B.Sc. III Year NEP Syllabus-2023-24

PSO No.	Programme Specific Outcomes Upon completion of these courses the student would be able to:
PSO-1	Analyse the concepts principle and theories of Physics
PSO-2	Analyse real world problems and develop mathematical equations to find acceptable solutions.
PSO-3	Develop problem solving skills and scientific reasoning by learning laboratory skills
PSO-4	Develop written and oral communication skills in communicating with diverse stakeholders.
PSO- 5	Create and collaborate in emergent physical, mathematical and computing technologies leading to innovative solutions for industry and academia.
PSO- 6	Crack various competitive exams for higher studies and employment.

Group- A Paper- I Quantum Mechanics, Atomic and Molecular Physics

Max. Marks: 30+70
Min. Passing Marks: 35
Credit Value: 4 (60 hrs)

Major

Course Objectives

The objectives of the course are

	Course Objectives	Cognitive Level
CO-I	To understand the necessity of quantum mechanics. Develop an understanding of Concept of wave packet and wave function	U, R, An, Ap ,C, E
CO -II	Learn the formulation Schrodinger wave equation and its solution under various conditions.	U, R, An, Ap , E
CO -III	Learn the concept of Quantum Numbers/ Selection rules and explanation of Spectra of Alkali/Alkaline Earth metals.	R , U , Ap
CO -IV	Learn the behavior of an atom under magnetic field and elementary idea about X-Rays.	U,R,An

CO -V	Learn the basics of Rotational, vibrational and electronic spectra.	U, R,An, Ap, E

Course Learning Outcome (CLO)

	Course Outcomes	PSOs Addressed	Cognitive Level
CLO-I	On completion of course Learner will be able to (a) understand aspects of the inadequacies of classical mechanics and historical development of quantum mechanics (b) build concepts of Wave packets, Phase and Group Velocities and Uncertainty principle.	1,2,3,6	U, R, An, Ap ,C, E
CLO -II	On completion of course Learner will be able to write the Schrodinger time dependent and time independent equations and Solve them for different cases.	2,3,4,5,6	U, R, An, Ap , E
CLO -III	On completion of course Learner will be able to extend the concept of Quantum Numbers and explanation of Spectra of Alkali/Alkaline Earth metals	1,3,6	R , U , Ap
CLO - IV	On completion of course Learner will be able to analyze the effect of Magnetic field on atoms.	1,2,3,6	U,R,An
CLO -V	On completion of course Learner will be able to build, compare & contrast the basic concepts of Rotational, Vibrational and Electronic spectra.	1,2	U, R,An, Ap, E

CO – Course Objectives; CLO – Course Learning Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

Unit-I

Quantum Mechanics-I [12 Lectures]

1. Quantum technology in India : National Mission on Quantum Technologies & Applications(NM-QTA)
2. Particle nature of Wave: Limitations of Classical Mechanics, Blackbody radiation; Photoelectric effect; Planck's radiation law; Compton effect.
3. Wave nature of Particle: De-Broglie hypothesis; experimental verification of De-Broglie hypothesis; concept of wave packet; concept of phase and group velocities.
4. Heisenberg's uncertainty principle, experiments for the verification of uncertainty principle, Different forms of uncertainty principle.
5. The Schrodinger wave equation: Schrodinger's time dependent and time independent equation; Physical interpretation of wave function; Probability Current Density; Equation of Continuity and its physical significance, Normalisation of the wave function.

Keywords: Photoelectric effect, Compton Effect, Heisenberg uncertainty principle, Schrodinger equation.

Unit-II

Quantum Mechanics-II [12 Lectures]

1. Operators in Quantum mechanics : Eigen functions and Eigenvalues; Hermitian operator; Position and Momentum operator; Total energy (Hamiltonian) operator; Expectation value; Concept of parity; Parity operator; Ehrenfest Theorem.
2. Application of Schrodinger equation: Free particle; Particle in one-dimensional box; Rectangular potential barrier; Tunnel effect, Applications of tunnel effect in barrier penetration(α-decay); One dimensional Harmonic Oscillator and concept of zero-point energy.

Keywords: Eigen function, Hermitian operator, Harmonic Oscillator.

Unit-III

Atomic Structure [12 Lectures]

1. Brief review of Bohr and Sommerfeld model of atom; Electron orbits; Energy levels and spectra; Vector atom model; Concepts of space quantization ; Electron spin; Stern-Gerlach experiment; One and two valence electron systems; Pauli's exclusion principle

and electron configuration; Spectroscopic notations of energy states, Multiplicity of energy level state.

2. Spin Orbit interaction; Selection rules; Spectra of alkaline atom; Fine structure of Sodium D line; Spectral terms of two electron atoms; L-S and j-j coupling; Spectra of Helium atom; Franck-Hertz experiment.

Keywords: Electron orbits, Exclusion principle, Spin Orbit Interaction.

Unit-IV

Zeeman Effect and X-Ray Spectroscopy [12 Lectures]

1. Zeeman Effect: Early discoveries and developments; Experimental arrangements, Normal and Anomalous Zeeman Effect; Zeeman shift, Stark effect.

2. Nature and Production of X-Rays: Discrete and continuous X-ray spectra; Characteristics X-ray spectrum; Duane and Hunts rule; X-ray emission spectra; Moseley's law and its applications; Auger effect; doublet structure of X-ray spectra; X-ray absorption spectra.

Keywords: Zeeman effect, X-Rays , Doublet structure.

