REG.NO.:

SCHOOL OF ELECTRONICS ENGINEERING

CONTINUOUS ASSESSMENT TEST - 2
WINTER SEMESTER 2025-2026

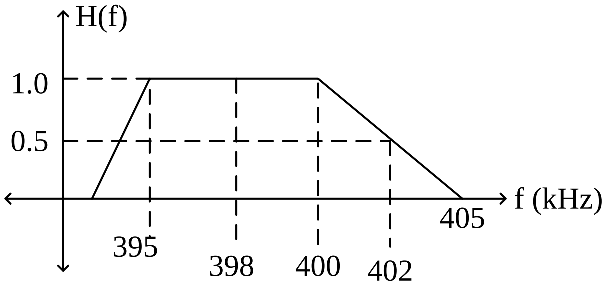
SLOT: B1+TB1

Programme Name & Branch : **B. Tech & Electronics and Communication Engineering**
Course Code and Course Name : **BECE304L - Analog Communication Systems**
Faculty Name(s) : **Dr.T. Shankar,Dr.K.V.N.Kavitha, Dr.G.Aarthi, Dr.D.Vijendra Babu, Dr. M Karthikeyan, Dr. Dilip Kumar Choudhary**
Class Number(s) : **VL2025260500748, 0763, 0767 , 0776, 0770, 0779**
Date of Examination : **16-03-2025 (2:00 PM to 3.30PM)**
Exam Duration : **90 minutes** **Maximum Marks: 50**

General instruction(s):

- **Answer All Questions**
- Assume any missing data, appropriately. Provide illustration, wherever necessary.
- **Course Outcomes (CO):**

  CO 2. Design the various amplitude modulation schemes and evaluate in terms of its power bandwidth and transmission efficiency.
  CO4 Analyze the effects of noise in various angle modulations
  CO5 Analyze the effects of noise on various angle modulation schemes

<table>
<tr><th>Q. No</th><th>Question</th><th>M</th><th>CO</th><th>BL</th></tr>
<tr><td>1.</td><td>A message signal $m(t) = 6\cos(4000\pi t) + 4\cos(18000\pi t)$ is applied to a product modulator where it is multiplied with the carrier signal $c(t) = \cos(8 \times 10^5 \pi t)$. The modulated signal is then passed through a vestigial bandpass filter, H(f) having gain characteristics shown in below figure. Determine the modulated output signal.

</td><td>10</td><td>2</td><td>3</td></tr>
<tr><td colspan="5">Message signal frequency, f_{m1} = 2 kHz,
Message signal frequency, f_{m2} = 9 kHz,
Carrier signal frequency, f_c = 400 kHz,
The output of product modulator, $x(t) = m(t).c(t)$
$$x(t) = [6\cos(4000\pi t) + 4\cos(18000\pi t)]\cos(8 \times 10^5 \pi t)$$
$$x(t) = 3\cos(f_c + 2000)t + 3\cos(f_c - 2000)t + 2\cos(f_c + 9000)t + 2\cos(f_c - 9000)t$$
Drawing the spectrum of x(t):</td></tr>
</table>

