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Exam: Mid term (Fall 2023) — **Time:** 2 Hours

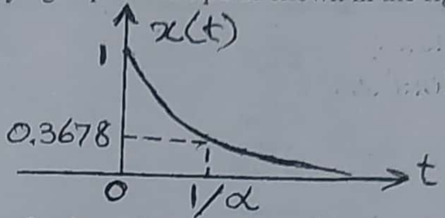
Paper: CSE-309, Communication Systems (5th Semester) — **Marks:** 80

Note: Attempt all questions on answer sheet.

Question No. 1 (Marks 10+10),(CLO-1, C4, PLO-2)

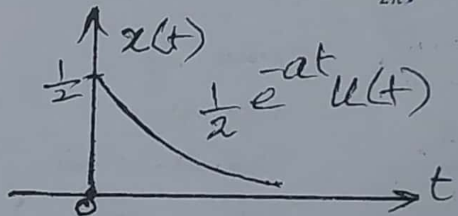
I. Obtain the Fourier transform and analyse spectrum of the RF pulse $x(t) = A\, rect\left(\frac{t}{\tau}\right) \cos \omega_c t$.

II. Find the Fourier transform of the decaying exponential pulse shown in the figure below.



Question No. 2 (Marks 10+10)

1. Determine the energy spectral density of a sinc pulse given by, $x(t) = A\, sinc\,(2Wt)$.
2. Consider the decaying exponential pulse of figure below, and sort out the percentage of total energy contained inside the essential band $-W \le f \le W$, where $W = \frac{a}{2\pi}$.



Question No. 3 (Marks 10+10), (CLO-2, C4, PLO-2)

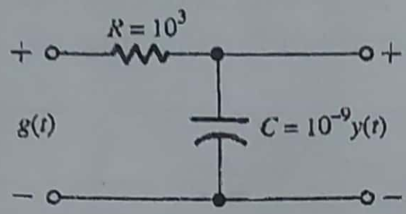
1. A sinusoidal carrier has amplitude of 10 V and frequency 30 kHz. It is amplitude modulated by a sinusoidal voltage of amplitude 3V and frequency 1 kHz. Modulated voltage is developed across 50 Ohms resistance.
   a) Write the equation for modulated wave.
   b) Plot the modulated wave showing maxima and minima of waveform.
   c) Determine the modulation index.
   d) Draw the spectrum of modulated wave.

   Analyse the same problem with modulation index greater than 1 and sort out which detection methods are not applicable.

2. An AM broadcast radio transfer radiates 10K watts of power if modulation percentage is 60. Calculate how much of this the carrier power is.

Question No. 4 (Marks 20)

Determine the maximum bandwidth of a signal that can be transmitted through the low pass RC filter in figure below with R = 1000 and C = 10^{-9} if, over this bandwidth, the amplitude response (gain) variance is to be within 5% and the time delay variation is to be within 2%.



Short Table of Fourier Transforms

$\cos\alpha \cdot \cos\beta = \dfrac{\cos(\alpha+\beta) + \cos(\alpha-\beta)}{2}$

	$g(t)$	$G(\omega)$	
1	$e^{-at}u(t)$	$\dfrac{1}{a+j\omega}$	$a>0$
2	$e^{at}u(-t)$	$\dfrac{1}{a-j\omega}$	$a>0$
3	$e^{-a\|t\|}$	$\dfrac{2a}{a^2+\omega^2}$	$a>0$
4	$te^{-at}u(t)$	$\dfrac{1}{(a+j\omega)^2}$	$a>0$
5	$t^n e^{-at}u(t)$	$\dfrac{n!}{(a+j\omega)^{n+1}}$	$a>0$
6	$\delta(t)$	1	
7	1	$2\pi\,\delta(\omega)$	
8	$e^{j\omega_0 t}$	$2\pi\delta(\omega-\omega_0)$	
9	$\cos\,\omega_0 t$	$\pi[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]$	
10	$\sin\,\omega_0 t$	$j\pi[\delta(\omega+\omega_0)-\delta(\omega-\omega_0)]$	
11	$u(t)$	$\pi\delta(\omega)+\dfrac{1}{j\omega}$	
12	$\text{sgn}\,t$	$\dfrac{2}{j\omega}$	
13	$\cos\omega_0 t\;u(t)$	$\dfrac{\pi}{2}[\delta(\omega-\omega_0)+\delta(\omega+\omega_0)]+\dfrac{j\omega}{\omega_0^2-\omega^2}$	
14	$\sin\omega_0 t\;u(t)$	$\dfrac{\pi}{2j}[\delta(\omega-\omega_0)-\delta(\omega+\omega_0)]+\dfrac{\omega_0}{\omega_0^2-\omega^2}$	
15	$e^{-at}\sin\omega_0 t\;u(t)$	$\dfrac{\omega_0}{(a+j\omega)^2+\omega_0^2}$	$a>0$
16	$e^{-at}\cos\omega_0 t\;u(t)$	$\dfrac{a+j\omega}{(a+j\omega)^2+\omega_0^2}$	$a>0$
17	$\text{rect}\left(\dfrac{t}{\tau}\right)$	$\tau\,\text{sinc}\left(\dfrac{\omega\tau}{2}\right)$	
18	$\dfrac{W}{\pi}\,\text{sinc}\,(Wt)$	$\text{rect}\left(\dfrac{\omega}{2W}\right)$	
19	$\Delta\left(\dfrac{t}{\tau}\right)$	$\dfrac{\tau}{2}\,\text{sinc}^2\left(\dfrac{\omega\tau}{4}\right)$	
20	$\dfrac{W}{2\pi}\,\text{sinc}^2\left(\dfrac{Wt}{2}\right)$	$\Delta\left(\dfrac{\omega}{2W}\right)$	
21	$\sum_{n=-\infty}^{\infty}\delta(t-nT)$	$\omega_0\sum_{n=-\infty}^{\infty}\delta(\omega-n\omega_0)$	$\omega_0=\dfrac{2\pi}{T}$
22	$e^{-t^2/2\sigma^2}$	$\sigma\sqrt{2\pi}\,e^{-\sigma^2\omega^2/2}$	