MASTER OF ELECTRICAL ENGINEERING/CONTROL SYSTEM ENGINEERING 1ST YR 1ST SEMESTER EXAMINATION, 2025

SUBJECT: - ACTIVE CIRCUITS & SYSTEMS

Time: Three hours   Full Marks: 100

Use separate sheets for each part

PART I (50)

No of questions	Answer question 1 and any two from the rest:	
	Answer any four questions:	
1.	a) Explain why automatic gain control feature is used in oscillator.	
	b) Explain how a tunned Hartley and Colpitt oscillator can be converted to voltage controll3d oscillator	
	c) How the performance of Wein-bridge oscillator is analyzed using S plane root locus plot.	
	d) Compare the characteristics of Butterworth and Chebyshev filter transfer function	
	e) What are the advantages of state variable filter	
	f) Explain the advantages of Shallen & Key circuit in realization active filter.	4X5=20
2.	a) Realize a three phase R-C phase shift oscillator using op-amp and RC ladder network. Derive the expression of frequency and gain of op-amp necessary for self sustained oscillation.	
	b) Realize a universal phase comparator using inverting op-amp and sample/hold circuit. Draw the waveform and find the expression of phase comparator output.	
	c) Explain how voltage controlled oscillator can be built using switched integrator circuit.	5+5+5
3.	a) Derive the expression of transfer function of a 2^{nd} order active filter using shallen & key circuit. Hence find out the cut-off frequency, pass band gain, Q-factor and BW in terms of passive RC components.	
		8+7

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PART I (50)

	b) Explain why filter transformation is required? Discuss the steps of transformation. What is meant by attenuation and loss function in designing active filter.	
4.	a) Prove that poles of s- domain Butterworth filter transfer function lie on unit circle locus. b) Determine the filter transfer function of Butterworth LP filter with following specification: i) -3 dB cut-off frequency=100 K rad /sec. ii) Order=2 iii) Damping factor=0.7 iv) Pass band gain=1 Realize the above transfer function using active circuit.	7+8
5.	Write short notes on any three of the following: a) Quadrature oscillator b) Voltage controlled oscillator using IC 555. c) Switched capacitor filter d) F-V convertor using diode pump circuit e) VCO using JFET.	3X5=15

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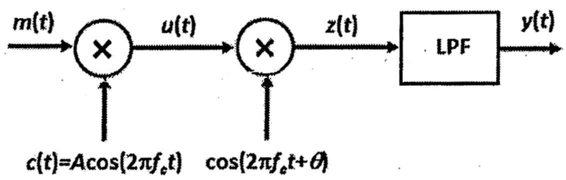
M. E. ELECTRICAL ENGG. FIRST YEAR 1ST SEMESTER EXAM, 2025
MASTER IN CONTROL SYSTEM ENGG. FIRST YEAR 1ST SEMESTER EXAM, 2025

SUBJECT: - ACTIVE CIRCUITS AND SYSTEMS

Time: Three hours | Full Marks 100

No. of Questions	PART II (50 Marks)	Marks
	Answer ALL questions.	
1.	Answer ***ANY TWO*** questions: (CO1-K1,K2)	10×02 =20
(a)	How can a noisy input signal produce false output changes in an op-amp based comparator? How can positive feedback be employed to eliminate this problem? How should hysteresis voltage be chosen in designing such comparators?	
(b)	Differentiate between a sample-and-hold circuit and a peak detector circuit. How does diode leakage current and shunt impedance loading hamper the performance of a basic switch-diode-capacitor combination of a peak circuit? Draw the two op-amp based circuit of peak detector and explain its operation when the input voltage is monotonically increasing.	
(c)	Why and how is modulation-demodulation employed in designing isolation amplifiers? Why do the scaling factor and bias in the input-output relation of a transdiode log amplifier vary with temperature variation? How does the gain vary with frequency in a chopper stabilized amplifier?	
2.	Answer ***ANY TWO*** questions: (CO2-K2)	10×02 =20
(a)	A message signal $m(t)$ undergoes DSB-SC modulation to generate $u(t)$, followed by mixing with a locally generated sinusoid that generates $z(t)$, which is then passed through a LPF having a bandwidth equal to the bandwidth of the message signal $m(t)$, as shown in Fig. 1. The final output signal is $y(t)$. Let the powers of the signals $u(t)$ and $y(t)$ be P_u and P_y, respectively. Plot (P_y/P_u) as a function of θ, for $0 \leq \theta \leq \pi$.  Fig. 1.	

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No. of Questions	PART II	Marks
2. (b)	Prove that, with detailed mathematical derivations, a power law modulator produces a conventional DSB AM signal at its output. How can a DSB-SC modulator be designed using two power law AM modulators?	
(c)	What are the salient merits and demerits of angle modulation? For a single tone modulation in FM, how is the instantaneous frequency related to frequency deviation? In a balanced discriminator based FM demodulation circuit, how is FM to AM signal converter designed?	
3.	Justify or correct ***ANY TWO*** of the following statements with suitable reasons/derivations, in brief. (CO4-K4)	05×02 =10
(*i*)	Instrumentation amplifiers are special types of differential amplifiers used in practical applications to achieve low values of common mode rejection ratio.	
(*ii*)	In a superheterodyne AM receiver, the bandwidth of the RF amplifier is carefully designed to eliminate possible interruptions by radio stations transmitting at image frequencies.	
(*iii*)	In DSB-SC amplitude modulation one must always use a carrier frequency lower in magnitude than the highest frequency value present in the message signal.	