Unit-V

Molecular Spectroscopy [12 Lectures]

1. Molecular Spectroscopy : Various types of spectra; Quantization of Vibrational and Rotational energies; Pure Rotational spectra; Determination of Intermolecular Distance of Diatomic Molecules; Pure Vibrational Spectra of Diatomic Molecules; Electronic Spectra of Diatomic Molecules.
2. Raman Spectroscopy: Raman Effect; Stoke and Anti Stoke lines; Experimental Setup of Raman effect; Classical theory of Raman effect; Quantum theory of Raman effect; Applications of Raman effect; Electronic Spectrum; Born-Oppenheimer approximation; Franck-Condon principle; Fluorescence and Phosphorescence.

Keywords: Molecular Spectroscopy, Vibrational spectra, Raman effect, Electronic spectra

Suggested Books :

1. Beiser A. , "Concepts of Modern Physics", Mc-Graw Hill.
2. Ghatak & Loknathan, "Quantum Mechanics", McMillan.
3. Mani H S, Mehra G K, "Introduction to Modern Physics", East West Press.
4. Rajam J B, "Modern Physics", S. Chand

5. Schiff L I, “Quantum Mechanics”, Mc-Graw Hill
6. White H E “ Introduction to Atomic Spectra” Mc-Graw Hill
7. Griffiths D J “ Introduction to Quantum Mechanics” Cambridge University Press

Suggested Web links:

1. **https://www.eshiksha.mp.gov.in/mpdhe**
2. **https://youtu.be/KSgzRxzhzrQ?list=PLCvpYrhOPdiX6-GqRU3eVMKScNP4jedGi** (Modern Physics by Prof. V. Ravishankar, IIT Delhi)
3. **https://youtu.be/THZNfDdt_w0?list=PL8g67naApM8hmh2mw19NX4fP1663He9it** (Quantum Mechanics By Prof H C Verma, IIT Kanpur)
4. **https://youtu.be/xlrvgLUsKqU?list=RDCMUCLI511QwKqQn0Cf4nzdGKeQ** (Quantum Mechanics By Prof P Ramadevi, IIT Mumbai)

Assessment and Evaluation

Maximum Marks: 100 (End of the year Exam 70 + CCE 30)

Minimum Passing Marks : 35

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Mode of Evaluation:	Digital Assignments, Quiz, Quarterly Exam, Half Yearly Exam, Final examination

Group- A Paper- I Quantum Mechanics, Atomic and Molecular Physics Lab [30 hours]

(Credit Value: 2)

List of Experiments

1. Determination of Planck's constant using Light Emitting Diode.
2. Determination of specific charge "e/m" by Thomson's method.
3 .Determination of Planck's constant using solar cell.
4. Determination of Rydberg's constant using hydrogen discharge tube.
5. To Determine the Lande's g-factor using Zeeman Effect.
6. To observe the Zeeman splitting of green mercury line using Fabry-Parot Etalon for normal transverse and longitudinal configuration.
7. Determination of wavelength of sodium light with the help of Bi-Prism.
8. Determination of thickness of mica sheet with the help of Bi-Prism.
9. Determination of wavelength of monochromatic light source with the help of Michelson Interferometer.
10. Measurement of wavelength of mercury source spectrum by constant deviation spectrograph and calibration of drum.
11. Determination of wavelength of monochromatic light source with the help of plane transmission grating and spectrometer.
12. Verification of Fresnel's Law of reflection.
13. Verification of Cauchy's formula using spectrometer.
14. Determination of electric charge by Millikan's oil drop method.
15. Determination of Stefan's constant.
16. Determination of resolving power of plane transmission grating with the help of spectrometer.
17. To count the number of particles emitting from radioactive source with the help of G M counter.

18. To draw the characteristic curves of Photo/Solar cell and determine stopping potential.

Learning Resources:

Texts:

1. Prakash I. & Ramkrishna, A Text Book of Practical Physics, Kitab *Mahal,2011.*
2. Squires G.L., Practical Physics, Cambridge Univercity Press,2015.
3. Flint B. L. & Worsnop H. T. Advanced Course in Practical Physics, New Central Book Agency.
4. Ghosh And Majumdar, Practical Physics Vol.1 & 2 Sharda Publications, 2012.
5. Chattopadhyay and Rakshit, An Advanced Course in Practical Physics, New Central Book Agency.
6. Singh S P, Advanced Practical Physics, Pragati Prakashan.

Weblinks:

1. **https://www.eshiksha.mp.gov.in/mpdhe**
2. **https://www.vlab.co.in/broad-area-physical-sciences**
3. **https:// storage.googleapis.com/uniquecourses/online.html**

Assessment & Evaluation:

Maximum Marks: 100 (End of the year Exam 70 + CCE 30)

Minimum Passing Marks: 35

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Mode of Evaluation:	Digital Assignments, Quiz, Quarterly Exam, Half Yearly Exam, Final examination

B.Sc. III Year NEP Syllabus-2023-24

Group- A Paper- II Solid State Physics and Electronics

Major (Credits 4)

<u>Course Objectives</u>

The objectives of the course are :

	Course Objectives	**Cognitive Level**
CO-I	To get an idea about classification of solids, crystal structure and Diffraction of X-Rays.	U,R, Ap, An, E
CO -II	To understand lattice vibration and its consequences .Develop an understanding about specific heat of solids.	U,R,C, An, E
CO -III	To understand semiconductor physics and idea about two terminal electronic devices (diode) and their applications.	R , U , Ap ,An
CO -IV	To understand construction and operation of various three terminal devices eg. Bipolar junction transistor, Field Effect Transistor etc. and applications of transistor as amplifier.	U,R, An, C
CO -V	To learn the function of transistor as Oscillator also to get an idea about modulation and demodulation.	U, An, Ap

