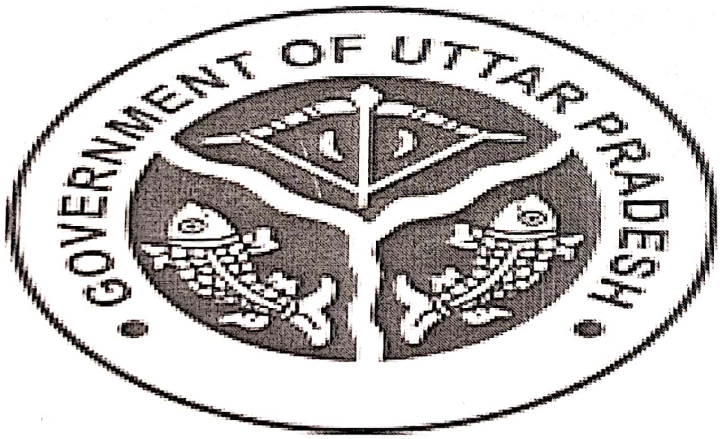
Undergraduate (UG) PHYSICS SYLLABUS

(As per Credit and Curriculum Frame work of Undergraduate Programmes (CCFUGP) of UGC under, NEP 2020)

Bachelor of Science (B.Sc.)

(Physics as major subject)



Department of Physics

Dr. Shakuntala Misra National Rehabilitation University, Lucknow, U.P. India, 226017

31-12-2025

B.Sc. Programme Outline

According to the recommendation of the NEP 2020 and Credit and Curriculum Frame work of Undergraduate Programmes (CCFUGP) of UGC under, NEP 2020), the programme and course structures/syllabi format of the Major discipline Physics are introduce. As per these recommendations for a student, admitted to the UG programme, to fulfill the degree requirements.

- *For the minor, AEC, SEC, VAC courses, a student may choose any course from the* ***central pool of courses*** *approved by the Academic Council and made available by any department of the university, with the approval of the Dean, Faculty of Science.*

PROGRAMME SPECIFIC OUTCOMES (PSOs)

Science teaches the value of rational thought as well as importance of freedom of thought. Additionally, it has proved to be of practical value in technology development, productivity and raising the standard of living.
Our teaching is not only aimed at formal knowledge and understanding but also encourages training and application oriented learning. The emphasis is on training, application and fostering independent thinking and creativity.

Physics is a basic science; it attempts to explain the natural phenomenon in as simple a manner as possible. It is an intellectual activity aimed at interpreting the Multiverse. The starting point of all physics lies in experience. Experiment, whether done outside or in the laboratory, is an important ingredient of learning physics and hence the present programme integrates six experimental physics papers focusing on various aspects of modern technology based equipments. With all the limitations imposed (even the list of experiments as given in the syllabus) if the spirit of discovery by investigation is kept in mind, much of the thrill can be experienced.

1. The main aim of this programme is to help cultivate the love for Nature and its manifestations, to transmit the methods of science (the contents are only the means) to observe things around, to generalize, to do intelligent guessing, to formulate a theory & model, and at the same time, to hold an element of doubt and thereby to hope to modify it in terms of future experience and thus to practice a pragmatic outlook.

2. The programme intends to nurture the proficiency in functional areas of Physics, which is in line with the international standards, aimed at realizing the goals towards self reliant (Atmanirbhar) BHARAT.

3. Keeping the application oriented training in mind; this programme aims to give students the competence in the methods and techniques of theoretical, experimental and computationalaspects of Physics so as to achieve an overall understanding of the subject for holistic development. This will cultivate in specific application oriented training leading to their goalsof employment.

4. The Bachelor's Project (Industrial Training / Survey / Dissertation) is intended to give an essence of research work for excellence in explicit areas. It integrates with specific job requirements / opportunities and provides a foundation for Bachelor (Research) Programmes.

31-12-2025

Course Structure for B.Sc. PHYSICS Major

SEMESTER-WISE TITLES OF THE PAPERS IN UG PHYSICS COURSE			
YEAR	**COURSE CODE**	**PAPER TITLE & TYPE**	**CREDIT**
First Year		**Semester-I**	
	BPHY 101 (T)	Major Course: Mechanics and Wave Motion	2
	BPHY 102 (P)	Major Course: Practical (Mechanical Properties of Matter)	1
	MDCPH-101 Elective	To be Launched by Department of Physics "Basics of Physics"(For other faculty students) OR A MOOCs, if Available	3
	SEC-101 Other subject	Skills Enhancement Course: Entrepreneurship Development (To be Floated by Department of Commerce)	3
	AEC-101	Ability Enhancement Course: English Language & Communication-I (To be Floated by English Department)	2
	VAC-101	Value-added Course: "Environmental Education" (To be Floated by Chemistry Department)	3
	Other Major Subject-II Other Major Subject-III		3 3
	Total		20
		Semester-II	
	BPHY 104(T)	Thermal Physics	2
	BPHY 105 (P)	Practical (Thermal Properties of Matter & Electronic Circuits)	1
	(MDCPH-102) Other Subject	Basic of Atmospheric Physics (For other faculty students) OR A MOOCs, if Available	3
	SEC-102 Other Subject OR SECS-102	Computer Applications (To be Floated by CS & IT Department) OR Solar PV(Photovoltaic) System Techniques and Installation-I	3

3-12-2025

	AEC-102	English Language & Communication-II (To be Floated by English Department)	2
	VAC-102	Value-added Course- (Related to Indian Knowledge System): **Introduction to Indian Astronomy**	3
	Other Major Subject-II Other Major Subject-III		3 3
	Total		20
	Semester-III		
	BPHY- 201 (T)	Optics	3
	BPHY - 202 (P)	Practical (Optics)	1
Second Year	MDCPH-201 Other Subject	Basics of Astrophysics (For other faculty students) OR A MOOCs if Available	3
	SEC-201 OR SECS-201	आयुर्वेदा एवं वन औषधि Ayurveda and Vanaushdhi (To be floated by Department of Microbiology) OR Solar PV(Photovoltaic) System Techniques and Installation-II	3
	AECH-201 OR AECS-201	हिन्दी भाषा एवं सम्प्रेषण-1 (To be floated by Department of Hindi) OR संस्कृत भाषा एवं सम्प्रेषण-1 (To be floated by Department of Sanskrit)	2 OR 2
	Other Major Subject-II Other Major Subject-III		4 4
	Total		20
	Semester-IV		

31-12-2025

	BPHY-203 (T)	Modern Physics	2
	BPHY-204 (T)	Basic Electronics	2
	BPHY-205 (P)	Practical (Basic Electronics Instrumentation)	2
	AECH-202 OR AECS-202	हिन्दी भाषा एवं सम्प्रेषण-2 (To be floated by Department of Hindi) OR संस्कृत भाषा एवं सम्प्रेषण-2 (To be floated by Department of Sanskrit)	2
	Other Major Subject-II Other Major Subject-III		6 6
	Total		20
**Internship: to be done by the students during summer break of 2nd Year having 4-credit			
	Semester-V		
Third Year	BPHY 301 (T)	Electromagnetic Theory	2
	BPHY 302 (T)	Basics of Quantum Mechanics	2
	BPHY 303 (P)	Practical (Demonstrative Aspects of Electricity & Magnetism)	1
	BPHY 304 (P)	General Physics Lab	1
	Other Major Subject-II(2-papers)		6
	Minor Course (Other faculty)		4
	Internship Summer term		4**
	Total		20
	Semester-VI		

31-12-2025

	BPHY 305(T)	Atomic & Nuclear Physics	3
	BPHY 306 (T)	Solid State Physics	3
	BPHY 307 (P)	Practical: Digital Electronics Lab	1
	BPHY 308 (P)	Practical : Analog Electronics Lab	1
	Other Major Subject-II		8
	Minor Course of Other Faculty		4
	Total		20
Fourth Year	**For B.Sc. (Honours) Degree:**		
	Semester-VII		
	BPHY-401 (T)	Mathematical Physics	3
	BPHY-402 (T)	Classical Mechanics	3
	BPHY-403 (T)	Advance Quantum Mechanics-I	3
	BPHY-404 (T)	Electronics	3
	BPHY-405 (P)	Physics Practical – Electronics-I	2
	BPHY-406 (P)	Physics Practical –Optics-I	2
	Minor Course of Other Faculty		4
	Total		20
	Semester-VIII		
	BPHY-407 (T)	Thermodynamics and Statistical Physics	3
	BPHY-408 (T)	Electromagnetic Theory and Plasma Physics	3
	BPHY-409 (T)	Nuclear & Particle Physics	3
	BPHY-410 (T)	Experimental Techniques and Computational Methods	3

31-12-2025

BPHY-411 (P)	Physics Practical – Electronics-II	2
BPHY-412 (P)	Physics Practical –Optics-II	2
Minor Courses of Other Faculty		4
	Total	20

For B.Sc. (Honors with Research) Degree:The Students who secure minimum 75% mark up to six semesters (i. e up to 3rd year) can opt for B.Sc. (Honors with research) mode:

Fourth Year	**Semester-VII**		
	BPHY-401 (T)	Mathematical Physics	3
	BPHY-402 (T)	Classical Mechanics	3
	BPHY-403 (T)	Advance Quantum Mechanics-I	3
	BPHY-404 (T)	Electronics	3
	BPHY-405 (P)	Physics Practical – Electronics	2
	BPHY-406 (P)	Physics Practical – Optics	2
	Minor Course of Other Faculty		4
	Research Project		6* To be evaluated in 8th Semester
	Total		20

31-12-2025

	Semester-VIII		
Fourth Year	BPHY-407 (T) OR BPHY-408 (T) OR BPHY-409 (T) OR BPHY-410 (T)	Thermodynamics and Statistical Physics OR Electromagnetic Theory and Plasma Physics OR Nuclear Physics OR Experimental Techniques and Computational Methods	4
	Minor Courses of Other Faculty		4
	BPHY-413 Research Project		6*+6= 12
	Total		20

31-12-2025

Mechanics and Wave Motion

Credit 2

BPHY 101

Course Outcomes (COs)

CO1 Study the response of the classical systems to external forces and their elastic deformation.

