Semester	**III**
Course	**Major**
Paper Code	**C2PH230321T**
Paper Title	**Vibrations & Waves and Analog Electronics I**
No. of Credits	**4**
Theory / Practical / Composite	**Full Theory**
Minimum No. of preparatory hours per week a student has to devote	4
Number of Modules	2
Syllabus	**Module A: Vibration & Waves:** 24 Lectures **Oscillations:** SHM: Simple Harmonic Oscillations. Differential equation of SHM and its solution. Damped oscillation. Energy of oscillations. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor, Applications to series LCR circuits. **[4 Lectures]** **Coupled Oscillations:** Study of vibrations of two masses connected by springs (Matrix formalism - optional) **[2 Lectures]** **Superposition of Collinear Harmonic oscillations :** Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences. **Superposition of two perpendicular Harmonic Oscillations :** Graphical and Analytical Methods. Lissajous Figures with equal and unequal frequency and their uses. **[5 lectures]** **Wave Motion :** Concept of waves. Plane and Spherical Waves. Longitudinal and Transverse Waves. Wave equation for Plane Progressive Waves. Particle and Wave Velocities. Pressure of a Longitudinal Wave. Energy Transport. Intensity of Wave. Logarithmic scale: Decibels **Velocity of Waves :** Velocity of Transverse Vibrations of Stretched Strings. Velocity of Longitudinal Waves in a Fluid in a Pipe. Newton's Formula for Velocity of Sound. Laplace's Correction. Doppler effect. **[7 lectures]**

	Superposition of Two Harmonic Waves : Standing (Stationary) Waves in a String: Fixed and Free Ends. Analytical Treatment. Energy of Vibrating String. **Wave packets:** Concept of wave group. Elementary idea of Fourier series. Phase and group velocities. Dispersion relationships**.** **[6 Lectures]** **Module B Electronics I Analog - (24 lectures)** Introduction to semiconductor electronics. Biasing of PN junction diode and its effect on energy band diagram. Current flow mechanism in forward and reverse biased diode. Static and Dynamic Resistance. Semiconductor diodes: Rectification, Clipper and Clamper circuits; Use of filters: Calculation of Ripple Factor and Rectification Efficiency for a C-filter. LED: applications. Breakdown mechanisms. Zener Diode: Characteristics and Voltage Regulation. **[7]** Bipolar Junction transistors: n-p-n and p-n-p Transistors. Current components in transistors. Characteristics of CB, CE, and CC Configurations. Active, Cutoff, and Saturation Regions. Current gains: α and β. Load Line analysis: DC Load line and Q-point. **[4]** Transistor Biasing and Stabilization: Fixed Bias and Voltage Divider Bias. Transistor as a 2-port Network: h-parameter Equivalent Circuit. Single-stage CE amplifier: Input and Output Impedance. Frequency response, RC coupling. Current, Voltage & Power Gains. **[5]** Feedback in Amplifiers: Effects of Positive and Negative Feedback on Input Impedance, Output Impedance, Gain, Stability, Distortion and Noise. Operational Amplifiers (Black Box approach):

	Characteristics of an Ideal and Practical Op-Amp. (IC 741) Open-loop and Closed-loop Gain, Frequency Response, CMRR, Concept of Virtual ground. Applications of Op-Amps: (1) Inverting and non-inverting amplifiers, Buffer, (2) Adder, (3) Differentiator, (4) Integrator, (5) Comparator. [6] Sinusoidal Oscillators: Barkhausen's Criterion for sustained oscillations. Hartley oscillator and Wien bridge oscillator. [2]
Learning Outcomes	**Module A Outcomes** **CO1 :** understanding the nature of free, damped, forced and coupled billion oscillations CO2: application of the superposition principle for oscillations along various directions and arising out of many correlated vibrations CO3: conceptual understanding of the PD is describing wave motion in various geometries and energy transport in wave media CO4: characterizing the properties of waves in musical instruments fluids and air and the effect of source observer motion on waves Doppler

	CO5: Learning how to analyze complex waves using Fourier series , the understanding wave packets and the relevance of dispersion relationships. **Module B Outcomes** CO1: Brief introduction to basics of semiconductor electronics, few applications of p-n junction diodes, Zener diode characteristics and application in voltage regulation CO2: Understanding of physical mechanism of current flow in BJTs; Characteristics of BJT in CB, CE and CC configurations, Load line analysis CO3: Different DC biasing configurations and understanding of the advantage(s) of one over other CO4: CE amplifier: Ac analysis using h-parameter model, Calculation of impedances and gains, Frequency response CO5: Concept of feedback in amplifiers CO6: Operational amplifiers: Concept of virtual ground, CMRR; Mathematical operations using Op-Amp CO7: Oscillators: Understanding the Barkhausen criterion for sustained oscillations and analysis of a few sinusoidal oscillators
Reading/Reference Lists	**Module A Reference Books** 1. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill 2. Optics, E. Hecht, Pearson 3. Optics, Ajoy Ghatak, 2008, Tata McGraw Hill 4. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons. 5. Principles of Optics, B.K. Mathur 6. Vibrations & Waves, A.P. French 7. Advanced Acoustics, D.P. Roy Chaudhuri 8.Oscillations and Waves Richard Fitzpatrick **Module B Reference Books:** 1. Electronic devices and circuit theory, Boylestad & Nashelsky, Pearson. 2. Integrated Electronics, J. Millman and C.C. Halkias, 1991, Tata Mc-Graw Hill. 3. Electronic fundamentals and applications, Chattopadhyay & Rakshit, New Central Book Agency. 4. Electronics: Fundamentals and Applications, J.D. Ryder, 2004, Prentice Hall.

	5. Solid State Electronic Devices, B. G. Streetman and S .K. Banerjee, 6th Edn.,2009, PHI Learning. 6. Semiconductor Devices: Physics and Technology, S.M. Sze, 2nd Ed., 2002, Wiley India.	
Evaluation	Theory CIA: 30 (2 x 10 + 5/assgn.+ 5/attn.) Semester Exam:70	
Paper Structure for Theory Semester Exam	For each module of 35 Marks: 15 Marks from 3 marks questions (5 out of 7) 20 Marks from 10 marks questions (2 out of 3)	