Course Learning Outcome (CLO)

	Course Learning Outcomes	**PSOs Addressed**	**Cognitive Level**
CLO-I	On completion of course Learner will be able to outline the idea about crystalline and amorphous solids, and diffraction of X-rays by Crystalline materials.	1,2,6	U,R, Ap, An, E

CLO-II	On completion of course Learner will be able to illustrate Lattice vibrations, phonons, theories of specific heat of solids.	4,5,6	U,R,C, An, E
CLO-III	On completion of course Learner will be able to formulate origin of energy bands in Solids, originate the idea of two terminal devices & their applications.	3,4,5,6	R , U , Ap ,An
CLO-IV	On completion of course Learner will be able make-up the concept of three terminal devices (BJT, FET etc.) and their applications.	1,3,5	U,R, An, C
CLO-V	On completion of course Learner will be able to analyze various modulation processes.	2,3,5,6	U, An, Ap

CO – Course Objectives; CLO – Course Learning Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

Unit-I

Crystal Structures [12 Lectures]

1. Premier Indian Institutes and their contribution: Bhabha Atomic Research Centre, Mumbai, Advanced Materials and Processes Research Institute (AMPRI), Bhopal; Defense Research and Development Organization (DRDO), New Delhi; Indian Institute of Science, Bangalore; Bose Institute, Kolkata, Raja Ramanna Centre for Advance Technology (RRCAT), Indore.
2. Classification of solids and space lattice: Crystalline and amorphous solids; Space lattice; Basis; Lattice translational vector; Unit cell; Primitive and non- primitive cells; Bravais lattice in two and three dimensions; Seven crystal systems; Fundamentals of elements of symmetry; Point groups and space groups; Lattice planes and miller indices; Relation between interplanar spacing and lattice constants.
3. Simple crystal structures: Simple cubic; Face centered cubic (NaCI); Body centered cubic (CsCI); Hexagonal closed packed; Diamond and Zinc sulfide structure; Coordination numbers and atomic packing fraction.

4. Reciprocal lattice and its properties, Diffraction in crystal: Laue's and Bragg's equations; Determination of crystal structure by X-rays (Powder method)

Keywords: Crystal structure, Miller indices, Coordination number, Diffraction in crystal.

Unit-II

Physical properties of matter [12 Lectures]

1. Specific heat: Specific heat of solid and its variation with temperature; Classical theory of Dulong and Petit; Einstein model assumptions and derivation for specific heat; Debye model assumptions and derivation for specific heat; Outcomes of different models**.**
2. Lattice vibrations in crystal: Mono-atomic lattice vibration and dispersion relation; Brillouin Zones; Concept of phonons.
3. Motion of electrons in metals: Lorentz Drude theory, electrical resistivity and electrical conductivity; Ohm's Law($J = \sigma E$); Wiedemann Frenz law; Hall effect, Hall coefficients and experimental determination.

Keywords: Specific heat, Lattice vibration, Phonon, Electrical resistivity.

Unit-III

Solid state devices and applications [12 Lectures]

1. Energy bands and semiconductors: Formation of energy bands in solid; Semi-conductors: Intrinsic and extrinsic; Concept of Fermi energy and Fermi energy level; Mobility and drift velocity of charge carriers; Conductivity of semiconductors; Derivation for expression of concentration of electrons and holes in an intrinsic and extrinsic semiconductor; P-N Junction, depletion layer, expression for potential barrier; Current equation for P- N junction diode.
2. Construction, operation and characteristic curve of diodes: P-N Junction Diode in forward and reverse bias; Characteristics curve; Static and dynamic resistance; Avalanche and Zener Breakdown; Zener diode and its application as a voltage regulator; Photodiode, Light Emitting diode and Solar cell.

3. Rectification: Half wave, full wave and bridge rectifier: Electrical circuit and working; Determination of efficiency; Ripple factor and voltage regulation; Unregulated and regulated power supply.

Keywords: Energy bands, Semiconductors, Zener-diode, Photo-diode, Rectifier,

Regulated power supply.

Unit-IV

Transistor and Amplifier [12 Lectures]

1. Transistors: Bipolar Junction Transistors (PNP and NPN); Biasing and operation; Operation of transistors in common base, common emitter and common collector modes and their characteristic curves; Relation between current gains (a, B and y); Hybrid (h)- parameters of transistor, JFET and MOSFET and its characteristic curve.
2. Transistor biasing: Biasing stabilization in transistor; Thermal runway and stability factor; Method of transistor biasing (voltage dividing method).
3. Amplifiers: Amplifiers and their classification in brief; Single stage common emitter amplifier, RC coupled Amplifier; Q -point, load line and frequency response curve, Power amplifiers (only introduction).

Keywords: Transistor, Amplifier.

Unit-V

Oscillators, Modulation and demodulation [12 Lectures]

1. Oscillators: Principle of feedback amplifiers; Positive and negative feedback amplifier; Principle of an oscillator and Barkhausen criterion; Introduction to Phase shift and Wien bridge oscillator.
2. Modulation: Definition; Theoretical analysis of amplitude modulation; Modulation index; Side bands and band width; Power dissipation in modulated wave.
3. Frequency modulation: Definition and mathematical analysis of frequency modulated wave; Modulation index, frequency spectrum and band width.
4. Phase modulation: Definition and theoretical analysis; Comparison among amplitude, frequency and phase modulation.