CO2 Understand the dynamics of planetary motion and the working of Global Positioning System (GPS).

CO3 Comprehend the different features of Simple Harmonic Motion (SHM) and wave propagation.

CO4 Study the response of the classical systems to external forces and their elastic deformation.

Unit 1 Dynamics of a Rigid Body

Angular momentum, Torque, Rotational energy and the inertia tensor. Theorem of parallel and perpendicular axis, Momentum of inertia for simple bodies (ring, disk, rod, solid and hollow sphere, solid and hollow cylinder, rectangular lamina). The combined translational and rotational motion of a rigid body on horizontal and inclined planes. Elasticity, relations between elastic constants, bending of beam and torsion of cylinder.

Unit 2 Oscillation

Differential equation of simple harmonic motion, Damped and forced oscillations and their solution, Transient time, Energy of oscillatory motion, Quality factor. Composition of simple harmonic motion and modes of oscillation, Lissajous figures.

Unit 3 Wave Motion

Differential equation of wave motion. Plain progressive waves. Principle of superposition of waves, stationary waves, phase and group velocity. Fourier series and Fourier coefficients (simple examples).

Suggested Readings:

1. Charles Kittel, Walter D. Knight, Malvin A. Ruderman, Carl A. Helmholz, Burton J. Moyer, "Mechanics (In SI Units): Berkeley Physics Course Vol 1", McGraw Hill, 2017, 2e
2. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 1", Pearson Education Limited, 2012
3. Hugh D. Young and Roger A. Freedman, "Sears & Zemansky's University Physics with Modern Physics", Pearson Education Limited, 2017, 14e
4. D.S. Mathur, P.S. Hemne, "Mechanics", S. Chand Publishing, 1981, 3e
5. Mechanics by J.C. Upadhyay
6. Waves and Oscillations by N. Subrahmanyam and Brij Lal

31-12-2025

Practical (Mechanical Properties of Matter)

Credit 1

BPHY 102

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the mechanical properties. Measurement precision and perfection is achieved through Lab Experiments.

Lab Experiment List

1. Moment of inertia of fly wheel.
2. Compound pendulum; Acceleration due to gravity and radius of gyration.
3. Modulus of rigidity by Maxwell's needle.
4. Young's modulus of rectangular bar by cathetometer or optical lever method
5. To determine the force constant of a spiral spring by statical and dynamical methods
6. To determine height of building and draw zero-error graph of sextant.
7. Elastic constants by Searle's apparatus.
8. Surface tension of water by Jaeger's method.
9. Coefficient of viscosity of water by Poiseuille's method.
10. Frequency of electrically maintained tuning fork.
11. Frequency of A.C. mains using sonometer.

Suggested Readings:

1. R K Shukla and Anchal Srivastava, Physics Practical, New Age International (P) Publications.
2. Practical Physics Volume-I, S. L. Srivastava, D. C. Srivastava, S. N. Tiwari.

31-12-2025

Multidisciplinary (Elective)

Basics of Physics

Credit 3

MDCPH-101

Course Outcome:

CO1 Develop familiarity with various Physics terms and concepts.
CO2 Appreciate the role of Physics in diverse everyday phenomenon.
CO3 Learning to observe and analyze natural phenomenon.
CO4 Develop scientific temper.

Unit – I

Physical quantities, important units, dimensional analysis, error analysis. Mechanics: conceptsof velocity, acceleration, momentum, force and energy. Gravity: Projectiles and satellites, orbitsof planets, eclipses, solar system, stars and galaxies. Elementary idea of origin of the universe.

Unit – II

Heat: Conservation of Energy, Temperature, heat capacities, thermal expansion and conductivity.

Light: Mirrors, prism, lenses, human eye, microscope and telescope. Electromagnetic spectrum, Hydrogen spectral lines, Solar Fraunhofer lines.

Unit – III

Sound: oscillations, waves, concept of musical notes. Electricity: Current, Potential, Resistance, Capacitance and Inductance. Household appliances. Conductors, Insulators and Semi-conductors.

References:

1. University Physics; Hugh Young and Roger Freedman (original edition by Mark Zemanskyand Francis Sears); Pearson Publication.

2. Concept of Physics by HC Verma

31-12-2025

Semester-II

Thermal Physics

BPHY-104 **Credit 2**

Course Outcomes (COs)

CO1 Recognize the difference between reversible and irreversible processes.
CO2 Understand the physical significance of thermodynamical potentials.
CO3 Comprehend the kinetic model of gases w.r.t. various gas laws.
CO4 Study the implementations and limitations of fundamental radiation laws.

Unit 1 Zeroth & First Law of Thermodynamics

State functions and terminology of thermodynamics. Zeroth law and temperature. First law, internal energy, heat and work done. Work done in various thermodynamical processes. Enthalpy, relation between C P and C V . Carnot"s engine, efficiency and Carnot"s theorem. Efficiency of internal combustion engines (Otto and diesel).

Unit 2 Second & Third Law of Thermodynamics

Different statements of second law, Clausius inequality, entropy and its physical significance. Entropy changes in various thermodynamical processes. Third law of thermodynamics and unattainability of absolute zero. Thermodynamical potentials, Maxwell"s relations, conditions for feasibility of a process and equilibrium of a system. Clausius- Clapeyron equation, Joule-Thompson effect.

Unit 3 Kinetic Theory of Gases

Kinetic model and deduction of gas laws. Derivation of Maxwell"s law of distribution of velocities and its experimental verification. Degrees of freedom, law of equipartition of energy (no derivation) and its application to specific heat of gases (mono, di and poly atomic).

Unit 4 Theory of Radiation

Blackbody radiation, spectral distribution, concept of energy density and pressure of radiation. Derivation of Planck's law, deduction of Wien"s distribution law, Rayleigh-Jeans law, Stefan-Boltzmann law and Wien"s displacement law from Planck"s law.

Suggested Readings

1. M.W. Zemansky, R. Dittman, "Heat and Thermodynamics", McGraw Hill, 1997, 7e
2. F.W. Sears, G.L. Salinger, "Thermodynamics, Kinetic theory & Statistical thermodynamics", Narosa Publishing House, 1998
3. Enrico Fermi, "Thermodynamics", Dover Publications, 1956
4. S. Garg, R. Bansal, C. Ghosh, "Thermal Physics", McGraw Hill, 2012, 2e
5. Meghnad Saha, B.N. Srivastava, "A Treatise on Heat", Indian Press, 1973, 5e

31-12-2025

Semester-II

Practical (Thermal Properties of Matter & Electronic Circuits)

Credit 1

BPHY-105

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the thermal and electronic properties. Measurement precision and perfection is achieved through Lab Experiments.

Lab Experiment List

1. Mechanical Equivalent of Heat by Callender and Barne's method
2. Value of Stefan's constant
3. Verification of Stefan's law
4. Measurement of inductance of a coil using Anderson's bridge.
5. Measurement of capacity and power factor of a capacitor using Schering's Bridge.
6. Determination of Plank's constant using photo current.
7. Study of resonance of digital display (LCR) in series and parallel circuit to find its resonance frequency.

Suggested Reading Books:

1. Anchal Srivastava and R K Shukla, Practical Physics (Electricity, Magnetism and Electronics), New Age International (P) Publications Limited.
2. Practical Physics Vol-1, Vol 2, B. Ghosh, K. G. Majumder, Sreedhar Publisher.
3. An Advanced Course in Practical Physics, D. Chattopadhyay, P.C. Rakshit, New Central Book Agency (P) Ltd

31-12-2025

Semester-II

Basic of Atmospheric Physics

MDCPH- 102 **Credit 3**

Course Outcomes:

CO1 Develop deeper insights in multiple aspects of Atmospheric Science for better scientific understanding and interpretation of various atmospheric phenomena.

CO2 Apply mathematical and computational tools and techniques to study atmospheric processes

CO3 Demonstrate quantitative skills for interpreting atmospheric observations to numerical modeling and forecasting of weather systems.

CO4 Explain the principles behind meteorological instrumentation and create graphical depictions of meteorological information.

CO5 Demonstrate critical and analytical skills to interpret and predict weather systems using different products (model results, maps, satellite imagery, etc.).

UNIT I Thermal structure of the Earth's Atmosphere, Ionosphere, Composition of atmosphere, Hydrostatic equation, Atmospheric Thermodynamics, Greenhouse effect and effective temperature of Earth, Local winds, monsoons, fogs, clouds, precipitation, Atmospheric boundary layer, Sea breeze and land breeze.

UNIT II Instruments for meteorological observations, including RS/RW, meteorological processes and different systems, fronts, Cyclones and anticyclones, thunderstorms. Composition of atomosphere.

