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6. (a) Describe the construction and working of a Thyristor with schematic diagram.
- (b) Describe latching current and holding current.
- (c) What is opto-coupler and why opto-couplers are used to 'trigger ON' power electronic devices like SCR, MOSFET and IGBT? 4+3+3

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Ex/SC/INSC/PG/CORE/TH/MI102/2025

M. Sc. (INSTRUMENTATION) EXAMINATION, 2025

(1st Year, 1st Semester)

(Analog, Digital and Power Electronics)

Time : 4 Hours

Full Marks : 80

Use separate answer scripts for each part.

PART—I

Answer *any two* questions. (CO-1)

1. Write down the characteristics of ideal and real OP-AMP. Draw an open loop differential amplifier using an OP-AMP and determine the output voltage v_o , if $A = 200000$, $R_{in} = 2 \text{ M}\Omega$, $R_o = 75 \Omega$, $v_{in1} = 2.1 \text{ mV dc}$ (non-inverting input), $v_{in2} = 2.0 \text{ mV dc}$ (inverting input) and supply voltages $= \pm 12 \text{ V}$. 3+1+3
2. What is feedback? List two types of feedback. Which type is used in linear application? The 741C OP-AMP having the following parameters ($A = 200000$, $R_i = 2 \text{ M}\Omega$, $R_o = 75 \Omega$, $R_1 = 5 \text{ Hz}$, supply voltage $= \pm 15 \text{ V}$) connected as inverting amplifier with $R_1 = 470 \Omega$, $R_F = 4.7 \text{ k}\Omega$. Calculate the values of A_F , R_{iF} and R_{oF} . 1+1+1+4
3. Define a filter. What are the advantages of active filters over the passive filters? What is an all pass filter? Design a low-pass filter at a cut-off frequency of 1 kHz with a pass band gain of 2. 1+2+1+3

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4. What is the slew rate? List the causes of slew rate. Draw a voltage follower circuit and derive the slew rate equation for a voltage follower with $v_{in} = V_p \sin \omega t$. 1+2+2+2

Answer *any two* questions. (CO-2)

5. According to Kronig-Penney model explain the formation of band in solid. Define and differentiate between direct and indirect band gap semiconductors with the help of energy band diagrams. 4+3
6. Find the expression of depletion width of a p-n junction diode. Draw the band structure of a p-n junction diode in equilibrium and forward and reverse bias condition. 4+3
7. Write short notes on any two of the following : 7
Light Emitting Diode (LED), Solar Cell, Zener Diode

Answer *any two* questions. (CO-3)

8. Discuss briefly about the construction of MOSFET. How does enhancement type MOSFET work? Draw the output characteristics of it. 2+2+2
9. Compare among the CB, CC and CE mode of transistor biasing. What are self-bias and fixed bias (Explain with circuit diagram) configuration? 3+3
10. Describe the structure and operation of n-channel FET. Describe the drain characteristics of n-channel FET. 3+3

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PART—II

GROUP—A

(CO-4)

1. If $(1012)_3 = (112)_R$, then find the value of R. Construct a full adder using two half adder. What is the condition of JK flip-flop to work as D flip-flop? 3+4+3
2. Draw the circuit diagram of a 4-bit Serial-in-Parallel-out shift register using circuit diagram. Explain the working of a 4-bit synchronous counter. 4+6
3. A 10-bit DAC has a step size of 10 mV. Determine the full-scale output voltage and the percentage resolution. Explain the working of R-2R Ladder type DAC. What is the advantage of R-2R ladder DAC over weighted register type DAC? 3+5+2

GROUP—B

(CO-5)

4. (a) Describe with schematic circuit the working of a H-Bridge type DC to DC converter.
(b) Write down at least four applications of pulsed power. 8+2
5. In an electric circuit a load consisting of inductance of 20 m Henry in series with a resistance of 10 Ohm is connected to an AC source of 240 Volts 50 Hz AC.
(a) Calculate the current and power factor of the circuit.
(b) What will be the capacitance value of capacitor to be connected in parallel to the existing load to make the power factor of the circuit unity? 6+4

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