5. Demodulation: Principle of detection of Amplitude Modulated wave; P-N diode as square law detector.

Keywords/Tags: Modulation, Modulation index, Demodulation.

Learning Resources

Text:

1. Kittel Charles, "Introduction to Solid State Physics", Wiley India Pvt. Ltd., India, (2007), 7" Edition.
2. Omar M.Ali, "Elementary Solid State Physics", Pearson Education, India, (2009), 6 Edition.
3. Singhal R. L., P. A. Alvi, et.Al., "Solid State Physics", Kedar Nath Ram Nath and Co., (2018),
4. Chattopadhyay D., Rakshit P.C., "Electronic Fundamentals and Application", New Age International,(2020).
5. Ashcroft Neil W., Mermin N. David., "Solid State Physics" Harcourt College Publishing, New York,2019.
6. Gupta S. L., Kumar V., "A Hand Book of Electronics", Pragati Prakashan, India, 2013, 19th Edition.
7. Kennedy George, Davis Bernard and Prasanna S. R. M., "Electronic Communication Systems" McGraw Hill Education, (2017), 6th Edition.
8. Malvino Albert Paul, Bates David, "Electronic Principles", McGraw Hill International Edition, India, (2006), 7 Edition.
9. Puri and Babbar, " Solid State Physics", S Chand Publications.

Suggested web links:

1. https://www.eshiksha.mp.gov.in/mpdhe
2. https://voutu.be/RJOCEz7wd0?list=PLUMVogViSn/QSiqiXDYuE6ETz5F5Kn4dA
3. https://voutu.be/L-eOdZF19BY
4. https://youtu.be/Kp-iS6NHsB8?list-PLF178600D851B098F
5. https://youtu.be/g7vYop 46tU?list=PL708EEA8184EA8F53

Assessment and Evaluation:

Maximum Marks: 100(End of the year Exam 70 Marks +CCE 30 Marks)
Minimum Passing Marks: 35

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Mode of Evaluation: Digital Assignments, Quiz, Quarterly Exam, Half Yearly Exam, Final examination

Group- A Paper- II Solid State Physics and Electronics [30 hours]

(Credit Value: 2)

List of Experiments

1. To study characteristic curve of a PN Junction diode.
2. To study characteristics curve of a Zener diode.
3. To study characteristics curve of a light emitting diode (LED).
4. To determine the energy band gap of a semiconductor using P-N diode in reverse bias.
5. To determine ripple factor and voltage regulation of half wave and full wave rectifiers.
6. To determine ripple factor and voltage regulation of a full wave rectifiers using filter circuit.
7. To study unregulated and regulated power supply.
8. To study characteristics curves of PNP/ NPN transistor in common base mode configuration and determination current gain.
9. To study characteristics curves of PNP/ NPN transistor in common emitter mode configuration and determination current gain.
10. To study characteristics curves of Junction field effect transistor.
11. To study thermal bias stability of transistor in common emitter mode.
12. To study frequency response curve of single stage RC amplifier in CE mode.
13. Measurement of h-parameters of a transistor.
14. Find out closed loop gain of feedback amplifier.
15. Study of wave form of Wein bridge oscillator and to measure frequency of oscillations.
16. Study of amplitude modulated wave and determination of modulation index using CRO.
17. Study of frequency modulated wave and determination of modulation index using CRO.
18. Study of characteristic curve of Photodiode.
19. Measurement of unknown capacitance by schering bridge.
20. To study the characteristic curve of Tunnel diode.

Learning Resources :

Text:

1. Prakash I. & Ramakrishna, *A Text Book of Practical Physics", Kitab Mahal, 2011.
2. Squires G. L., "Practical Physics", Cambridge University Press, 2015, 4/e.
3. Flint B. L. and Worsnop H. T., "Advanced Practical Physics for students", Asia Publishing House, 197.
4. Chattopadhyay D. & Rakshit P. C., "An Advanced Course in Practical Physics", New Central Book Agency.
5. Chattopadhyay D., Rakshit P.C. and Saha B., "An Advanced Course in Practical Physics", New Central Book Agency P. Ltd.
6. Singh S.P., "Advanced Practical Physics", Pragati Prakashan.
7. Tayal D. C., *University Practical Physics", Himalaya Publishing House
8. Kumar P. R. Sasi, " Practical Physics*, PHI Publication
9. Srivastava Anchal, Shukla R. K., * Practical Physics", New Age International Publishers.
10. Agarwal D. C., "Experimental electronics", Technical Publishing House.
11. Srivastava J. P., " Elements of Solid state Physics", PHI Publication.
12. Books published by Madhya Pradesh Hindi Granth Academy, Bhopal.

Web links

1. https://www.eshiksha.mp.gov.in/mpdhe
2. https://www.classcentral.com/course/edx-principle-of-semiconductor-devices-part-i-emiconductors-pn-junctions-and-bipolar-junction-transistors-11365
3. https://www.classcentral.com/csourse/swayam-semiconductor-devices-and-circuits-19997
4. https://www.vlab.co.in/broad-area-physical-sciences
5. https://storage.googleapis.com/uniquecourses/online.html

Assessment and Evaluation:

Maximum Marks: 100 (End of the year Exam 70 + CCE 30)

Minimum Passing Marks : 35

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Mode of Evaluation: Digital Assignments, Quiz, Quarterly Exam, Half Yearly Exam, Final examination

B.Sc. III Year NEP Syllabus-2023-24

Group- B Paper- I Astronomy and Space Physics

Major (Credits 6)