UNIT III Scale analysis, Fundamental forces, Basic conservation laws, The Vectorial form of the momentum equation in rotating coordinate system, scale analysis of equation of motion, Applications of the basic equations, Circulations and vorticity, Atmospheric oscillations, Mesoscale circulations.

Reference Books:

1. Fundamental of Atmospheric Physics – Murry L Salby; Academic Press, Vol 61, 1996
2. The Physics of Atmosphere – John T. Houghton; Cambridge University press; 3rd edn. 2002.
3. An Introduction to dynamic meteorology – James R Holton; Academic Press, 2004
4. Radar for meteorological and atmospheric observations – S Fukao and K Hamazu, Springer Japan, 2014

31-12-2025

IKS: Introduction to Indian Astronomy
(Course related to Indian Knowledge System)

Course Code: VAC-102 **Credit 3**

Course Objectives: To inculcate the values, sanskar of Bhartiya sanskriti and tradition through scientific interpretation and to prepare generations capable of following mordernity blends with tradition: respecting values and sankars and culture.

Unit – I

Ancient records of the observation of the motion of Celestial bodies in the Vedic corpus. Sun, Moon, Nakshatra & Graha. Astronomy as the science of determination of time, place and direction by observing the motion of the celestial bodies. The motion of the Sun and Moon. Motion of equinoxes and solstices. Element of Indian calendar systems as followed in different regions of India.

Unit-II

Important texts of Indian Astronomy. Basic ideas of the planetary model of Aryabhata and its revision by Nilakantha.

Large corpus of inscriptions recording observation of eclipse. Astronomical instruments.

How Indian astronomy continued to flourish in the $18^{th}/19^{th}$ centuries. Astronomical endeavors of Jaisingh, Sankaravarman, Chandrasekhara Samanta.

Unit – III

Realization of Astronomical space time transformation through festivals: Makarsakaranti मकर संक्राति and Sharad purnima (शरद पूर्णिमा) Solar parameters and solar constant, Environment conservation through faith and practices, Family system (कुटुम्ब व्यवस्था) and Marriage system (विवाह व्यवस्था) as scientifically designed way for empowered society and empowered Bharat (सशक्त समाज एवं सशक्त भारत)

Reference: (1) Atmospheric sciences: An Introductory survey- J M Wallace and P V Hobbs, Elsevier academy press, 2006

(2) An Introduction to Atmospheric Physics, D G Andrews, Cambridge University Press, 2010

(3) Indian National Science Academy Publications: (i) "Aryabhatiya": original by Aryabhat and Hindi Translation by Ram Niwas Rai. (INSA, New Delhi) (ii) "Aryabhatiya":Aryabhat's original text with English Translation by Kripa Shankar Shukla and K.V. Sharma (INSA, New Delhi).

Course outcome:

1. Student shall become aware about scientific approach embedded with Bhartiya Sanskriti.
2. Student shall feel pride to glorious history of our tradition and sanskars
3. A Human Manpower full of values and sanskars will be made available to the Society and Nation.

31-12-2025

Semester-III

OPTICS

BPHY 201 **Credit 3**

Course Outcomes (COs)

CO1 Study Fermat's principle of least time
CO2 familize with incident ray, reflected ray and refracted ray.
CO3 Study the working and applications of Michelson and Fabry-Perot interferometers.
CO4 Recognize the difference between Fresnel's and Fraunhofer's class of diffraction.
CO5 Comprehend the use of polarimeters.
CO6 Understand Gauss general theory of image formation

A: Geometrical Optics:
Unit I: Fermat's principle and its application to deduce law of reflection and refraction, Gauss's general theory of image formation, Coaxial optical system. Cardinal points of an optical system, Magnification (Helmholtz Lagrange and Newtons) formula.

Unit II: Lens system and Properties:
Combination of Lenses, Cardinal points of combination of two lenses, Microscope and Telescope, Dispersion, Abberation.

B: Physical Optics
Unit III: Interference
Conditions for interference and spatial & temporal coherence. Division of Wavefront - Fresnel's Biprism and Lloyd's Mirror. Division of Amplitude - Parallel thin film, wedge shaped film and Newton's Ring experiment. Interferometer - Michelson and Fabry-Perot.

Unit IV: Diffraction And Polarisation
Fresnel's and Fraunhofer's class of diffraction. Fresnel's Half Period Zones and Zone plate. Fraunhofer diffraction at a single slit, Double-slits and Diffracting Grating Rayleigh's criterion of resolution, Resolving Power of Grating Optical Instruments.

Polarisation of light, birefringence, Nicol prism, retardation plates. Production and Analysis of polarized light. Optical Rotation - Fresnel's explanation of optical rotation, Half Shade & Biquartz polarimeters.

Suggested Readings
1. Francis A. Jenkins, Harvey E. White, "Fundamentals of Optics", McGraw Hill, 2017, 4e
2. Samuel Tolansky, "An Introduction to Interferometry", John Wiley & Sons Inc., 1973, 2e
3. A. Ghatak, "Optics", McGraw Hill, 2017, 6e

31-12-2025

Practical (Demonstrative Aspects of Optics & Lasers)

Credit 1

BPHY 202(P)

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the optical properties. Measurement precision and perfection is achieved through Lab Experiments.

Lab Experiment List

1. Focal length of thin lenses and their combination by Nodal slide.
2. Wavelength of light using bi-prism.
3. Wavelength of Sodium light by Newton's rings method.
4. Breadth of single slit by diffraction of light using spectrometer.
5. Wavelength of light diffraction grating (using spectrometer).
6. Refractive index of a prism using spectrometer.
7. To determine the wavelength and separation between D1 and D2 line with the help of Michelson Interferometer.
8. To determine the Young's modulus by Cornue's Fringes or Newton's rings.
9. To determine the velocity of ultrasonic wave by acoustic grating.
10. To determine the diameter of a thin wire by interference in a wedge shape air film.
11. Specific relation of sugar with the help of Polarimeter.

31-12-2025

Semester-IV

Modern Physics

BPHY-203 **Credit 2**

Course Outcomes (COs)

CO1 Recognize the difference between the structure of space & time in Newtonian & Relativistic mechanics.
CO2 Understand the physical significance of consequences of Lorentz transformation equations.
CO3 Comprehend the wave-particle duality.
CO4 Develop an understanding of the foundational aspects of Quantum Mechanics.

Unit 1 Special Theory of Relativity:
Inertial & non-inertial frame of references, Galilean transformations. Galilean newton transformation and its limitation. Michelson-Morley experiment and significance of the null result. Einstein's postulates of special theory of relativity. Space-Time Coordinate and Lorentz Transformation equations, Length contraction, Time dilation, Relativity of simultaneity, Relativistic velocity addition, Transformation of acceleration, Variation of mass with velocity, Einstein's mass & energy relation, Relation between Energy & Momentum, Twin paradox, pair-production.

Unit 2 Inadequacy of Classical Mechanics:
Black Body radiation, Plank's Quantum hypothesis, Photoelectric effect, Compton effect, Wave particles duality and Louis de Broglie's hypothesis of matter waves and their experimental verification by Davisson-Germer's experiment and Thomson's experiment.

Unit 3 Introduction to Quantum Mechanics:
Concept of Wave group, Group (particle) velocity, Phase (wave) velocity and relation between Group & Phase velocities. Wave Function and its properties.

Suggested Readings

1. A. Beiser, Shobhit Mahajan, "Concepts of Modern Physics: Special Indian Edition", McGraw Hill, 2009, 6e
2. John R. Taylor, Chris D. Zafiratos, Michael A.Dubson, "Modern Physics for Scientists and Engineers", Prentice-Hall of India Private Limited, 2003, 2e
3. R.A. Serway, C.J. Moses, and C.A. Moyer, "Modern Physics", Cengage Learning India Pvt. Ltd, 2004, 3e
4. R. Resnick, "Introduction to Special Relativity", Wiley India Private Limited, 2007
5. R. Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e
6. R K Shukla and Anchal Srivastava, Text Book of Quantum Mechanics: Atomic and Molecular Spectra, New Age International (P) Publications Limited

31-12-2025

Basic Electronics

BPHY-204 **Credit 2**

Course Outcomes (COs)

Course Outcomes:

CO1 Understand various number systems and binary codes.
CO2 Familiarize with binary arithmetic.
CO3 Comprehend the design of combinational and sequential circuits.

Unit 1 Semiconductors & Diodes

P and N type semiconductors, qualitative idea of Fermi level. Formation of depletion layer in PN junction diode, field & potential at the depletion layer. Qualitative idea of current flow mechanism in forward & reverse biased diode.

Diode fabrication: PN junction diode and its characteristics, static and dynamic resistance. Principle, structure, characteristics and applications of Zener, Tunnel, Light Emitting, Point Contact and Photo diodes. Half and Full wave rectifiers, calculation of ripple factor, rectification efficiency and voltage regulation. Basic idea about filter circuits and voltage regulated power supply.

Unit 2: Transistors and Its Application

Bipolar Junction PNP and NPN transistors. Study of CB, CE & CC configurations w.r.t. active, cutoff & saturation regions; characteristics; current, voltage & power gains; transistor currents & relations between them. Idea of base width modulation, base spreading resistance & transition time, FET.

Unit 3: Basic Logic Gates and Logic Circuit with Application

Gates: AND, OR, NAND, NOT, Ex-OR, Combinational Circuits: Half Adder, Full Adder, Parallel Adder, Half Subtractor, Full Subtractor. Data Processing Circuits: Multiplexer, Demultiplexer, Decoders & Encoders.

