Semester	**VI**
Course	**Major**
Paper Code	
Paper Title	**Atomic and Molecular Physics & Electronics III**
No. of Credits	**4**
Theory / Practical / Composite	**Theory**
Minimum No. of preparatory hours per week a student has to devote	4
Number of Modules	2
Syllabus	**Module A - Atomic and Molecular Physics [24 L]** Brief review of the hydrogen atom: energy levels and quantum numbers **Atoms in Electric & Magnetic Fields:** Electron angular momentum. Space quantization. Electron Spin and Spin Angular Momentum. Larmor's Theorem. Spin Magnetic Moment. Stern-Gerlach Experiment. Basic Stark effect; selection rules (statement & simple illustrative examples). **[10 Lectures]** **Multi-Electron Atoms and Angular Momentum Coupling:** Spectrum of alkali atoms; Pauli exclusion principle, Symmetric and Anti-symmetric wavefunctions, Singlet and Triplet structure; Hund's rule, L-S (Russell-Saunders) coupling scheme, brief note on J-J coupling; Spectroscopic symbols for simple configurations: transition rules; qualitative introduction to electron-electron interactions **[5 Lectures]** **Fine Structure and Zeeman Patterns:** Spin-orbit coupling: interaction between electron spin and orbital angular momentum, spin-orbit splitting patterns; fine structure: Landé g-factor, normal and anomalous Zeeman splitting patterns; qualitative overview of Paschen-Back (strong-field) behavior; electric dipole (E1) selection rules in term notation; brief remarks on line strengths and intensity patterns **[4 Lectures]** **Molecular Spectra of Diatomic Molecules:** Franck-Condon principle; Electronic, Vibrational and Rotational spectra of diatomic molecules; Selection rules for di-atomic transitions; Qualitative comparison of atomic vs. molecular energy scales

	(binding, vibrational, and rotational energies); Introduction to diatomic molecular structure and energy level spacing **[5 Lectures]** **Module B - Electronics III** **[24 L]** **Junctions and devices:** Charge, Electric field, potential variation across the transition region of a P N junction. Metal-semiconductor diode: Device structure and energy band diagram, Schottky effect, barrier height, ohmic contact. Field-Effect Transistors: JFET: Device structure and operation, pinch-off and saturation, I-V characteristics. MOS capacitors: Energy band diagram, accumulation, depletion and inversion mode of operation, threshold voltage, flat band voltage, capacitance-voltage characteristics, MOSFET: Device structure and operation, band diagram, I-V characteristics, Short channel effects. **[10 Lectures]** **Analog communication:** Principles and Applications: Introduction to analog communication, Signals and Spectral Analysis, Amplitude Modulation (DSB, DSB-SC, SSB), Frequency and Phase Modulation, Noise in Analog Communication, Analog Communication system blocks – basic idea of receivers, transmitters, RF amplifiers, Mixers, filters. Application in Physics and Instrumentation. **[9 Lectures]** **Digital Communication:** Introduction to digital communication, Sampling and Pulse Code Modulation (PCM), Line Coding (NRZ, RZ, Manchester) and digital communication techniques (ASK, FSK, PSK), Noise, SNR, Error Detection, Application in Physics. **[5 Lectures]**

Learning Outcomes	**Module A** **CO1: In this course, first some applications of quantum mechanics for simple systems will be dealt with. This will initiate the idea of how a theoretical framework is applicable to real life problems.** **CO2: At the last section of this course, more advanced applications of quantum mechanics will be discussed which arise in atomic physics, nuclear physics and in other areas of physics** **CO 3: Students will be able to explain spectra of di-atomic molecules and will be able to extract information regarding bond-length, anharmonicity constant, dissociation energy from the spectra.** **Module B** 1. Understanding the basics in junctions formed by metal, semiconductor and insulators. 2. Understanding how voltage dependent transistors work. 3. getting an overview of the pros and cons of MOSFET 4. Basic concepts of modulation and demodulation 5. Understanding the requirements and limitations of analog and digital modulation
Reading/Reference Lists	**Module A References** 1. D.J. Griffiths & D.F. Schroeter, Introduction to Quantum Mechanics, CUP 2. B.H. Bransden & C.J. Joachain, Physics of Atoms and Molecules, Longman 3. R. Eisberg & R. Resnick, Quantum Physics of Atoms, Molecules, Solids, Nuclei and Particles, Wiley 4. C.J. Foot, Atomic Physics, OUP Oxford. 5. P. Atkins & R. Friedman, Molecular Quantum Mechanics, OUP Oxford. 6. G. Herzberg, Molecular Spectra and Molecular Structure: I. Spectra of Diatomic Molecules, Springer US 7. P.M. Mathews & K. Venkatesan, A Textbook of Quantum Mechanics, Tata McGraw-Hill Publishing 8. H.E. White, Introduction to Atomic Spectra, McGraw-Hill book Company, Incorporated. 9. Arthur Beiser, Concepts of Modern Physics, McGraw-Hill Education (India) Pvt Limited. 10. S. Gasiorowicz, Quantum Physics, Wiley India Pvt. Limited. **Module B References:** 1. **Streetman and Banerjee** : Solid State Electronic Devices – Prentice Hall India 2. **S M Sze and Kwok K Ng**: Physics of semiconductor devices – Wiley publishers

	3. **Roddy and Coolen**: Electronic Communications, Pearson 4. **Taub and Schilling**: Principles of Communication Systems – McGraw Hill 5. **Kennedy and Davis**: Electronic Communication Systems – Tata McGraw Hill 6 **B P Lathi**: Modern Digital and Analog communication Systems - Oxford 7. **Millman and Halkias**: Integrated Electronics - McGraw-Hill	
Evaluation	CIA 30 (2 x 10 + 5 Assignment +5 Attendance) SEM Exam 70	
Paper Structure for Theory Semester Exam	For each module of 35 Marks: 15 marks from 3 mark questions (5 / 7) 20 marks from 10 mark questions (2 / 3)	