<u>Course Objectives</u>

The objectives of the course are :

	Course Objectives	**Cognitive Level**
CO -I	To get an idea about the basic concepts of Astronomy and Space Physics.	U,R
CO -II	To understand the working principle of astronomical tools and how to use them.	U,C, Ap,E
CO -III	To understand the physical processes in stars and evolution and classification of stars.	R, U, An
CO -IV	To understand the basics of sun & solar system.	U,R
CO -V	To learn the structure and dynamics of galaxies.	U, An

Course Learning Outcome (CLO)

	Course Learning Outcomes	**PSOs Addressed**	**Cognitive Level**
CLO-I	On completion of course Learner will be able to understand various terms of astronomy and astronomical coordinate systems.	1,2	U,R
CLO -II	On completion of course Learner will be able to understand the technique in observational astronomy.	3,5,6	U,C, Ap,E
CLO -III	On completion of course Learner will be able to Describe the classification and evolution of stars and their physical properties.	4,5,6	R, U, An
CLO -IV	On completion of course Learner	1,6	U,R

	will be able to detail the presently accepted theories of the solar system.		
CLO -V	On completion of course Learner will be able to understand morphology and classification of galaxies.	1,3,6	U, An

CO – Course Objectives; CLO – Course Learning Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

Unit-I

Introduction [18 Lectures]

1. A Brief historical background of Astronomy and space physics, Introduction of five ancient astronomical observatories (Jantar Mantar) of India (Ujjain, Jaipur, Delhi, Mathura, Varanasi), Contribution of Aryabhata, Brahmagupta, Bhaskara II, Vainu Bappu, Prof. Jayant Narlikar, Prof. Kasturi Rangan and Prof. S.K Mitra in the field of Astronomy and Space physics.
2. Astronomical Distances and their measurements, Determination of Mass, Concept of space and time, Luminosity, Temperature and distances of a stars.
3. Stellar classification and its interpretation, H.R. diagram of clusters, Empirical mass-luminosity relation.
4. Positional astronomy, Celestial Sphere, Astronomical Coordinate Systems, Conversion of Coordinates.

Keywords: Stars, Stellar classification, Astronomy, Celestial Sphere.

Unit-II

Astronomical techniques [18 Lectures]

1. Basic Optical Definitions for Astronomy: Magnification, Light Gathering Power, Resolving Power, Diffraction Limit and Atmospheric Windows, Optical Telescopes:Types of Reflecting Telescopes, Telescope Mountings.
2. Detectors and Their Use with Telescopes, Types of Detectors, Detection Limits with Telescopes, Spectrograph, CCD Camera, Photometers, Filters, Polarimeter.
3. Radio Telescope- Interferometry, UV, IR, X-ray and Gamma ray telescope, Space telescope-Himalayan Chandra telescope (HST) in India.

Keywords: Atmospheric Window, Telescopes, Himalayan Chandra telescope.

Unit-III

Evolution of Stars and their life cycle [18 Lectures]

1. Brightness, Radiant Flux and Luminosity, Apparent and Absolute magnitude scale, Distance Modulus, Determination of Temperature and Radius of a star, Stellar Interior, Energy generation in Stars, Contraction Hypothesis,
2. Evolution of Stars: Pre main sequence, Main sequence and post main sequence stages.
3. Classification of stars, Binary, Neutron star, Black hole, Chandrashekhar limit.

Keywords: Radiant Flux, Neutron star, Black hole.

Unit-IV

Sun and Solar System [18 Lectures]

1. Solar Structure and its processes, Solar Atmosphere, Photosphere, Chromosphere, Corona, Concept of quiet and active Sun. Development of centre of activity, Sunspots, Butterfly diagram, Solar Cycle,Solar flares.
2. Solar System: Age, Planetary orbits and distance, Physical size, rotation periods.
3. Origin of the Solar System: The Nebular Model, Tidal Forces and Planetary Rings, Extra-Solar Planets.

Keywords : Solar Structure, Sunspots, Planetary orbits.

Unit-V

Galaxies [18 Lectures]

1. The Milky Way (our own galaxy): Basic Structure and Properties, Nature of Rotation, Stars and Star Clusters of the Milky Way, Dark Matter.
2. Morphology of galaxies, Classification of Galaxies, basic properties of Elliptical, Spiral and Seyfert Galaxies, Galactic clusters, Pulsars and Quasars.
3. Gas and Dust in the Galaxy, Big Bang theory.

Keywords: Milky Way, Classification of Galaxies, Pulsars, Big Bang theory.

Learning Resources :

Text :

1. Carroll B. W. & Ostlie D.A., "Modern Astrophysics", Addison- Wesley Publishing Co.

2. Zeilik M. & Gregory S. A., "Introductory Astronomy and Astrophysics", 4th Edition, Saunders College Publishing.
3. Karttunen H. et al., "Fundamental of Astronomy", Springer.
4. Krishnasamy K.S., "Astro Physics a modern perspective*, Reprint, New Age International (p) Ltd, New Delhi, 2002.
5. Basu Baidyanath, "An introduction to Astro physics", Second printing, Prentice -Hall of India Private limited, New Delhi,2001.
6. Bhatia V. B., "Textbook of Astronomy and Astrophysics with elements of cosmology" Narosa Publication.
7. Books published by Madhya Pradesh Hindi Granth Academy, Bhopal

Web links:

1. https://www.eshiksha.mp.gov.in/mpdhe
2. https://youtu.be/UpyiNpQW0?list=PLyQSN7X0ro2092IHnrUzShGPTm5nfO2Fr Lectures by Prof. Walter Lewin.
3. https://youtu.be/vDv3iSMdYyc Astrophysics and Cosmology by Prof. Somnath Bharadwaj, Department of Physics and Meteorology, IIT Kharagpur.