References:

1. D. Leach, A. Malvino, Goutam Saha, "Digital Principles and Applications", McGraw Hill, 2010, 7e
2. William H. Gothmann, "Digital Electronics: An Introduction to Theory and Practice", Prentice-Hall of India Private Limited, 1982, 2e
3. R.P. Jain, "Modern Digital Electronics", McGraw Hill, 2009, 4e

31-12-2025

Practical (Basic Electronics Instrumentation)

BPHY-205

Credit 2

Course Outcomes (COs)

Basic Electronics instrumentation has the most striking impact on the industry wherever the components / instruments are used to study and determine the electronic properties. Measurement precision and perfection is achieved through Lab Experiments.

Lab Experiment List

1. Measurement of dc and ac voltages and frequency using cathod ray oscilloscope.
2. To study the characteristics of R-C network.
3. To study the characteristics of a rectifier circuit.
4. To study the characteristics of an unregulated power supply.
5. Logic gates and verification of Truth Table.
6. Design of basic Logic Circuits: Half Adder, Full Adder, Half Substractor, Full Substractor
7. To study the characteristics of interstage audio transformer.
8. Resolving power of telescope
9. Resolving power of plane transmission grating

31-12-2025

Semester-V

BPHY-301 **Electromagnetic Theory**

Credit 2

Course Outcomes (COs)

CO1 Better understanding of electrical and magnetic phenomenon in daily life.
CO2 To troubleshoot simple problems related to electrical devices.
CO3 Comprehend the powerful applications of ballistic galvanometer.
CO4 Study the fundamental physics behind reflection and refraction of light (electromagnetic waves).

Unit 1 Electrostatics

Electric force between two charges. General expression for Electric field in terms of volume charge density (divergence & curl of Electric field), general expression for Electric potential in terms of volume charge density and Gauss law (applications included). Study of electric dipole. Electric fields in matter, polarization, auxiliary field D (Electric displacement), electric susceptibility and permittivity. Dielectrics, Thevenin's theorem, Norton's theorem and Maximum power Transfer theorem.

Unit 2 Magnetostatics

Magnetic force between two current elements. General expression for Magnetic field in terms of volume current density (divergence and curl of Magnetic field), General expression for Magnetic potential in terms of volume current density and Ampere's circuital law (applications included). Magnetic fields in matter, Magnetisation, Auxiliary field H, magnetic susceptibility and permeability.

Unit 3 Time Varying Electromagnetic Fields

Faraday's laws of electromagnetic induction and Lenz's law. Displacement current, equation of continuity and Maxwell-Ampere's circuital law. Self and mutual induction (applications included). Maxwell's equations and their physical significance. Electromagnetic energy density and Poynting vector.

Suggested Readings:

1. D.J. Griffiths, "Introduction to Electrodynamics", Prentice-Hall of India Private Limited, 2002, 3e
2. E.M. Purcell, "Electricity and Magnetism (In SI Units): Berkeley Physics Course Vol 2", McGraw Hill, 2017,2e
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 2", Pearson Education Limited, 2012
4. D.C. Tayal, "Electricity and Magnetism", Himalaya Publishing House Pvt. Ltd., 2019, 4

31-12-2025

Basics of Quantum Mechanics

BPHY-302

Credit 2

Course Outcomes (COs)

CO1 Understand the significance of operator formalism in Quantum mechanics.
CO2 Study the eigen and expectation value methods.
CO3 Understand the basis and interpretation of Uncertainty principle.
CO4 Develop the technique of solving Schrodinger equation for 1D and 3D problems.

Unit 1 Uncertainty Principle & Schrodinger Equation

Uncertainty Principle: Commutativity & simultaneity (theorems with proofs). Non commutativity of operators as the basis for uncertainty principle and derivation of general form of uncertainty principle through Schwarz inequality. Uncertainty principle for various conjugate pairs of physical- dynamical parameters and its applications.
Schrodinger Equation: Derivation of time independent & time dependent forms, Schrodinger equation as an eigen equation, Deviation & interpretation of equation of continuity in Schrodinger representation, and Equation of motion of an operator in Schrodinger representation.

Unit 2 Applications of Schrodinger Equation

Application to 1D Problems: Infinite Square well potential (Particle in 1D box), Finite Square well potential, Potential step, Rectangular potential barrier and 1D Harmonic oscillator. Application to 3D Problems: Infinite Square well potential (Particle in a 3D box).

Unit 3 Eigen & Expectation Values

Eigen & Expectation Values: Eigen equation for an operator, eigen state (value) and eigen functions. Linear superposition of eigen functions and Non-degenerate & Degenerate eigen states. Expectation value pertaining to an operator and its physical interpretation. Hermitian Operators: Definition, properties and applications.

Suggested Readings

1. D.J. Griffiths, "Introduction to Quantum Mechanics", Pearson Education, India, 2004, 2e
2. E. Wichmann, "Quantum Physics (In SI Units): Berkeley Physics Course Vol 4", McGraw Hill, 2017
3. Richard P. Feynman, Robert B. Leighton, Matthew Sands, "The Feynman Lectures on Physics - Vol. 3", Pearson Education Limited, 2012
4. R Murugeshan, Kiruthiga Sivaprasath, "Modern Physics", S. Chand Publishing, 2019, 18e

31-12-2025

BPHY-303 **Practical (Demonstrative Aspects of Electricity & Magnetism)** **Credit 1**

Course Outcomes (COs)

Experimental physics has the most striking impact on the industry wherever the instruments are used to study and determine the electric and magnetic properties. Measurement precision and perfection is achieved through Lab Experiments.

Lab Experiment List

1. Determine unknown resistance using Carey Foster's bridge.
2. Determination of high resistance by method of leakage.
3. Reduction factor of Helmholtz galvanometer.
4. Variation of magnetic field along the axis of Helmholtz coil
5. Low resistance by potentiometer.
6. Current sensitivity of a dead-beat moving coil galvanometer.
7. Charge sensitivity of a ballistic galvanometer by capacity discharge method.
8. Characteristic of CB, CE, & CC configuration of n-p-n transistor.
9. Time constant using charging discharging of capacitor.
10. Characteristics of FET.

31-12-2025

BPHY-304

General Physics Lab
(Practical)

Credit 1

Course Outcomes: At the end of this laboratory course, each and every student is expected to understand the basic concepts of Optics and Electronics through experiments. Recording data, plotting of graphs, extraction of relevant information from graphs and identifying the sources of experimental error is also a key outcome along with analyzing and presenting experimental findings through written laboratory reports.

Students have to perform a total of eight experiments from the following list:

List of Experiments:

01. Michelson Interferometer
02. Etalon
03. Edser Butler
04. Polarization
05. Babinet Compensator
06. To determine the wavelength of mercury spectral lines with the help of reflection grating.
07. Hall Effect
08. E.S.R.
09. Four Probe
1. Forbidden Energy Gap
2. Gm Counter
3. β-Energy
4. Klystron

REFERENCES:

1. Advanced Practical Physics for Students: B.L. Worsnop & H.T. Flint
2. Fundamentals of Optics: Francis Jenkins, Harvey White
3. Geometrical and Physical Optics: RS Longhurst
4. Principles of Optics: Born and Wolf
5. Electronic Devices and Circuit Theory: Robert L. Boylestad
6. Integrated electronics: Millman and Halkias
7. Solid State Physics: Streetman
8. Electronic Principles: Albert Malvino and David bates (Eighth edition)
9. Electronic Communication systems: Kennedy

31-12-2025

Atomic and Nuclear Physics

BPHY-305

Credit 3

Course Outcomes (COs)

CO1 Atomic Physics studies the behavior of atoms and molecules and the manifestations of its properties through emission of light, X rays and so on.
CO2 The esoteric world of subnuclear particles at ultrahigh energies will be dealt with in particle physics and cosmic rays.
CO3 Study the salient features of nuclear forces & radioactive decays.
CO4 Understand the importance of nuclear models & nuclear reactions.
CO5 Comprehend the working and applications of nuclear accelerators and detectors.
CO6 Understand the classification and properties of basic building blocks of nature.

Unit 1 Atomic & Molecular Physics (Atom Models)

Rutherford scattering experiment and the Atom model, size of the nucleus, atomic spectra and spectral series. Bohr model of the atom: energy levels and spectral series, line spectra, me : mH H, He+ spectra, X-rays: production, Laue's experiment, Bragg's law, X-ray spectra: continuous and characteristic spectra, Mosley's law and X-ray series, Auger effect, X-ray absorption spectra, absorption edges.

Unit II

Discovery of deuterium, correspondence principle, nuclear (reduced) mass and its effect of the atomic spectra: discovery of deuterium, positronium and muonic atom energy levels compared to hydrogen energy levels, critical potentials, atomic excitation, FranckHertz experiments. Sommerfeld relativistic model and fine structure of hydrogen. Vector atom model, Coupling scheme-L-S and J-J coupling, Zeeman effect(normal and anomalous), Paschen back effect, Stark effect.

Unit III Nuclear Forces & Nuclear Models

General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor. Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties. Nuclear Reactions: Bethe's notation, types of nuclear reaction, Conservation laws, Cross- section of nuclear reaction, nuclear fission and fusion(qualitative), Nuclear reactors.

Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Nuclear shell model (the level scheme in the context of reproduction of magic numbers included).

