(Affiliated to University of Mumbai)	***End Semester Examination (R-24) FH 2026***
Branch: ECS/EXTC	Course: Linear Integrated Circuits
Year/ Semester: SE / IV	Course code: ECC403/ ETC403
Time: 03 hours	Marks: 80

Note: 1. All questions are compulsory. 2. Figures to right indicate full marks. 3. Assume suitable data wherever necessary.		Marks	CO	BL
Q. 1	Attempt any FOUR. (All questions carry equal marks)	**20**		
A.	Draw the typical Block diagram of op-amp and explain in detail. • Block diagram = 2 marks • Explanation = 3 marks	05	CO1	L1
B.	Design a first order Butterworth high pass filter for cut off frequency of 1 kHz and pass-band gain of AF=2. Given: fc = 1 kHz, Af = 2 For 2nd order HPF: $f_c = \frac{1}{2\pi RC}$ Assume C = 0.01 µF $R = \frac{1}{2\pi(1000)(0.01 \times 10^{-6})} \approx 15.9k\Omega$ Gain: $A_f = 1 + \frac{R_f}{R_1} = 2 \Rightarrow R_f = R_1$ Let R_1 = 1kΩ and R_f = 1kΩ • Frequency Formula = 1 mark • R calculation = 1 mark • Gain Formula = 1 mark • R_f & R_1 values = 1 mark • Circuit Diagram = 1 mark	05	CO2	L6
C.	Explain the comparator using IC 741 and its types. Inverting comparator 2.5M	05	CO3	L2

	Non inverting comparator 2.5M			
D.	Draw functional block diagram and working of VCO IC 566. • Diagram = 1 marks • Working = 2 marks • Derivation = 1 marks • Waveforms = 1 marks	05	CO6	L1
E	Explain R-2R ladder type digital to analog converter. • Circuit diagram = 1 marks • Working = 2 marks • Advantages = 2 marks	05	CO5	L2
F	Distinguish between Inverting and Non-inverting configuration of Opamp. Each point = 1 marks At least five points	05	CO1	L4
Q.2	Attempt any FOUR. (All questions carry equal marks)	**40**		
A.	Draw the neat diagram of instrumentation amplifier using operational amplifier and Derive equation of output voltage. • Circuit diagram = 2 marks • Explanation = 3 marks • Derivation = 3 marks • Final expression = 2 marks	10	CO2	L1,L4
B.	Design a Schmitt trigger circuit to convert 5V, 1kHz sinusoidal signal to square wave using 741IC, V_{UT} = 0.8 V, V_{LT} = −0.8 V and V_{sat} = +11V or - 11 V. Draw its transfer characteristics, input and output waveforms. Given: Input sine signal: 5 V, 1 kHz $V_{UT} = +0.8\,V$ $V_{LT} = -0.8\,V$ $V_{sat} = \pm 11\,V$	10	CO3	L6

	For a symmetrical Schmitt trigger: $V_{UT} = +\beta V_{sat}, V_{LT} = -\beta V_{sat}$ Thus, $\beta = \frac{V_{UT}}{V_{sat}} = \frac{0.8}{11} = 0.0727$ For the standard op-amp Schmitt trigger: $\beta = \frac{R_2}{R_1 + R_2}$ So, $\frac{R_2}{R_1 + R_2} = 0.0727$ $R_2 = 0.0727(R_1 + R_2)$ $0.9273R_2 = 0.0727R_1$ $\frac{R_1}{R_2} = 12.75$ Let $R_2 = 1\ k\Omega$, then $R_1 = 12.75\ k\Omega$ $\boxed{R_1 = 12.7\ k\Omega, R_2 = 1\ k\Omega}$ • Circuit diagram = 2 marks • Threshold formula = 2 marks • Calculation of resistor values = 3marks • Input and output waveforms = 2 marks • Transfer Characteristics = 1 mark			
C.	Draw and Explain Astable multivibrator. Design an astable multivibrator using IC 555 for an output frequency of 5KHz and duty cycle of 60%. Assume capacitor 0.01µF. Explanation --------3M $f = \frac{1.44}{(R_A + 2R_B)C}$ $D = \frac{R_A + R_B}{R_A + 2R_B}$	10	CO4	L5,L6