Assessment and Evaluation:

Maximum Marks: 100 (End of the year Exam 70 + CCE 30)

Minimum Passing Marks : 35

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Mode of Evaluation: Digital Assignments, Quiz, Quarterly Exam, Half Yearly Exam, Final examination

Group- B Paper- II Nuclear and Particle Physics

Major (Credits 6)

Course Objectives

The objectives of the course are :

	Course Objectives	Cognitive Level
CO-I	To get an idea about properties of nucleus, nuclear force, nuclear energy and radioactivity.	U,R, An
CO -II	To understand the concept of nuclear models and various decay processes.	U,Ap,An, E
CO -III	To develop an understanding about nuclear reactions, fusion and fission.	R , U , Ap ,C
CO -IV	To understand construction and functioning of various nuclear detector and accelerators.	U,An, C
CO -V	To learn about elementary particles their classification and properties.	U,Ap

Course Learning Outcome (CLO)

	Course Learning Outcomes	**PSOs Addressed**	Cognitive Level
CLO -I	On completion of course Learner will be able to understand the ground state properties of a nucleus, process of radioactivity, the radioactive decay law, its uses .	1,3,6	U,R, An
CLO -II	On completion of course Learner will be able to understand (a) nuclear models and their roles in explaining the ground state properties of the nucleus (b) mechanisms of alpha, beta and gamma rays emission.	3,4,6	U,Ap,An, E

CLO -III	On completion of course Learner will be able to formulate the basic aspects of nuclear reactions, the Q-value of such reaction, fission and fusion reaction.	2,5	R , U , Ap ,C
CLO -IV	On completion of course Learner will be able to understand the principles and basic constructions of particle (radiation) detectors and accelerators	1,5	U,An, C
CLO -V	On completion of course Learner will Gain knowledge about the classifications of particles and various symmetry elements involved in particle physics.	1,4	U,Ap

CO – Course Objectives; CLO – Course Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

Unit-I

Nucleus, Nuclear Forces and Radioactivity [18 Lectures]

1. Introduction to Bhabha Atomic Research Centre (BARC), Defence Research and Development Organization (DRDO) and Indian Space Research Organization (ISRO), Raja Ramanna Centre for Advanced Technology,(RRCAT) Indus-1 and Indus-2 synchrotron.
2. Composition, charge, size, shape, mass and density of the nucleus; Nuclear angular momentum; Nuclear magnetic dipole moment; Electric quadrupole moment; Mass defect; Packing fraction and Binding energy; Binding energy of Deuteron; Stability of nuclei (N vs Z curve), Binding energy curve.
3. Nuclear Forces: General concept of Nuclear force; Yukawa Meson field theory of Nuclear forces; Properties of Nuclear forces.
4. Radioactive disintegration; Properties of alpha, beta, gamma rays; law of radioactive decay; successive radioactive decay; radioactive equilibrium; Radioisotopes; application of radioactivity (Agriculture, Medicinal, Industrial and Archaeological).

Keywords: Nuclear Forces, Binding energy, Deuteron, Radioactive disintegration.

Unit-II

Nuclear models and Nuclear Decay [18 Lectures]

1. Nuclear models: Shell model; magic number; Square well potential; Harmonic oscillator potential well; Spin-Orbit potential; Unified (collective) model; Liquid Drop model; Semi-empirical mass formula.
2. Two Body system: The ground state properties of the Deuteron; Deuteron in Central potential (Square well); Excited state of the deuteron; Neutron-Proton scattering at low energies; Scattering length.
3. Alpha decay: Alpha particles spectra; Gamow's theory of Alpha decay; Beta decay: Shape of Beta ray spectrum; Explanation of Beta decay on the basis of Neutrino and Antineutrino hypothesis; Fermi theory of Beta decay; Selection rules; Conservation of B-decay: Gamma ray emission: Multipole radiation.

Keywords: Shell model, Liquid Drop model, Scattering, Alpha decay, Beta decay Radioisotopes

Unit-III

Nuclear reactions and Nuclear Energy [18 Lectures]

1. Nuclear reactions: Kinds of Nuclear reactions; Nuclear reaction kinematics; Q-value; Compound Nucleus and concept of direct reactions; Conservation laws; Nuclear reaction cross- sections
2. Nuclear energy: Nuclear Fission; Chain reaction and Critical Mass; Nuclear Reactors and its basic components; Nuclear Fusion; Condition for the maintained Fusion reactions; Energy production in stars; Fusion reaction in Sun, Principle of atomic bomb and hydrogen bomb.

Keywords: Nuclear reactions, Nuclear Fission, Q-value.

Unit-IV

Nuclear counters and detectors [18 Lectures]

1. Ionization Chamber; Proportional counter; Geiger-Müller counter; Scintillation counter; semiconductor detectors; P-N junction detector; Lithium drifted; High purity Ge Detector; Gamma ray interactions NaI (TI) Scintillation.

2. Detector electronics and Pulse processing: Pulse counting systems; Pulse height analysis systems; Pulse timing; Pulse shape discrimination.

3. Accelerators: Cyclotron, Betatron, synchrotron.

Keywords: Ionization Chamber, Detector, Pulse processing.