Suggested Readings

1. Concepts of Modern Physics, Arthur Beiser, (Tata McGraw-Hill)
2. Modern Physics, R. Murugeshan and S. Sivaprasath, (S. Chand & Company Ltd)
3. Modern Physics, K. S. Krane, (Wiley India Pvt Ltd)
4. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
5. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
6. S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019

31-12-2025

Solid State Physics

BPHY-306

Credit 3

Course Outcomes (COs)

CO1 This course ensures a basic knowledge of fundamental of crystal structures and various semiconductor devices like p-n junction diodes, BJT, FET and power devices.
CO2 The course also includes basic understanding of semiconductor devices and their characteristics using hardware and circuit simulation software tools.

Unit I: P-N Junction Diode : Formation of Depletion Layer, Space Charge at a Junction, Derivation of Electrostatic Potential Difference at Thermal Equilibrium, Depletion Width and Depletion Capacitance of an Abrupt Junction. Derivation of Diode Equation and I-V Characteristics. Zener and Avalanche Junction Breakdown Mechanism.

Unit II: Bipolar Junction Transistors (BJT): PNP and NPN Transistors, Basic Transistor Action, Review of the characteristics of transistor in CE and CB configurations, Regions of operation (active, cut off and saturation), Current gains α and β. Relations between α and β. dc load line and Q point.

Unit III: Field Effect Transistors: JFET, Construction, Idea of Channel Formation, Pinch-Off and Saturation Voltage, Current-Voltage Output Characteristics. MOSFET, types of MOSFETs, Circuit symbols, Working and Characteristic curves of Depletion type MOSFET (both N channel and P Channel) and Enhancement type MOSFET (both N channel and P channel). Unit 4 Combinational & Sequential Circuits

Unit IV: Advanced Digital Modulation Technique: DPCM, DM, ADM. Binary Line Coding Technique, Multi level coding, QAM (Modulation and Demodulation).

Suggested Readings:

1) Ben G Streetman and S. Banerjee, Solid State Electronic Devices, Pearson Education (2006)

2) Dennis Le Croissette, Transistors, Pearson Education (1989)

3) Jasprit Singh, Semiconductor Devices: Basic Principles, John Wiley and Sons (2001)

4) Kanaan Kano, Semiconductor Devices, Pearson Education (2004)

5) Robert F. Pierret, Semiconductor Device Fundamentals, Pearson Education (2006)

31-12-2025

Practical (Analog & Digital Circuits)

BPHY-307 **Credit 1**

Course Outcomes (COs)

Analog & digital circuits have the most striking impact on the industry wherever the electronics instruments are used to study and determine the electronic properties. Measurement precision and perfection is achieved through Lab Experiments.

Lab Experiment List

1. Verification of Richardson-Dushman equation and evaluation of work function of cathode material.
2. To draw the characteristics and to determine the parameters of a field effect transistor (FET).
3. Characteristics of MOSFAT
4. Verification of truth table of OR, AND and NOT gates.
5. Study and Verification of AND gate using TTL IC 7408
6. Study and Verification of OR gate using TTL IC 7432
7. Study and Verification of NAND gate and use as Universal gate using TTL IC 7400
8. Study and Verification of NOR gate and use as Universal gate using TTL IC 7402
9. Study and Verification of NOT gate using TTL IC 7404
10. Study and Verification of Ex-OR gate using TTL IC 7486

31-12-2025

BPHY-308 **Electronics and Digital Lab**

Credit 1

Course Outcomes (COs)

Course Outcomes

1. Experimental physics has the most striking impact on the industry wherever the instruments are used to determine the thermal and electronic properties.
2. Measurement precision and perfection is achieved through Lab Experiments.
3. Online Virtual Lab Experiments give an insight in simulation techniques and provide a basis for modeling.

Lab Experiment List
Electronics and Digital Lab

01. PN Junction/ Zener diode characteristics
02. Half wave & full wave rectifiers and Filter circuits
03. Characteristics of a transistor (PNP / NPN) in CE, CB and CC configurations
04. Unregulated and Regulated power supply
05. Diode as clipper and Clamper
06. Frequency response of RC coupled amplifier
07. Various measurements with Cathode Ray Oscilloscope (CRO)
08. Charging and discharging in RC circuits
09. A.C. Bridges: experiments based on measurement of L and C
10. Resonance in series and parallel RCL circuit

REFERENCES:

1. B.L. Worsnop, H.T. Flint, "Advanced Practical Physics for Students", Methuen & Co., Ltd., London, 1962, 9e
2. S. Panigrahi, B. Mallick, "Engineering Practical Physics", Cengage Learning India Pvt. Ltd., 2015, 1e
3. Anchal Srivastava and R.K. Shukla,"Practical Physics (Electricity, Magnetism and Electronics)", Published by: New Age International (P) Limited Publishers
4. R.L. Boylestad, L. Nashelsky, "Electronic Devices and Circuit Theory", Prentice-Hall of India Pvt. Ltd., 2015, 11e
5. A. Sudhakar, S.S. Palli, "Circuits and Networks: Analysis and Synthesis", McGraw Hill, 2015, 5e

31-12-2025

Fourth Year Syllabus
Semester-VII
Mathematical Physics

BPHY-401: **Credit 3**

Course Objectives: Understanding mathematical functions and solution methods useful in various branches of Physics.

Unit – I

Special Functions: Second order linear differential equations; Solution by series expansion; Legendre, Bessel, Hermite and Laguerre differential equations, their solutions and properties, Spherical Harmonics.

Unit – II

Fourier Transform: Dirac Delta function, Fourier Transform, Sine and Cosine transform, Linearity, Change of Scale, Translation, Modulation, simple applications.

Green Function: Green's function as a technique to solve linear ordinary differential equations, Homogeneous and Inhomogeneous boundary conditions, Solution of Poisson equation using Green's function technique, Symmetry property.

Unit – III

Complex Variables I: General function of complex variable, Cauchy-Riemann differential equation and analyticity, conformal mapping (translation, rotation, inversion), Cauchy's integral formula, Taylor's and Laurent's series, singularity poles.

Unit – IV

Complex Variables II: Residue theorem. Evaluation of definite integrals, around (i) unit circle and (ii) infinite semi-circle; using Jordan's lemma with poles lying on real axis, and of integrals involving multiple valued function-branch point.

References:

1. Mathematical Methods for Physicists by G. Arfken, H. Weber and F.E. Harris (Elsevier)
2. Mathematics for Physicist by P. Dennery and A. Krzynicki (Dover Publication)
3. Special Functions and their Applications by N.N. Lebedev (Dover Publication)
4. Mathematical Methods for Physics and Engineering by K.F. Riley, M.P. Hobson and S.J.Bence (Cambridge University Press)
5. Mathematical Physics by B. S. Rajput (Pagati Prakashan)
6. Complex Variables and Applications by J.W. Brown and R. V. Churchill (McGraw-Hill)

Course Outcomes:

- The students will understand various functions and solutions to differential equations.
- The foundation for understanding of Classical and Quantum Mechanics will be laid.
- The techniques learnt will be useful in different branches of Physics.

Classical Mechanics

BPHY-402: **Credit 3**

Course Objectives: Understanding basic methods of mechanics and use of Lagrangian and Hamiltonian approach.

Unit - I

Vectors: Curvilinear Coordinates, Gradient, Divergence and Curl, Laplace equation in spherical polar and cylindrical polar coordinates and their solution, Green's theorem, Gauss and Stokes Theorems.

Tensors: Covariant and Contravariant vectors, Tensors – Addition, Multiplication, Contraction, Symmetry properties; Tensor density, Pseudo-tensors.

Unit-II

Mechanics of a system of particles: Generalized coordinates and Constraints, Generalized coordinates, D' Alembert's principle, Lagrange's Equation. Hamilton's principle, Least action principle, Langrange's equations, symmetry properties and Noether's theorem, Lagrangian formulation for elementary mechanical systems - free particle, simple and double pendulum.

Unit-III

Two Body Problem: Reduction to one-body problem, reduced mass, Virial Theorem, planetary orbits.

Scattering: Collision between particles, disintegration of particles, elastic collisions,scattering, Rutherford's formula.

Small oscillations: Damped and Forced oscillations, coupled vibrations.

Unit-IV

Hamiltonian Formulation: Hamilton equations, canonical transformations, Poisson'sbracket, Symplectic approach to canonical transformations; Hamilton Principle function, Hamilton-Jacobi equation, Harmonic Oscillator Problem, Hamilton characteristic Function, separation of variables, Central Force problem.

References:

1. Vector Analysis and Introductory Tensor Analysis by M.R. Spiegel (Schaum Series)
2. Matrices and Tensors in Physics by A.W. Joshi (New Age)
3. Classical Mechanics by H. Goldstein (Narosa, New Delhi)
4. Classical Mechanics by K.C. Gupta (Wiley Eastern)
5. Classical Mechanics by L.D. Landau (Elsevier)
6. Classical Mechanics by N.C. Rana and P.S. Joag (Tata-McGraw-Hill)
7. The Feynman lectures on Physics Vol.1

Course Outcomes:

- The students will understand dynamics of particles and conservation laws.

The understanding of different mechanical problems and their solutions will be developed.

31-12-2025

Advance Quantum Mechanics-I

BPHY-403:

Credit 3

Course Objectives: Understanding concepts of quantum mechanics and solving operator equations for different quantum problems.

