SRM Institute of Science and Technology
College of Engineering and Technology

SET-A

DEPARTMENT OF ECE

SRM Nagar, Kattankulathur – 603203, Chengalpattu District, Tamil Nadu

Academic Year: 2022-23 (Odd)

Test: CLAT-1 | **Date: 07/09/2022**
Course Code & Title: 18ECC205J–Analog and Digital Communication | **Duration: 60 Minutes**
Year & Sem: III / V | **Max. Marks: 25**

	18ECC205J - ANALOG AND DIGITAL COMMUNICATION	Program Outcomes (POs)														
		Graduate Attributes												PSO		
COs	Course Outcomes (COs)	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3
CO-1 :	Distinguish between various analog modulation and demodulation techniques	3	3	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-2 :	Demonstrate a good understanding in the working of analog radio transmitters and receivers.	3	2	-	-	-	-	-	-	-	-	-	-	2	-	-
CO-3 :	Analyze the performance of PCM, DPCM and DM in a digital communication system	3	-	-	3	-	-	-	-	-	-	-	-	-	-	3
CO-4 :	Compute Bit Error Rate performance of pass band data transmission under different shift keying techniques	3	-	-	2	-	-	-	-	-	-	-	-	-	2	-
CO-5 :	Interpret the features of various spread spectrum and error coding techniques	3	2	-	-	-	-	-	-	-	-	-	-	3	-	-
CO-6 :	Evaluate the operation of analog and digital communication systems and take measurement of various communication systems to compare experimental results in the laboratory with theoretical analysis	-	-	3	-	2	-	-	-	-	-	-	-	-	-	3

Part – A
(1 × 5 = 5 Marks)

Instructions: Answer ALL Questions.

Q. No	Question	Marks	BL	CO	PO
1	The modulation technique that uses the minimum channel bandwidth and transmitted power is _______. **Ans: SSB**	1	1	1	1
2	The modulating frequency in frequency modulation is increased from 10 kHz to 20 kHz. The bandwidth is _________. (a) doubled (b) halved (c) increased by 20 kHz (d) decreased by 20 kHz **Ans: (c) increased by 20 kHz**	1	2	1	2
3	Amplitude limiter in FM receivers are used to _________. (a) remove amplitude variations due to noise (b) filtration (c) demodulation (d) amplification **Ans: (a) remove amplitude variations due to noise**	1	2	1	1
4	A 3 GHz carrier is DSB SC modulated by a signal with maximum frequency of 2 MHz. The minimum sampling frequency required for the signal so that the signal is ideally sampled is _______. (a) 4 MHz (b) 6 MHz (c) 6 GHz (d) 6.004 GHz **Ans: (d) 6.004 GHz**	1	3	1	2
5	The process of recovering information signal from received carrier is known as _______. **Ans: detection**	1	1	1	1

Part – B
(10 × 2 = 20 Marks)

Instructions: Answer any TWO Questions.

Q. No	Question	Marks	BL	CO	PO
6	What is amplitude modulation? With the help of a message signal and a carrier signal derive the DSB-FC signal expression and phasor diagram. Also calculate		1	1	1

the total power and efficiency of the DSB-FC signal.

Sol.:

A modulation process in which amplitude of the carrier signal is varied in accordance with instantaneous value of the modulating signal is known as amplitude modulation.

1+4+1 +2+2

Representation of amplitude modulated signal:

Carrier signal is mathematically denoted as $e(t) = E_c cos\omega_c t$

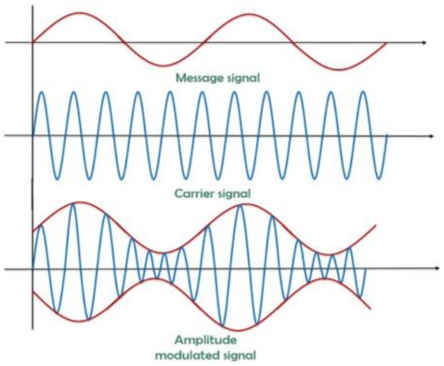
E_c = Amplitude of the carrier signal, ω_c = angular frequency of the carrier signal