	$0.6 = \frac{R_A + R_B}{R_A + 2R_B}$ ------ 2M $f = 5 \times 10^3 = \frac{1.44}{(R_A + 2R_B)C}$ $R_B \approx 11.5\,k\Omega$ $R_A = 0.5R_B = 0.5 \times 11520 = 5760\,\Omega \approx 5.6\,k\Omega$ --2M Diagram with all calculated values -------3M			
D.	Explain analog to digital converter using successive approximation method. • Block diagram = 2 marks • Working = 4 marks • Conversion tree diagram = 2 marks • Conversion table/transfer characteristic plot = 2 mark	10	CO5	L5
E.	With the help of a functional block diagram explain the working of voltage regulator LM317 to give an output voltage variable from 6 V to 12 V to handle maximum load current of 500 mA. $V_o = 1.25\left(1+\frac{R_2}{R_1}\right) + I_{adj}R_2$ Let $R_1 = 240\,\Omega$ $I_{adj} = 100\,\mu A$ Output range: 6 V to 12 V Max load current: 500 mA Calculation of R_2 for 6V: $6 = 1.25\left(1+\frac{R_2}{240}\right) + 0.0001R_2$ $6 = 1.25 + \frac{1.25}{240}R_2 + 0.0001R_2$ $6 - 1.25 = \left(\frac{1.25}{240} + 0.0001\right)R_2$ $4.75 = (0.005208 + 0.0001)R_2$ $4.75 = 0.005308R_2$	10	CO6	L3,L5

$R_2 = 895\,\Omega$

$\boxed{R_{2(min)} = 0.895\,k\Omega}$

Calculation of R_2 for 12V:

$$12 = 1.25\left(1+\frac{R_2}{240}\right) + 0.0001R_2$$
$$12 - 1.25 = 0.005308R_2$$
$$10.75 = 0.005308R_2$$
$$R_2 = 2025\,\Omega$$
$\boxed{R_{2(max)} = 2.025\,k\Omega}$

$\boxed{R_2 = 0.895\,k\Omega \text{ to } 2.025\,k\Omega}$

Load Resistor calculation:

$$I_L = \frac{V_o}{R_L}$$

$$R_L = \frac{V_o}{I_L}$$

For minimum voltage:

$$R_L = \frac{6}{0.5} = 12\,\Omega$$

For maximum voltage:

$$R_L = \frac{12}{0.5} = 24\,\Omega$$

Load resistor:

$\boxed{R_L = 12\,\Omega \text{ to } 24\,\Omega}$

	• Output formula = 2 marks • Calculation of R_2 = 4 marks • Calculation of R_L = 4 marks			
F	Draw adder-subtractor circuit using op-amp. Derive its output expression. Adder 5M Subtractor 5M	10	CO1	L5
Q.3	Attempt any FOUR (All questions carry equal marks)	**20**		
A.	Define the following terms- i) PSRR ii) CMRR iii) Slew rate iv)Input resistance v)Input offset voltage each point carries 1M	05	CO1	L1
B.	Draw and explain the working of square wave generator using IC 741. • Circuit diagram = 2 marks • Working = 2 marks • Waveforms = 1 marks	05	CO3	L2
C	Explain the working of Wein bridge oscillator and design a Wein Bridge oscillator using opamp to oscillate at a frequency of 965 Hz. Given: $f_0 = 965\,Hz$ For Wien bridge oscillator: $f_0 = \frac{1}{2\pi RC}$ Assume: $C = 0.01\,\mu F$ Then $R = \frac{1}{2\pi f_0 C}$ $R = \frac{1}{2\pi(965)(0.01 \times 10^{-6})} = 16494\,\Omega$ $\boxed{R = 16.5\,k\Omega}$	05	CO2	L6

	$\boxed{R = 16.5\,k\Omega}$ $\boxed{C = 0.01\,\mu F}$ • Circuit diagram = 2 marks • Derivation of frequency expression = 2 marks • Calculation of resistor = 1 marks			
D	Draw and explain functional block diagram of IC 555. Diagram 2M Explanation 3M	05	CO4	L1,L5
E	What are the different types of feedback? Explain Barkhausen's criteria for an oscillator. Types of feedback 2M Barkhausen's criteria 3M	05	CO2	L2
F	Explain phase locked loop IC 565. • Detailed diagram of IC565 = 2 marks • Working = 2 marks • Waveforms = 1 marks	05	CO6	L5
	********* **All the Best**********			