Unit-I

Wave Mechanical formulation: Schrodinger wave equation, Hermitian operators and observables, Discreet and continuous spectrum, Dirac delta function, Commuting observables and related algebra, Pure and mixture states; Simple applications: potential well, barrier potential, tunnel effect, unbound states: reflection and transmission of waves.

Unit - II

Identity of Particles: Distinguishability of identical particles, exchange degeneracy and operator, construction of symmetric and antisymmetric wave functions, Pauli's exclusion principle and Slater's determinant, Electron spin hypothesis, spin matrices and eigen value equations, symmetric and antisymmetric wave functions for hydrogen molecule.

Unit - III

Matrix formulation: Concept of Hilbert Space, Dirac's bra and ket notations, Orthonormality and completeness relations (discrete and continuous), linear and real operators, eigen value equations and related theorems, projection operators and measurement,application to Harmonic Oscillator, Equivalence of wave and matrix mechanics.

Unit - IV

Theory of Angular momentum: Orbital, spin and total angular momentum operators: eigen value equations and matrix representations, Ladder operators, commutation relations, Addition of angular momenta, Clebsch-Gordon coefficients.

References:

1. Quantum Mechanics, Vol. I & II by Albert Messiah (Dover Publication)
2. The Principles of Quantum Mechanics by P.A.M. Dirac (Oxford University Press)
3. Quantum Mechanics by L.I. Schiff (Tata-McGraw-Hill)
4. Modern Quantum Mechanics by J.J. Sakurai (Addison Wesley)
5. Introduction to Quantum Mechanics by D.J. Griffths (Pearson Education)
6. Quantum Mechanics by C. Cohen-Tannoudji, B. Diu and F. Laloe (Wiley VCH)
7. Quantum Mechanics by B. K. Agarwal and Hari Prakash (Prentice-Hall, India)
8. The Feynman Lectures on Physics Vol.3
9. Quantum mechanics(Concepts and applications) by N. Zettili (Wiley)

Course Outcomes:

- The students will understand wave mechanical formulation of quantum particles and various rules arising out of it.
- The understanding of different formulations of quantum mechanics laying foundations for the study of molecules, atoms and fundamental particles

21-12-2025

Electronics

BPHY-404

Credit 3

Course Objectives: Understanding functions of electronic devices and circuit logic.

Unit - I

Power Electronics: SCR: Basic structure, I-V characteristics and two- transistor model of SCR, SCR controlled half and full wave rectifier circuit and their analysis. UJT, equivalent circuit, I-V characteristics, Saw tooth wave generation. Elements of SMPS.

Unit - II

Operational Amplifier: Characteristics of op-amp; inverting and non-inverting inputs: Input offset current and Input offset voltage, differential amplifier, CMRR, Slew rate and power band width, op-amp as an amplifier.

Unit - III

Boolean Algebra and Gates: Boolean algebra, composite function and their algebraic simplification, De-Morgan's theorem, duality in Boolean algebra, Universality of NANDand NOR gates. SOP and POS forms, karnaugh map, design of logic circuits, X-OR gate and its applications

Unit - IV

Elements of Logic Families: Transistor as a switch, FAN IN , FAN OUT, Noise Immunity, propagation delay, RTL, DTL, TTL logic

References:

1. Switch Mode Power Conversion by K. Kit Sum (Marcel Dekker).
2. Power Electronics by P.C. Sen (Tata Mc Graw-Hill)
3. Pulse, Digital and Switching Wave Forms by J. Milman and H. Taub (McGraw-Hill)
4. Op-amp and Linear Integrated Circuits by R.A. Gayakwad (Prentice-Hall India)
5. Integrated Circuits by J. Millman and C.C. Halkias (Tata-McGraw-Hill)
6. Digital Principle and Application by A.P. Malvino and D.P. Leach (McGraw-Hill)
7. Modern Digital Electronics by R.P. Jain (Tata McGraw-Hill)

31-12-2025

Physics Practical-Electronics

BPHY-405: **Credit 2**

Course Objectives: The student will handle instruments, take readings and analyze the results, to understand various concepts and applications.

LIST OF EXPERIMENTS

Students will be required to perform at least five experiments from each course. They will have to maintain record books of experiments done.

1. Study of regulator circuits.
2. Study of switch mode power supply (SMPS)
3. Study of characteristic of SCR and controlled rectification by SCR.
4. Study of RC coupled amplifier
5. Study of emitter follower
6. Study of phase shift oscillator
7. Study of multivibrator: Use of 555
8. Study of saw tooth wave generation by UJT
9. Study of characteristics of operational amplifier
10. Study of TTL gates
11. Study of combinational logic circuits
12. Study of super heterodyne receiver
13. Study of linear and square wave detector
14. Microwave measurement: Mode analysis and standing wave ratio

Course Outcomes:

- Learning circuit fundamentals and making connections to study properties of electronic devices.
- Learn to present observations, results and analysis in suitable and presentable form.

Physics Practical- Optics

BPHY-406: **Credit 2**

Course Objectives: The student will handle instruments, take readings and analyze the results, to understand various concepts and applications.

LIST OF EXPERIMENTS

Students will be required to perform at least five experiments from each course. They will have to maintain record books of experiments done.

1. Use of constant deviation spectrograph
2. Use of Fabry-Perot interferometer

31-12-2025

3. Use of concave grating
4. He-Ne Laser
5. e/m by Zeeman effect
6. EPR of free radicals
7. Programming on PC
8. Velocity of ultrasonic wave
9. Hall effect
10. Magnetic Susceptibility
11. Measurement of dipole moment
12. Use of scintillation counter
13. Determination of Dielectric Constant
14. Double slit/Triple slit/ Four slit Wedge shape

Course Outcomes:

- Hands on experience with optical instruments and understanding concepts of physical optics.
- Learn to present observations, results and analysis in suitable and presentable form.

31-12-2025

Semester-VIII
Thermodynamics and Statistical Physics

BPHY-407:

Credit 3

Course Objectives: Understanding laws of thermodynamics and microscopic statistical description.

Unit – I

Second law of thermodynamics, Entropy and Probability, Thermodynamic Potentials, Thermodynamic Equilibrium, Third law of thermodynamics, First and Second order phase transistions: Clausius - Clapeyron and Ehrenfest's equations; Chemical potential and phase equilibria, Gibb's phase rule.

Unit – II

Thermodynamic properties of liquid Helium II, The lambda - transition, London's explanation, Quantum liquid, Tisza two fluid model, Landau spectrum, concept of second sound. Conditions for Equilibrium, Entropy of an Ideal Boltzmann gas, Gibb's paradox, Sackur - Tetrode equation.

Unit – III

Canonical and Grand Canonical Ensembles, Entropy of a system in contact with heat reservoir, Ideal gas in canonical ensemble, Maxwell velocity distribution, Grand canonical ensemble, Thermodynamics of photons, Translational, Rotational and Vibrational partition functions of a molecule and their applications.

Unit – IV

Thermodynamical properties, Black body radiation, Bose - Einstein Condensation, IdealFermi - Diarc gas, Fermi temperature, applications of degeneracy to free electrons in metals, Magnetic susceptibility, White dwarfs and Chandrashekhar limit.

Course Outcomes:

- The students will understand laws of thermodynamics and relation between macroscopic and microscopic properties.
- The students will be able to apply the concepts in different states of matter.

References:

2. A Treatise on Heat by M.N. Saha and B.N. Srivastava (Indian Press Limited, Allahabad)
3. Heat and Thermodynamics by M.W. Zemansky and R.H. Dittman (McGraw Hill)
4. Fundamentals of Statistical and Thermal Physics by F. Reif (McGraw-Hill)
5. Statistical Mechanics by K. Huang (John Wiley & Sons)
6. Statistical Mechanics by R.K. Pathria (Elsevier)
7. Statistical Mechanics and Properties of Matter by E.S.R. Gopal (Macmillan Ltd., Delhi)
8. Statistical Mechanics by B. K. Agarwal and M. Eisner (Wiley Eastern)

31-12-2025

Electromagnetic Theory and Plasma Physics

BPHY-408:

Credit 3

Course Objectives: Understanding Physics of Electromagnetic waves and plasma state.

Unit – I

Maxwell Equations: Microscopic and Macroscopic fields, Macroscopic Maxwell equations, Fields **D** and **H**, Dielectric tensor, Principal dielectric axes.

Potential and Gauges: Scalar and vector potentials, Gauge transformation, Lorentz guage and Transverse gauge, Maxwell equations in terms of electromagnetic potentials.

Unit - II

Propagation of Electromagnetic Waves: Propagation of electromagnetic waves in freespace, conducting and non-conducting medium, skin depth, Boundary conditions on EM Fields, Reflection and refraction at a plane interface between dielectrics.

Polarisation of EM Waves: Fresnel's Formula, Normal- and anomalous- Dispersion, metallic reflection. EM Wave in bound media: rectangular and circular wave guides, TE, TM and TEM Modes, Cut-off frequency and Wavelength.

Unit – III

Plasma State: Plasma state of matter, Motion of charge particles in uniform E & B fields, non-uniform fields, drifting motion, electrostatic and magnetostatic lenses; Time varying E &B fields, Adiabatic invariants, Plasma confinements(Pinch effect, Mirror confinement,Van Allen Belts), Elementary idea of fusion technology.

Unit – IV

Hydrodynamics of Plasma: Hydrodynamical description, Equation of magneto hydrodynamics, High frequency plasma oscillations, Short wavelength limit and Debye-screening distance.