Modulating signal is mathematically denoted as $f(t) = E_m cos\omega_m t$

E_m = Amplitude of the carrier signal, ω_m = angular frequency of the carrier signal (rad/sec)

After AM, Amplitude of the carrier signal, $E_c = E_c + f(t)$

$$e_{AM}(t) = [E_c + f(t)]\ cos\omega_c t\ ,\quad eAM(t) = E_c cos\omega_c t + f(t)cos\omega_c t$$



Substitute $f(t) = E_m cos\omega_m t$

$$e_{AM}(\mathrm{t}) = E_c cos\omega_c t + E_m cos\omega_m t\ cos\omega_c t$$

$$= E_c cos\omega_c t(1 + E_m/E_c cos\omega_m t\ )$$

Modulation index, $E_m/E_c = m_a$ (Ratio of modulating voltage to carrier voltage)

$e_{AM}(\mathrm{t}) = E_c cos\omega_c t(1 + m_a cos\omega_m t)$

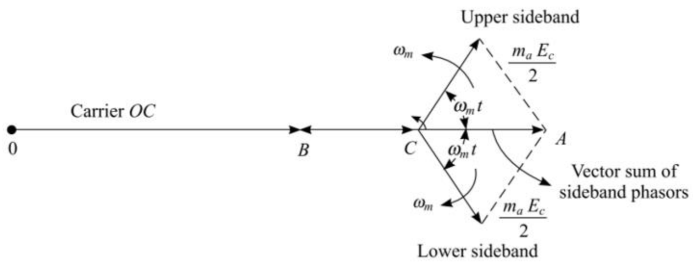
$e_{AM}(\mathrm{t}) = E_c cos\omega_c t + m_a E_c\ cos\omega_c t\ cos\omega_m t$, Apply $cosAcosB$ formula, Then,

$e_{AM}(\mathrm{t}) = E_c cos\omega_c t + m_a E_c/2\ [cos(\omega_c + \omega_m)t + cos(\omega_c - \omega_m)t]$

Carrier signal USB LSB

e_{AM}(t) = Amplitude modulated signal

Phasor diagram:



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Carrier power (Pc):

$P_C = \overline{(A\cos\omega_c t)^2} = A^2/2$ = Mean square value of the carrier signal

Side band power (P_S) $P_s = \overline{[f(t)\cos\omega_c t]^2} = \frac{1}{2\pi}\int_0^{2\pi} f^2(t)\cos^2\omega_c t\, d(\omega t)$

$$= \frac{1}{2\pi}\int_0^{2\pi} \frac{1}{2} f^2(t)[1+\cos 2\omega_c t]\, d(\omega t)$$

$$= \frac{1}{2\pi}\int_0^{2\pi} \frac{1}{2} f^2(t)\, d(\omega t) + \frac{1}{2\pi}\int_0^{2\pi} \frac{1}{2} f^2(t)\cos 2\omega_c t\, d(\omega t)$$

The second integral is filtered out by BPF centered around ω_c

$P_S = \frac{1}{2}\overline{f^2(t)} = \frac{1}{2}\overline{(E_m\cos\omega_m t)^2} = \frac{E_m^2}{4}$, $\overline{f^2(t)}$ = Mean square value of modulating signal

$P_S = P_{LSB} + P_{USB} = Em^2/4$

Total Radiated Power: $P = P_C + P_S$, $E_m/E_c = m_a$

$E_m = m_a A$

Side band power $P_S = m_a^2 A^2/4$

Total power $P = P_c + P_S$

$P = P_c + m_a^2 P_c/2$

$= P_c[1 + (m_a^2/2)]$

$P = 1.5P_c$ $m_a = 1$ for critical modulation

Efficiency:

The amount of useful message power Ps present in AM is expressed by a term called transmission efficiency denoted by Eff. It is defined as percentage of total power contributed by the sidebands.

