Faculty of Science

Bachelor of Science (B.Sc.)

SUBJECT: PHYSICS

B.Sc. V Semester

Paper-Major(CORE)

QUANTUM MECHANICS, ATOMIC AND MOLECULAR PHYSICS

Course Outcomes

	Course Outcomes	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.	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.	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	R , U , Ap
CLO - IV	On completion of course Learner will be able to analyze the effect of Magnetic field on atoms.	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.	U, R, An, Ap, E

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	40	60	**100**
Practical	2	40	60	**100**
Total	**6**	**200**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)
Practical	3 Internal Exams (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 4.5 Hrs. per week

Total No. of Lectures: 60 Hrs. **Maximum Marks:** 60

Units	Topics	No. of Lectures
I	**Quantum Mechanics-I** 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; Postulates of Quantum Mechanics, 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	12
II	**Quantum Mechanics-II** 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; Potential Step, Rectangular potential barrier; Tunnel effect, Applications of tunnel effect in barrier penetration (□-decay); One dimensional Harmonic Oscillator and concept of zero-point energy. **Keywords:** Eigen function, Hermitian operator, Harmonic Oscillator	12

III	**Atomic Structure** 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.	12
IV	**Zeeman Effect and X-Ray Spectroscopy** 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.	**12**
V	**Molecular Spectroscopy** 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	**12**

References

Test/Reference 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

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)

List of Practical

1. Determination of Planck's constant using Light Emitting Diode.

2. 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 wavelength of monochromatic light source with the help of Michelson Interferometer.

9. To study characteristic curve of a PN Junction diode.

10. To study characteristics curve of a Zener diode.

11. To study characteristics curve of a light emitting diode (LED).

12. To determine the energy band gap of a semiconductor using P-N diode in reverse bias.

13. To determine ripple factor and voltage regulation of half wave and full wave rectifiers.

14. To determine ripple factor and voltage regulation of a full wave rectifiers using filter circuit

15. To study unregulated and regulated power supply.

16. Determination of Stefan's constant.

17. Determination of resolving power of plane transmission grating with the help of spectrometer.

B.Sc. V Semester

Paper-Major(DSE)

ELECTRONICS

Course Outcomes

	Course Outcomes	Cognitive Level
CO-I	On completion of course Learner will be able to outline the idea about Semiconductors and Diodes	U,R, Ap, An, E
CO-II	On completion of course Learner will be able make-up the concept of three terminal devices (BJT, FET etc.) and their applications.	U,R, An, C
CO-III	On completion of course Learner will be able to understand the use of P-N Diode as Rectifier	R , U , Ap ,An
CO-IV	On completion of course Learner will be able to understand the use of transistor as an Amplifier and Oscillator	U,R,Ap
CO-V	On completion of course Learner will be able to analyze various modulation processes.	U, An, Ap

Credit and Marking Scheme

	Credits	Marks		Total Marks
		Internal	External	
Theory	4	40	60	**100**
Total	**4**	**100**		

Evaluation Scheme

	Marks	
	Internal	**External**
Theory	3 Internal Exams of 20 Marks (During the Semester) (Best 2 will be taken)	1 External Exams (At the End of Semester)

Content of the Course

Theory

No. of Lectures (in hours per week): 4.5 Hrs. per week

Total No. of Lectures: 60 Hrs. **Maximum Marks:** 60

Units	Topics	No. of Lectures
I	**Semiconductor Physics and Devices** 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. **Keywords:** Energy bands, Semiconductors, Zener-diode, Photo-diode, Rectifier, Regulated power supply.	12
II	**Bipolar Junction Transistor and Field Effect Transistor** 1. Transistors: Bipolar Junction Transistors (PNP and NPN); Biasing and operation; Operation of transistors in common base, common	12

	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). **Keywords:** Bipolar Junction Transistor and Field Effect Transistor	
III	**Rectifier, Filters and Power Supply** 1. Rectification: Introduction, Half wave, full wave and bridge rectifier: Electrical circuit and working; Determination of efficiency; Ripple factor and voltage regulation; Comparison between different rectifiers, 2. Filter Circuits: Series Inductor, Shunt Capacitor, L Section and π Section 3. Power Supply: Unregulated and Regulated power supply (Components, Characteristics and Voltage Regulation) **Keywords:** Rectifier, Filters and Power Supply	12
IV	**Amplifiers and Oscillators** 1. Amplifiers: Amplifiers and their classification in brief; Single stage common emitter amplifier, RC coupled Amplifier; Q -point, load line and frequency response curve and Bandwith , Power amplifiers (only introduction). 2. Oscillators: Use of transistor as an oscillator, Principle of feedback amplifiers; Positive and negative feedback amplifier; Principle of an oscillator and Barkhausen criterion; Colpitts Oscillator, Hartley Oscillator, Introduction to Phase shift and Wien bridge oscillator. **Keywords:** Amplifier, Oscillator	12
V	**Modulation and Demodulation**	12

	1. Modulation: Need of Modulation, Types of Modulation, Theoretical analysis of amplitude modulation; Modulation index; Side bands and band width; Power dissipation in modulated wave. 2. Frequency modulation: Definition and mathematical analysis of frequency modulated wave; Modulation index, frequency spectrum and band width. 3. Phase modulation: Definition and theoretical analysis; Comparison among amplitude, frequency and phase modulation. 4. Demodulation: Principle of detection of Amplitude Modulated wave; P-N diode as square law detector. **Keywords/Tags:** Modulation, Modulation index, Demodulation	

References

Test/Reference Books:

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 Publication

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
6. https://www.classcentral.com/course/edx-principle-of-semiconductor-devices-part-i-

   emiconductors-pn-junctions-and-bipolar-junction-transistors-11365
7. https://www.classcentral.com/csourse/swayam-semiconductor-devices-and-circuits-19997
8. https://www.vlab.co.in/broad-area-physical-sciences
9. https://storage.googleapis.com/uniquecourses/online.html

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