Unit-V

Fundamental particle [18 Lectures]

1. Fundamental particles: Classification of particles-antiparticles and their interactions; Conservation laws; Charges; Isospin; Baryon number; Strangeness; Parity; Charge conjugation; CPT theorem; CP violation and natural K-decay.
2. Fundamental particle symmetry: SU(2) and SU(3) symmetry and their application to Multiplet Meson and Baryon state; Quark as the building blocks of Hadrons; Quark Model; Colour degree of freedom, Ghost particles, Higgs Boson Particle (God particle), Large Hadron collider (LHC).

Keywords: Fundamental particles, Isospin, Baryon. Quark.

Learning Resources :

Text :

1. Waghmare Y. R., "Introductory Nuclear Physics", Oxford & IBH Oub.
2. Kapoor S. S., Ramamurthy V. S., "Nuclear Radiation Detectors", New Age International Publishers.
3. Cohen B. L., "Concepts of Nuclear Physics", McGraw Hill Education.
4. Tayal D. C., "Nuclear Physics", Himalaya Publishing House.
5. Patel S. B., "Nuclear Physics: An Introduction", New Age International Publishers.
6. Singh Jahan, "Fundamental of Nuclear Physics", Pragati Publications.
7. Books published by Madhya Pradesh Hindi Granth Academy, Bhopal.

Web links:

1. https://www.eshiksha.mp.gov.in/mpdhe

2. https://youtu.be/josqicH79PE?list=PLbMVogVj5nJRvq-w3zway7k3GzmUDte3a

Nuclear Physics: Fundamentals and Applications by Prof. H.C. Verma, Department of Physics, IIT Kanpur.

3 https://youtu.be/H7OipY8RzX0?list-PLOb6maW-5d1fvnUXykaaDOJPjEB0pTDF9

Lecture Series on Nuclear and Particle Physics by Prof. Poulose Poulose, Department of Physics, IIT Guwahati.

Assessment & Evaluation:

Maximum Marks: 100 (End of the year Exam 70 + CCE 30)

Minimum Passing Marks : 35

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Mode of Evaluation:	Digital Assignments, Quiz, Quarterly Exam, Half Yearly Exam, Final examination

B.Sc. III Year NEP Syllabus-2023-24

Quantum Mechanics, Solid State Physics and Devices

Minor/Elective (Credits: 3+1)

Course Objectives

The objectives of the course are:

	Course Objectives	Cognitive Level
CO -I	To get an idea about necessity of quantum mechanics, concept of wave packet and operators in quantum mechanics.	U,R, Ap , An, E
CO -II	To learn the formulation Schrodinger wave equation and its applications (solution under various conditions).	U,R,An, E
CO -III	To understand and explain atomic structure, properties of X-Rays and molecular spectra.	R , U , Ap ,An
CO -IV	To get an idea about classification of solids, crystal structure and thermal properties of solids.	U,An
CO -V	To learn semiconductor physics and idea about two & three terminal electronic devices (diode, transistor etc.) and their applications.	U, An, Ap,C

Course Learning Outcome (CLO)

	Course Learning Outcomes	**PSOs Addressed**	**Cognitive Level**
CLO-I	On completion of course Learner will be able to (a) understand aspects of the inadequacies of classical mechanics and historical development of quantum mechanics (b) build the concepts of Wave packets, Phase and Group Velocities and Uncertainty principle.	1,3,6	U,R, Ap , An, E
CLO -II	On completion of course Learner will be able	2,4	U,R,An, E

	to write the Schrodinger time dependent and time independent equations and Solve them for different cases.		
CLO -III	On completion of course Learner will be able to (a) extend the concept of Quantum Numbers and explanation of Spectra of Alkali/Alkaline Earth metals (b)analyze the effect of Magnetic field on atoms.	1,2,3,5	R , U , Ap ,An
CLO -IV	On completion of course Learner will be able to analyze the effect of Magnetic field on atoms.	2,5	U,An
CLO -V	On completion of course Learner will be able to build, compare & contrast the basic concepts of Rotational, Vibrational and Electronic spectra.	1,2	U, An, Ap,C

CO – Course Objectives; CLO – Course Learning Outcome; R- Remember; U- Understand; Ap – Apply; An – Analyse; E- Evaluate; C – Create

Unit-I

Introduction to Quantum Mechanics [12 Lectures]

1. A brief biography of Chandrasekhara Venkata Maman and their major contribution to science.
2. Limitations of classical mechanics and origin of quantum mechanics, Black body radiation, Photoelectric effect, Compton effect, de-Broglie hypothesis, Davisson-Germer experiment, Wave packet, Phase velocity and Group velocity.
3. Heisenberg uncertainty principle, Different forms of uncertainty principle, Schrödinger wave equation: Time dependent and independent equation, Physical interpretation of wave function, Equation of Continuity.
4. Operator in quantum mechanics: Eigenfunctions and Eigenvalues, Hermitian operator, Position and Momentum operator, Total energy operator (Hamiltonian), Expectation value, Parity operator, Ehrenfest Theorem.

Keywonds: Quantum mechanics, Uncertainty principle, Eigenfunctions.

Unit-II

Application of Quantum Mechanics and Atomic Structure [12 Lectures]

1. Application of Schrodinger equation: Free particle, Particle in one dimensional box, Rectangular potential barrier, Tunnel effect, One dimensional Harmonic Oscillator.
2. Three dimensional Schrodinger equation, the radial and angular equation, Hydrogen atom, electron probability density.
3. Bohr's atomic model, Atomic spectra of hydrogen, Sommerfeld model, electron spin, Stern-Gerlach experiment, Orbital and Spin angular momentum, Concept of space quantization, Quantum numbers.