$$Eff = \frac{\overline{f^2(t)}}{A^2 + \overline{f^2(t)}} \times 100 \qquad (Eff)_{AM} = \frac{P_s}{P}\times 100 = \frac{\frac{1}{2}\overline{f^2(t)}}{\frac{1}{2}A^2 + \frac{1}{2}\overline{f^2(t)}}\times 100 = \frac{100\overline{f^2(t)}}{A^2 + \overline{f^2(t)}}$$

$$\text{Efficiency} = \frac{\frac{Em^2}{2}}{A^2 + \frac{Em^2}{2}} \times 100$$

Dividing numerator and denominator by $A^2/2$, we get

$Eff. = m_a^2/(2 + m_a^2)$ As we know, $Em/A = ma$

$m_a = 1$, 100% modulation or critical modulation

$Eff. = (1/3) \times 100 = 33.3\%$

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(a) An AM modulated signal is given by $10\cos(2\pi\times10^6 t)$ + $5\cos(2\pi\times10^6 t)\cos(2\pi\times10^3 t)$ V. Find the various components present (carrier frequency, upper sideband and lower sideband) and modulation index. Draw the frequency spectra and find the bandwidth.

Sol: $s(t) = 10[1+5/10\cos(2\pi\times10^3 t)]\cos(2\pi\times10^6 t)$

$s(t) = 10[1+0.5\cos(2\pi\times10^3 t)]\cos(2\pi\times10^6 t)$

Here, $E_c = 10$

$\omega_1 = 2\pi\times10^3$

$\omega_c = 2\pi\times10^6$

(i) $f_c = \omega_c/2\pi = 10^6$ Hz = 1 MHz

(ii) $\omega_c + \omega_1 = (f_c + f_1)/2\pi = (2\pi\times10^6 + 2\pi\times10^3)/2\pi$
$= (10^6 + 10^3) = 1.001$ MHz

(iii) $\omega_c - \omega_1 = (f_c - f_1)/2\pi = (2\pi\times10^6 - 2\pi\times10^3)/2\pi$
$= (10^6 - 10^3) = 0.999$ MHz

(iv) $m_a = 0.5$

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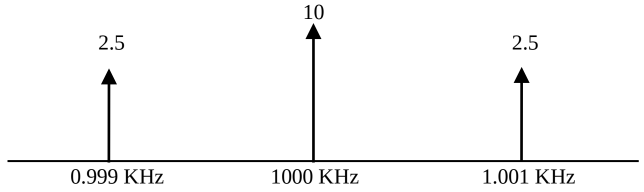
<td>(v)

(vi) $BW = 2 \times 2$ KHz = 4 KHz</td>
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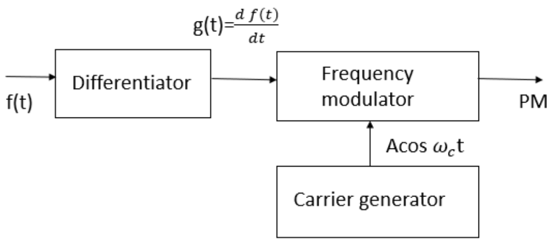
<td>(b) How a PM signal is generated from a frequency modulator. Explain using a suitable diagram.

Sol:
PM generation using Frequency modulator
</td>
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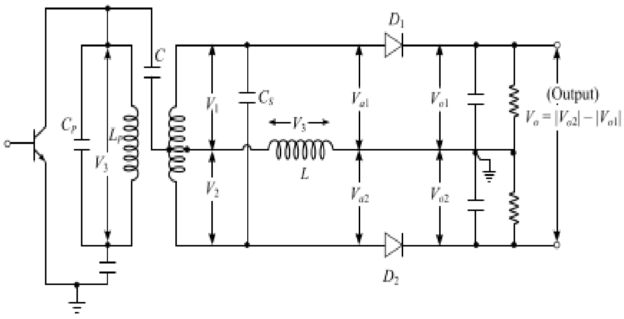
<td>(a) Draw the circuit diagram of Foster-Seeley discriminator and explain its working.