Wave Phenomenon in Magneto-Plasma: Electromagnetic waves perpendicular to B_0, phase velocity, Polarization, Cut-off and resonances, Electromagnetic waves parallel to B_0, Alfven waves.

Course Outcomes:

- The students will understand nature of Electric and Magnetic fields, Electromagnetic waves and plasma state.
- The students will be able to apply the concepts in various branches of Physics.

References:

2. Introduction to Electrodynamics by D.J. Griffiths (Prentice - Hall, New Delhi)
3. The Classical theory of Fields by L.D. Landau and E.M. Lifshitz (Elsevier)
4. Classical Electrodynamics by J.D. Jackson (Wiley Eastern)
5. Introduction to Plasma Physics by F.F. Chen (Plenum Press, New York)

6. Plasma Physics by S.N. Sen (Pragati Prakashan)
7. The Feynman lecture on Physics vol-2

Nuclear & Particle Physics

BPHY-409:

Credit 3

Course Objectives:

CO1 Study the salient features of nuclear forces & radioactive decays.
CO2 Understand the importance of nuclear models & nuclear reactions.

CO3 Comprehend the working and applications of nuclear accelerators and detectors.CO8 Understand the classification and properties of basic building blocks of nature.

Unit 1 Nuclear Forces & Radioactive Decays

General Properties of Nucleus: Mass, binding energy, radii, density, angular momentum, magnetic dipole moment vector and electric quadrupole moment tensor. Nuclear Forces: General characteristic of nuclear force and Deuteron ground state properties. Radioactive Decays: Nuclear stability, basic ideas about beta minus decay, beta plus decay, alpha decay, gamma decay.

Unit 2 Nuclear Models & Nuclear Reactions

Nuclear Models: Liquid drop model and Bethe-Weizsacker mass formula. Single particle shell model (the level scheme in the context of reproduction of magic numbers included).
Nuclear Reactions: Bethe"s notation, types of nuclear reaction, Conservation laws, Cross-section of nuclear reaction, Theory of nuclear fission (qualitative).

Unit 3 Accelerators & Detectors

Accelerators: Theory, working and applications of Van de Graaff accelerator, Cyclotron and Synchrotron. Detectors: Theory, working and applications of GM counter, Semiconductor detector, Scintillation counter and Wilson cloud chamber.

Unit 4 Elementary Particles

Fundamental interactions & their mediating quanta. Concept of antiparticles. Classification of elementary particles based on intrinsic-spin, mass, interaction & lifetime. Families of Leptons, Mesons, Baryons & Baryon Resonances. Conservation laws for mass-energy, linear momentum,

Suggested Readings

1. Kenneth S. Krane, "Introductory Nuclear Physics", Wiley India Private Limited, 2008
2. Bernard L. Cohen, "Concepts of Nuclear Physics", McGraw Hill, 2017
3. S.N. Ghoshal, "Nuclear Physics", S. Chand Publishing, 2019

31-12-2025

BPHY-410 Experimental Techniques and Computational Methods

Credit3

Course Objectives: Students will get exposure of working principal and theories of various spectroscopic and structural characterization techniques useful in characterizing materials and to introduce some computational approaches being used in molecular modelling.

Unit I-Spectroscopic Techniques:

Microstructural characterization using X-ray Diffraction and neutron diffraction spectroscopy, UV and Visible absorption spectroscopy, IR and Raman spectroscopy, Basics of nuclear magnetic resonance (NMR) and electron spin resonance (ESR) spectroscopy.

Unit II-Microscopic Characterization Techniques:

Basics and applications of Scanning electron microscopy (SEM), Scanning tunnelling microscopy (STM), Atomic Force Microscopy (AFM), Focussed ion beam (FIB) system, Transmission Electron Microscopy (TEM).

Unit III - Basics of Molecular Modelling

Introduction to coordinate systems, potential energy surfaces, model building and computer simulation; introduction to quantum mechanics – postulates –Schrodinger wave equation – operators – eigen function – eigen values – expectation values – hydrogen molecule – Born-Oppenheimer approximation.

Unit IV- Molecular mechanics, Energy minimization and MD Simulation: Empirical force field models – Bond stretching – angle bending – torsional term –nonbonding interactions – thermodynamics properties using a force field; boundary conditions, searching configuration space and generating ensemble; Derived and non-derive denergy minimization methods.

Course Outcome:

- Learning the basics of various spectroscopic and microscopic techniques useful for material characterization.
- This course may be useful for students from other departments as well.
  - Students will learn basic theories of computer modelling and molecular dynamics

Reference Books:

1. Spectroscopy Volume 1, 2 and 3: B.P. Straughan and S. Walker.
2. Modern Spectroscopy: J.M. Hollas.
3. Transmission Electron Microscopy of Metals: Gareth Thomas
4. Elements of X-ray Diffraction: Bernard Dennis Cullity.
5. Atomic Force Microscopy/Scanning Tunneling Microscopy: M.T. Bray, Samuel H. Cohen and Marcia, L. Lightbody.
6. A. R. Leach - Molecular Modelling Principles and Application, 2nd edition, Longman Publications, 1996.
7. F. Jensen – Introduction to Computational Chemistry, 2nd edition, John Wiley & Sons Ltd.,2007.
8. T. K. Attwood, D. J. parry-Smith, Introduction to Bioinformatics, Pearson Education, 1st Edition, 11th Reprint 2005

31-12-2025

Dr. Shakuntala Misra National Rehabilitation University, Lucknow

Course Objectives

1. Provide fundamental knowledge of Electrical & Electronics System and renewable energy technologies.
2. Develop skills in installation and commissioning of solar photovoltaic systems.
3. Train students in operation and maintenance of solar power plants.
4. Enable students to perform troubleshooting and system diagnostics.
5. Promote safe working practices in solar energy projects.

Course Learning Outcomes

1. Understand basic electrical concepts and safety practices.
2. Explain principles of solar photovoltaic technology.
3. Identify and use tools and equipment used in solar PV installation.
4. Design and size solar PV systems based on load requirements.
5. Install, test, and commission solar photovoltaic systems.
6. Perform troubleshooting and maintenance of solar PV components.

31/12/2025

31/12/25

31/12/25

3/12/25

Dr. Shakuntala Misra National Rehabilitation University, Lucknow

Skill Enhancement Course (SEC) under the guidelines for providing skill-based education under National Skill Qualification Framework (NSQF) issued by UGC

Course Title: Solar PV (Photovoltaic Systems Techniques and Installation)

Duration: Two Consecutive Semesters (II and III) (As per the resolution of Academic Council through agenda point no. 13/38 of its 38th meeting)

NSQF Level: 4

REF ID: SGJ/Q0101, V1.0 (as per model curriculum of Skill Council for Green Jobs (SCGJ))

Eligibility: Students passed 10+ 2 examination with conventional schooling without any background of vocational training (category-3 of UGC guidelines for providing skill-based education under NSQF)

Number of Seats: *60 students per batch*

Industrial Internship/ Apprenticeship: Students have to complete internship/ Apprenticeship of 6 to 8 weeks during summer term of 2nd year in solar installation companies, renewable energy industries, green job sector etc.

(Student shall be recognized as Suryamitra after the successful completion of this two-semester course.)

31/12/2025

31/12/2025

31/12/25

31/12/25

Dr. Shakuntala Misra National Rehabilitation University, Lucknow

Semester II

Course Title: Solar PV (Photovoltaic Systems Techniques and Installation-I)
Course Code: SECS-102
Mode of Learning: L T P (Lecture, Tutorial, Practical)
L T P: 1 0 2
Lecture: 15 hrs.
Practical: (Lab/Workshop/Site Visit): 60 hrs.

Module	Title	Topics (/ Practical/ Lab/Workshop)
1	Basic Electrical Engineering	**Lecture:** Electrical Quantities: Voltage, Current, Resistance, Power, Energy Ohm's Law: Relationship between V, I, R, and simple circuit calculations AC/DC Fundamentals: Difference between Alternating Current and Direct Current, waveform characteristics, frequency, amplitude Power Generation & Distribution: Basic overview of power plants, transmission lines, distribution networks, grid connectivity **Practical:** Electrical Safety: Personal protective equipment, safe working practices, lockout/tagout procedures, shock prevention Electrical Tools: Screwdrivers, pliers, wire strippers, cutters,crimpingtools Wiring Techniques: Types of wires, color coding, cable termination, joint making. Electrical Safety: Personal protective equipment, safe working practices, lockout/tagout procedures, shock prevention
2	Renewable Energy & Solar Energy	**Lecture:** Renewable Energy Sources: Solar, Wind, Hydro, Biomass, Geothermal - principles and applications Solar Radiation Terminology: Direct Normal Irradiance (DNI), Global Horizontal Irradiance (GHI), Diffused Irradiance, Irradiation Solar Geometry: Sun path, solar window, altitude angle, azimuth angle, air mass Solar Thermal vs PV Systems: Working principles, applications, advantages, and limitations of each technology Sun Movement Effects: Seasonal variation, shading impact, orientation and tilt optimization

