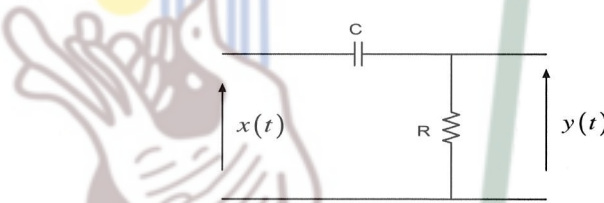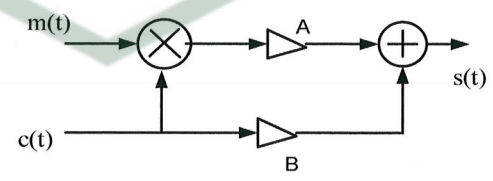**2023**

ANALOG COMMUNICATION

Full Marks: 100
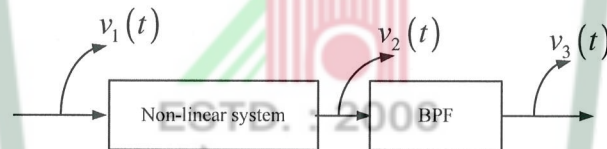
Time: Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any five** questions.*

1.	a)	$x(t) = e^{-\frac{t}{\tau}} \times u(t)$ is applied as input to an L-section high-pass RC filter with a time constant of 'τ' seconds. Find the energy spectral density (ESD) at the output of the filter. Also express the output signal energy as a percentage of the input signal energy. 	7+3
	b)	Prove that the system bandwidth (B) and rise time (t_r) are related by $t_r \cong \dfrac{0.35}{B}$; where the symbols have their usual meaning.	10
2.	a)	Discuss the operation of a ring modulator in connection with the generation of DSB-SC signal. How the circuit is capable of suppressing the effect of carrier alone?	8+2
	b)	The figure shown below is a scheme for generating a conventional AM signal. Let us choose $m(t) = \cos(2\pi \times 10^3 \times t)$ and $c(t) = \cos(2\pi \times 10^6 \times t)$. (a) Obtain an expression for the modulation index of the AM signal. (b) For a modulation index of 90% and PEP (normalized, i.e., across $1\,\Omega$) of 100 W, find the values of the amplifier gains A and B.	4+6
3.	a)	Show that Hilbert transforming an input signal is equivalent to change its output phase by ± 90 deg.	8

	b)	Derive the condition on the filter transfer function necessary to demodulate a VSB signal.	12
4.	a)	Derive the time domain representation of upper single sideband modulated suppressed carrier signal (USSB-SC)	10
	b)	Discuss the direct method of generation of WBFM (Wide Band Frequency Modulation) using reactance modulator.	10
5.	a)	Discuss the operation of a balanced discriminator. Hence, discuss the working of a Foster-Seeley discriminator.	4+10
	b)	A sinusoidal modulating signal $x(t) = A_m \cos(\omega_m t)$ is applied to a phase modulator with sensitivity 'k_P'. The un-modulated carrier has a frequency 'f_c' and amplitude 'A_c'. Determine the spectrum of the phase modulated signal, assuming that the maximum phase deviation does not exceed 0.3 rad, i.e., $\beta_P (= k_P \times A_m) \leq 0.3$.	6
6.	a)	Give the necessary theory behind the demodulation technique of FM signal using a linear phase locked loop (PLL).	10
	b)	In the figure shown below, obtain an expression for the output $v_3(t)$, when the input is $v_1(t) = 10\cos(2000\pi \times t) + 4\sin(200\pi \times t)$. Assume that the non-linearity is given by $v_2(t) = v_1(t) + 0.1 \times v_1^2(t)$ and the band-pass filter (BPF) is an ideal unity gain filter with pass-band from 800 Hz to 1200 Hz.	10

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