Sol.:

Operation:
• The circuit has inductively coupled doubled tuned circuit.
• The primary and secondary are tuned to the same frequency.
• Centre of secondary is connected to the collector end of primary through a capacitor C.
Functions of capacitor C:
o Blocks d.c. from primary to secondary
o Couples the primary signal frequency to center-tapping of secondary.
• The primary voltage V_3 appears across the inductance L.
• The center-tapping of the transformer has equal and opposite winding.
• Hence V_1 and V_2 are equal in magnitude but opposite in phase.
• The radio frequency voltages V_{a1} and V_{a2} applied to the diodes D_1 and D_2 are: $V_{a1} = V_3 + V_1$ and $V_{a2} = V_3 - V_2$
• Voltages $V_{a1}$and V_{a2} depend on the phasor relation between V_1, V_2, and V_3.
• The phasor position of V_1 and V_2 are always equal and are in phase opposition.
• The phase position of V_1 and V_2 relative to V_3 will depend on the tuned secondary at the resonance or off resonance.</td>
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<td>(b) An FM wave is given as $s(t) = 20\sin(6\times10^8 t + 7\sin1250t)$
Determine: the carrier and modulating frequencies, modulation index, and maximum deviation. How much power is dissipated by this FM wave in a 100 Ω resistor.

Solution : (a) The standard expression for FM is
$$s(t) = A\sin\left[\omega_c t + m_f \sin(\omega_m t)\right]$$
Given expression is
$$s(t) = 20\sin\left[6\times10^8 t + 7\sin1250t\right]$$
On comparing equations (i) and (ii), we obtain
$$f_c = \frac{\omega_c}{2\pi} = \frac{6\times10^8}{2\pi} = 95.5 \text{ MHz}$$
$$f_m = \frac{\omega_m}{2\pi} = \frac{1250}{2\pi} = 199 \text{ Hertz}$$
and $m_f = 7,\ \Delta f = m_f f_m = 7\times199 = 1393$ Hz Ans.
(ii) Power dissipated by the given FM wave in 100 ohm resistor can be calculated as
$$P = \frac{\left(\frac{A}{\sqrt{2}}\right)^2}{R} = \frac{\left(\frac{20}{\sqrt{2}}\right)^2}{100} = 2 \text{ watt.} \quad \textbf{Ans.}$$
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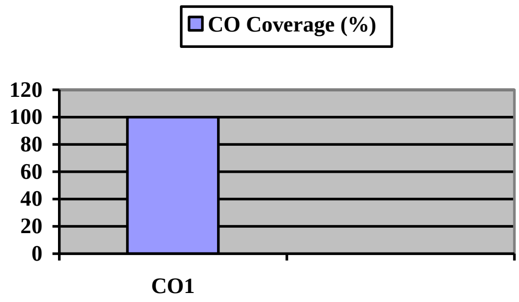
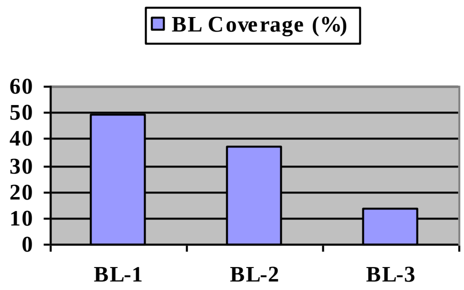
Course Outcome (CO) and Bloom's level (BL) Coverage in Questions





Evaluation Sheet

Name of the Student:

Register No.:

Part - A (1 × 5 = 5 Marks)					
Q. No.	**CO**	**PO**	**Max. Marks**	**Marks Obtained**	**Total**
1	1	1	1		
2	1	2	1		
3	1	1	1		
4	1	2	1		
5	1	1	1		
Part - B (10 × 2 = 20 Marks)					
6	1	1	10		
7(a)	1	2	6		
7(b)	1	1	4		
8(a)	1	2	5		
8(b)	1	2	5		

Consolidated Marks:

CO	Max. Marks	Marks Obtained
CO1	35	
Total	35	

PO	Max. Marks	Marks Obtained
PO1	17	
PO2	18	

Total	**35**	

Signature of the Course Teacher