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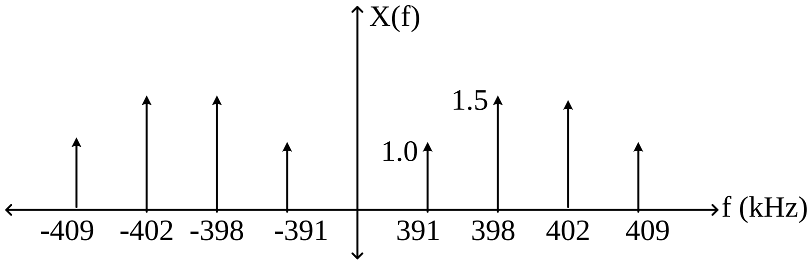
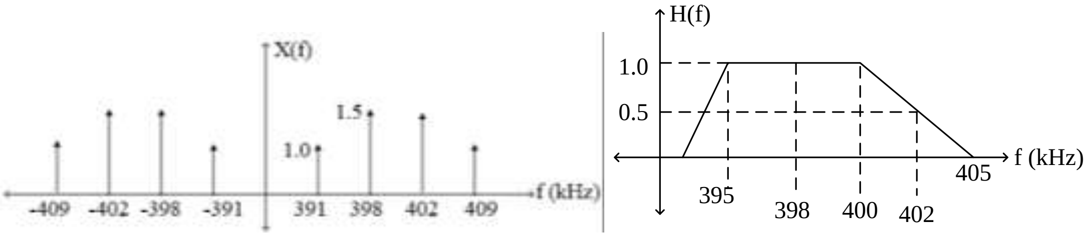
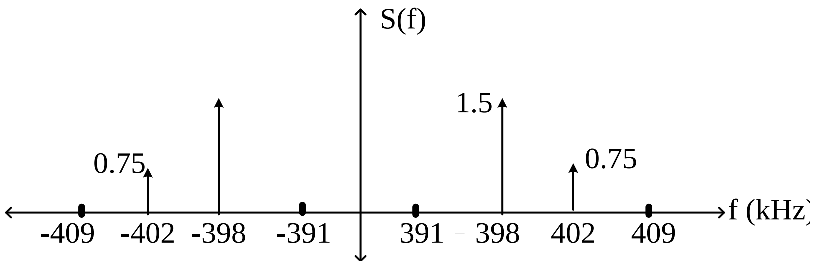


After passing through the bandpass filter, the spectrum of output becomes:





The modulated output in time domain,

$$S(t) = 1.5\cos(f_c + 2000)t + 3\cos(f_c - 2000)t$$

2.	(a) In frequency modulated (FM) signal, the maximum frequency deviation is 4 kHz and modulating signal frequency is 2 kHz. (i)Determine the bandwidth of FM signal. (ii)The modulating signal amplitude is increased by a factor of 5, and its frequency is lowered to 1kHz. Determine the maximum frequency deviation and the bandwidth of the new FM signal. (b) In a phase modulation system, when the audio frequency (AF) is 250 Hz and AF voltage is 2.4 V, the deviation is 3.6kHz. If the AF voltage is now increased to 5.2 V, what is the new deviation? If the AF voltage is further raised to 10 V while the AF is dropped to 100Hz, what is total deviation?	10	3	3

Solution 2(a):

Given Data's:

$$(\Delta f)_{max} = 4\ kHz$$
$$f_m = 2\ kHz$$

(i) $Bandwidth = 2(\Delta f_{max} + f_m) = 2(4+2)kHz = 12\ kHz$

(ii) $\Delta f = k_f A_m$

$$\because \Delta f \propto A_m$$

When signal amplitude is increased by a factor 5, Δf_{new} becomes 5 times of previous Δf.

$$\Delta f_{new} = 5 \times 4kHz = 20\ kHz$$

$$Bandwidth = 2(\Delta f_{max} + f_m) = 2(20 + 2)kHz = 44\ kHz$$

Solution 2(b):

(b) Given, f_{m1} = 250 Hz, V_{m1} = 2.4 V, $\delta_{p1} = 4.8\ kHz$.

$$k_p = \frac{\delta_{p1}}{V_{m1}} = \frac{3.6}{2.4} = 1.5\ kHz/V$$

Case-1: f_{m1} = 250 Hz, V_{m2} = 5.2 V

$$\delta_{p2} = k_p \times V_{m1} = 1.5 \times 5.2 = 7.8\ kHz$$

Case-2: f_{m1} = 100 Hz, V_{m3} = 10 V

$$\delta_{p3} = k_p \times V_{m3} = 1.5 \times 10 = 15\ kHz$$

3.	An FM transmitter operates with the following parameters: Carrier frequency fc = 100 MHz Modulating frequency fm = 10 kHz Peak frequency deviation Δf = 50 kHz The transmitter power when unmodulated is 120 W. Find: a) Modulation index β b) Carrier power c) Power in the sidebands d) Calculate the total power. e) Draw the power spectrum.	10	3	3

Solution:

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Given:

$f_c = 100\,MHz,\ f_m = 10\,kHz,\ \Delta f = 50\,kHz,\ P_T = 120\,W$

(a) Modulation Index

$\beta = \frac{\Delta f}{f_m} = \frac{50}{10} = 5$

(b) Carrier Power

$P_c = P_T J_0^2(\beta)$

$J_0(5) = -0.177$

$P_c = 120(0.177)^2 = 3.75\ W$

(c) Sideband Power

$P_n = P_T J_n^2(\beta)$

$J_1 = 0.328 \Rightarrow P_1 = 120(0.328)^2 = 12.91W$

Total $= 2P_1 = 25.82W$

$J_2 = 0.047 \Rightarrow P_2 = 120(0.047)^2 = 0.265W$

Total $= 0.53W$

$J_3 = 0.364 \Rightarrow P_3 = 120(0.364)^2 = 15.90W$

Total $= 31.80W$

$J_4 = 0.391 \Rightarrow P_4 = 120(0.391)^2 = 18.35W$

Total $= 36.70W$

$J_5 = 0.261 \Rightarrow P_5 = 120(0.261)^2 = 8.17W$

Total $= 16.34W$

(d) Total Power

$P_T = 120W$

(e) Spectrum Lines

$f_c \pm nf_m$

$100MHz \pm n(10kHz)$

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4.	An Armstrong modulator with Crystal oscillator frequency = 100 kHz and Initial deviation = ±10 Hz. The various stages in the modulator are i) Multiplier ×n1 ii) Multiplier ×n2 iii) Mixer with oscillator (difference frequency selected) The modulator is targeted to produce the final carrier frequency as 180 MHz and Δf =75 KHz. Find n1, n2, and local oscillator frequency.	10	3	3

Solution:

$$\Delta f_{final} = \Delta f_i \times n_1 n_2$$

$$75\,000 = 10 \times n_1 n_2$$

$$n_1 n_2 = 7500$$

$$n_1 = 75, \qquad n_2 = 100$$

$$n_1 n_2 = 7500$$

$$f_1 = f_c \times n_1 n_2$$

$$f_1 = 100\,\text{kHz} \times 7500$$

$$f_1 = 750\,\text{MHz}$$

Since **difference frequency is selected**

$$f_{final} = f_1 - f_{LO}$$

$$180 = 750 - f_{LO}$$

$$f_{LO} = 570\text{ MHz}$$

5.	A satellite receiving system consists of a Low Noise Amplifier (LNA) with a gain of 35 dB and a noise temperature of 80 K. The LNA is followed by a coaxial cable having a loss of 4 dB. The main receiver has a noise figure of 6 dB. Calculate the equivalent noise temperature referred to the input for the following system configurations. a) LNA → Cable → Receiver b) Cable → LNA → Receiver c) Comment on which configuration is preferred for better communication performance. Assume standard temperature T_0=290K	10	5	3

Solution:

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LNA gain

$$G_1 = 10^{35/10} = 3162$$

Cable loss

Loss $= 4\ \mathrm{dB}$

$$L = 10^{4/10} = 2.512$$

Cable gain

$$G_2 = \frac{1}{L} = 0.398$$

Noise temperature of cable

$$T_{cable} = (L-1)T_0$$

$$T_{cable} = (2.512 - 1) \times 290$$

$$T_{cable} = 438.5K$$

Receiver noise temperature

Noise figure $NF = 6\ \mathrm{dB}$

$$F = 10^{6/10} = 3.98$$

$$T_{receiver} = (F-1)T_0$$

$$T_{receiver} = (3.98 - 1) \times 290$$

$$T_{receiver} = 864.2K$$

(a) LNA → Cable → Receiver

Using the cascade noise temperature formula

$$T_{sys} = T_1 + \frac{T_2}{G_1} + \frac{T_3}{G_1 G_2}$$

Substitute values

$$T_{sys} = 80 + \frac{438.5}{3162} + \frac{864.2}{3162 \times 0.398}$$

$$T_{sys} = 80 + 0.138 + 0.686$$

$$T_{sys} \approx 80.82K$$

(b) Cable → LNA → Receiver

Now the order changes.

$$T_{sys} = T_{cable} + \frac{T_{LNA}}{G_{cable}} + \frac{T_{receiver}}{G_{cable} G_{LNA}}$$

Substitute values

$$T_{sys} = 438.5 + \frac{80}{0.398} + \frac{864.2}{0.398 \times 3162}$$

$$T_{sys} = 438.5 + 201.0 + 0.686$$

$$T_{sys} \approx 640.19K$$

The LNA → Cable → Receiver configuration is preferred because the low-noise amplifier is placed closest to the antenna, amplifying the weak signal before cable losses occur.

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