Keywonds: Tunnel effect, Harmonic Oscillator, Quantum numbers, Atomic model.

Unit-III

Many-Electron Atom [12 Lectures]

1. Pauli's exclusion principle, Electronic configuration, Symmetric and anti-symmetric wave function (Bosons and Fermions).
2. Spin-Orbit interaction, Selection rules, Spectra of alkaline atom, Fine structure of Sodium D line, Spectral terms of two electron atoms, L-S and j-j coupling, Multiplicity of energy levels, Spectra of Helium atom, Zeeman effect: Types and Experimental arrangement.
3. Various types of molecular spectra, Electronic, Rotational and vibrational spectra of diatomic molecule, Raman effect: Experimental setup and explanation by quantum principle, Production of X-rays, Continuous and characteristics X-ray spectrum, Moseley's law.

Keywords: Exclusion principle, Bosons and fermions, Spin-Orbit interaction, Molecular Spectra, X-rays.

Unit-IV

Solid State Physics [12 Lectures]

1. Crystalline and amorphous solids, Space lattice; Basis, Lattice translational vector, Primitive cell, Bravais lattice, seven crystal systems, Symmetry, Miller indices, Interplanar spacing.

2. Crystal Structures: Simple cubic, Face centered cubic (NaCl), Body centered cubic (CsCl), Hexagonal closed packed, Diamond structure, Coordination numbers and atomic packing fraction, Laue's and Bragg's equations, Reciprocal lattice.
3. Dulong and Petit's theory of Specific heat, Einstein's theory of specific heat, Debye's theory of specific heat, Lattice vibrations in crystal: Mono-atomic lattice vibration and dispersion relation, Brillouin Zones, Concept of phonons, Lorentz Drude theory, Ohm'S law ($J=\sigma E$), Wiedemann Frenz Law, Hall effect.

Keywords: Exclusion Principle, Bosons and Fermions, Spin-Orbit interaction, Molecular spectra, X-rays.

Unit-V

Semiconductor and Devices [12 Lectures]

1. Energy bands in solids, Intrinsic and extrinsic semiconductors; Fermi energy level, Mobility, Conductivity of semiconductors, Concentration of electrons and holes in Semiconductors.
2. P-N Junction, depletion layer, Potential barrier, Shockley diode equation (Without derivation), Zener diode and its application, Elementary knowledge of photodiode ,Light Emitting diode and solar cell, Bipolar Junction Transistors and its characteristics curves, Current gains(α,β and γ) Junction Field Effect Transistor.
3. Amplifiers and their classification, Single stage common emitter amplifier, Q-point, load line and frequency response curve, Feedback amplifiers, Barkhausen criterion, Phase shift and Wien bridge oscillator.

Keywords: Semiconductors, P-N Junction, Amplifiers, Oscillators.

Learning Resources

Text :

1. Beiser A. "Concepts of Modem Physics" McGraw Hill.
2. Ghatak and Lokanathan, "Quantum Mechanics", McMilan India.
3. Mani H S, Mehra G K., "Introduction to Modern Physics", East West Press.
4. Schiff L, I., "Quantum Mechanics", McGraw Hill Education.
5. Rajam J. B., "Modern Physics", S. Chand.
6. White H. E., "Introduction to Atomic Spectra", McGraw Hill.
7. Griffiths D. J., "Introduction to Quantum Mechanics", Cambridge University Press.
8. Kittel Charles, "Introduction to Solid State Physics", Wiley India Pvt. Ltd.
9. Omar M Ali, "Elementary Solid State Physics", Peason Education, India.
10. Singhal R L.,P.A. Alvi, et al., "Solid State Physics", Kedar Nath Ram Nath and Co.
11. Chattopadhyay D., Rakshit P.C.," Electronic Fundamentals and Application", New

Age International.
12. Srivastava J.P., “Elements of Solid State Physics”, Prentice Hall of India.
13. Ashcroft Neil W., Mermin N. David,” Solid State Physics” Harcourt College Publishing, New York
14. Gupta S.L., Kumar. V., “A Hand Book of Electronics”, Pragati Prakashan.
15. Malvino Albert Paul, Bates David, “Electronic Principles”, Mc-Graw hill International.
16. Verma H.C., “Quantum Mechanics”,
17. Zettili N., “Quantum Mechanics: Concepts and Applications”, Wiley International.
18. Puri and Babbar, “Solid State Physics”, S. Chand.
19. Mehta V. K., “Basic Electronics”, S. Chand.

Web Links:

1. https://www.eshiksha.mp.gov.in/mpdhe
2. https://youtu.be/KSgzRxzhzrQ?list=PLCvpYrhOPdiX6-GqRU3eVMKScNP4jedGi Modern Physics by Prof. V. Ravishankar, IIT Delhi.
3. https://youtu.be/THZNfDdt_wo?list=PL8g67naApM8hmh2mw19NX4fP1663Hc9it Quantum Physics by Prof, H. C. Verma, IIT Kanpur.
4. https://youtu.be/xlrvgLUsKqU?list=RDCMUCL1511QwKqQn0Cf4nzdGKeQ Quantum Mechanics by Prof. P. Ramadevi, IIt Mumbai.

Assessment & Evaluation:

Maximum Marks: 100 (End of the year Exam 70 + CCE 30)

Minimum Passing Marks : 35

Mode of Evaluation: Digital Assignments, Quiz, Quarterly Exam, Half Yearly Exam, Final examination

Note: Students will perform 5 experiments from Major Paper I and 5 experiments from Major Paper II