31/12/2025 31/12/2025 31/12/25 31/12

Scanned with OKEN Scanner

		Practical: Solar Potential Assessment: Site evaluation, solar resource mapping, radiation measurement instruments (pyranometer, pyrheliometer)
3	Photovoltaic Technology	**Lecture:** PV Effect: Physics of solar energy conversion, photon absorption, electron-hole pair generation Solar Cell Types: Monocrystalline, Polycrystalline, Thin-film (amorphous, CdTe, CIGS) - manufacturing process, characteristics, applications PV Module Characteristics: Construction, lamination, framing, junction box, bypass diodes **Practical:** I-V Curve: Current-Voltage characteristics, effect of irradiance and temperature on curve, maximum power point (MPP) Efficiency Ratings: Cell efficiency, module efficiency, factors affecting efficiency, temperature coefficients Manufacturing Datasheets: Reading and interpreting electrical parameters (Voc, Isc, Vmp, Imp, Pmax), mechanical specifications, warranties
4	Components of Solar PV Systems	**Lecture:** Batteries: Types (Lead-acid, Lithium-ion, Nickel-based), construction, specifications (voltage, capacity, C-rate, DOD, SOC), sizing, maintenance, safety Solar Inverters: Types (String, Central, Micro, Hybrid), working principle, specifications (power rating, efficiency, THD, input/output voltage), features (MPPT, islanding protection) Charge Controllers: PWM vs MPPT controllers, working principle, selection criteria, specifications, settings **Practical:** Balance of System (BOS) Components: Cables (DC and AC cables, sizing, insulation), Connectors (MC4), Junction boxes, Combiner boxes, Fuses, Circuit breakers, Surge protection devices (SPD) System Types: Off-grid (standalone), On-grid (grid-tie), Hybrid systems - configurations, components, applications, advantages, limitations Grounding/Earthing: Types (equipment ground, system ground), purpose, installation methods, standards, earth resistance measurement
5	PV System Design & Sizing	**Lecture:** Customer Requirement Assessment: Load analysis, energy consumption pattern, customer expectations, budget constraints Load Estimation: Identifying AC and DC loads, calculating daily energy consumption (Wh/day), peak power demand, duty cycles

31/12/2025 31/12/2025 31/12/2025 31/12

Scanned with OKEN Scanner

		Practical: Site Survey Techniques: Site visit procedures, data collection, measurement of available area, roof condition assessment, structural integrity evaluation Shading Analysis: Shading sources (trees, buildings, chimneys), tools for shading analysis (solar pathfinder, shading analysis software), impact of shading on system performance Sun Path Observation: Understanding sun path diagrams, determining optimal orientation and tilt angle, seasonal adjustments System Sizing: Array sizing, inverter sizing, battery bank sizing, cable sizing, selection of protection devices System Layout: Module layout planning, string configuration, optimizing for space and performance
6	Troubleshooting PV Modules	**Lecture:** Monitoring Instruments: Pyranometer (irradiance measurement), multimeter (voltage, current measurement), clamp meter (current measurement), I-V curve tracer Physical Defects: Micro-cracks, delamination, discoloration (browning/yellowing), glass breakage, junction box issues, bypass diode failure, hotspot formation Electrical Defects: Open circuit faults, short circuit faults, ground faults, reduced insulation resistance, PID (Potential Induced Degradation) **Practical:** Performance Testing: Measuring open circuit voltage (Voc), short circuit current (Isc), operating voltage and current, comparing with datasheet values I-V Curve Analysis: Interpreting curve shape, identifying mismatch, degradation, and fault conditions Infrared Thermography: Identifying hotspots and abnormal temperature patterns
7	Troubleshooting Batteries & Inverters	**Lecture:** Battery Testing: Voltage measurement (open circuit, under load), specific gravity test (for lead-acid batteries), capacity test, internal resistance measurement, identifying sulfation, corrosion, electrolyte level issues **Practical:** Battery Health Assessment: Determining state of charge (SOC), state of health (SOH), end-of-life criteria Inverter Faults: Common fault codes and their meanings, input voltage issues (over/under voltage), output faults (overload, short circuit), ground faults, grid synchronization issues (for grid-tie inverters), fan failure, communication errors Charge Controller Troubleshooting: PWM vs MPPT controller faults, improper charging, display errors, communication issues, settings verification

31/12/2025 31/12/2025 31/12/25 31/12

		Fault Diagnosis Techniques: Systematic troubleshooting approach, using manufacturer manuals, error code interpretation, visual inspection, electrical measurements Preventive Maintenance: Cleaning, terminal tightening, firmware updates, performance logging

Evaluation Scheme:

Internal Assessment (25 Marks)			External Examination (75 Marks)			Total Marks
Class Test (CT)	Assignment(A)	Practical(P)	Laboratory work 1	Laboratory work 2	Viva-Voce	100
15 Marks	5Marks	5 Marks	30 Marks	30 Marks	15 Marks	

31/12/2025

31/12/2025

31/12/25

31/12/25

Dr. Shakuntala Misra National Rehabilitation University, Lucknow

Semester III:

Course Title: Solar PV (Photovoltaic Systems Techniques and Installation-II)
Course Code: SECS-201
Mode of Learning: L T P
L T P: 1 0 2
Lecture: 15 hrs.
Practical: (Lab/Workshop/Site Visit): 60 hrs.

Module	Title	Topics
8	Tools and Equipment	**Lecture:** Installation Tools: Spanners, pliers, cutters, screwdrivers, crimping tools, hammers, files, hacksaw, drill machine **Practical:** Measuring Tools: Measuring tape, vernier caliper, wire gauge, spirit level, water level, plumb bob Testing Equipment: Multimeter, clamp meter, megger, earth tester, pyranometer, phase sequence meter Safety Tools: Helmet, safety shoes, safety belt, goggles, nose mask, ear plugs, gloves (PVC, cotton, rubber), reflective jacket
9	*Installation Preparation*	**Lecture:** Documentation: Reading Single Line Diagrams (SLD), layout diagrams, civil/electrical drawings Bill of Materials (BOM): Understanding and verifying components against BOM **Practical:** Material Handling: Receiving inspection, storage requirements, damage prevention Site Inspection: Structural assessment, access assessment, safety checks
10	Structure Erection & Civil Works	**Lecture:** Foundation Types: RCC foundation, ground screw, ballasted roof mount, selection based on site Structure Installation: Marking, drilling, post installation, rail alignment, leveling **Practical:** Corrosion Protection: Anti-corrosive paint on cut surfaces, galvanized components Weatherproofing: Sealant application, flashings, drainage at roof penetrations

11	Solar PV System Installation	**Lecture:** Module Mounting: Module handling, clamping, alignment, cleaning after installation Wiring: DC string connections, MC4 connectors, polarity checking, cable management **Practical:** Battery Installation: Battery stand assembly, interconnections, ventilation requirements Inverter Installation: Location selection, DC/AC connections, communication setup Distribution Boxes: DCDB, ACDB, utility disconnect, metering installation
12	Cable Laying & SCADA	**Lecture:** Cable Routing: Route planning, segregation of DC/AC cables, depth for underground Cable Trays: Tray types, support spacing, cable laying, bend radius maintenance **Practical:** Conduits: PVC/GI conduits, sizing, routing, earthing of metal conduits Cable Termination: Lug crimping, polarity check, insulation testing SCADA: System monitoring, data logging, remote fault identification
13	*Testing and Commissioning*	**Lecture:** Visual Checks: Mechanical inspection, electrical inspection, safety inspection **Practical:** Electrical Testing: Grounding verification, insulation resistance, polarity check, Voc/Isc measurement Performance Testing: Inverter startup, power output, efficiency, anti-islanding test Documentation: Commissioning checklist, test reports, as-built drawings Customer Handover: System demonstration, maintenance schedule, emergency procedures
14	Operation and Maintenance	**Lecture:** Preventive Maintenance: Daily, weekly, monthly, quarterly, annual checks • Module Maintenance: Cleaning techniques, inspection, vegetation management **Practical:** Battery Maintenance: Electrolyte level, specific gravity, terminal cleaning, equalization • Inverter Maintenance: Cooling system, display monitoring, firmware updates

31/12/2025

31/12/2025

31/12/2025

31/12

emergency procedures

		• Troubleshooting: Low power output, inverter not starting, battery issues, earth faults • Safety Procedures: Emergency handling

Evaluation Scheme:

Internal Assessment (25 Marks)			External Examination (75Marks)			Total Marks
Class Test (CT)	Assignment(A)	Practical(P)	Laboratory work 1	Laboratory work 2	Viva-Voce	100
15 Marks	5Marks	5 Marks	30 Marks	30 Marks	15 Marks	

31/12/2025

31/12/2025

31/12/2025

31/12/25

Dr. Shakuntala Misra National Rehabilitation University, Lucknow

31/12/2025

Dr. D.B. Singh
(Assistant Professor, Physics)
DSMNRU, Lucknow
Member, BOS

31/12/2025

Dr. Ashok Kumar Mishra
(Assistant Professor, Physics)
DSMNRU, Lucknow
Member, BOS

Prof. R.K. Shukla
Department of Physics
University of Lucknow
External Expert, BOS

(online Mode)

Prof. Prabhakar Singh
Department of Physics
I.I.T., BHU, Varanasi
External Expert, BOS

31/12/25

Prof. C. K. Dixit
Head, Department of Physics
DSMNRU, Lucknow
Chairman of BOS

(Invited Members)

Mr. Vinay Kumar Singh
Assistant Professor (Contractual)
Electronics and Communication Engg. Department
FOET, DSMNRU, Lucknow

31/12/25

Mr. Amit Kumar Yadav
Guest lecturer
Electronics and Communication Engg. Department
FOET, DSMNRU, Lucknow