Roll No. | | | | | | | | | | | |

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST 1

Sem: Odd Sem 2019-20

Course Code: ECE 210

Course Name: ANALOG COMMUNICATION

Program & Sem: B.Tech (ECE) & V

Date: 30.09.2019

Time: 11.00AM to 12.00PM

Max Marks: 40

Weightage: 20%

Instructions:

(i) *Read the question properly and answer accordingly.*
(ii) *Question paper consists of 3 parts.*
(iii) Scientific and Non-programmable calculators are permitted.

PART A [Memory Recall Question]

Answer all the Questions. Each Question carries one marks. **(5Qx1M=5M)**

1. The modulation technique that uses the minimum channel bandwidth and transmitted power is

   a. FM b. DSB-SC c. SSB d. None

2. The Bandwidth of Amplitude Modulation is __

   a. W b. W/2 c. 2W d. W/4

3. The Balance Modulator generates the ___

   a. SSB b. DSB-SC c. AM d. FM

4. The modulation need for ___

   a. frequency translation b. reduced the antenna size c. for efficient transmission d. all

5. Frequency bands of of AM are

   a. fc±fm, fc b. fc –fm c. fc +fm d. fc

PART B [Thought Provoking Questions]

Answer all the Questions. Each Question carries five marks. (3Qx5M=15M)

6. Show that a square law device is used to generate a message signal from AM wave by squaring the input signal? (C.O.NO.1)[Comprehension]

7. If the message signal has a bandwidth of W=1KHz, if it is applied to a product modulator together with a carrier wave of $A_c\cos(2\pi f_c t)$, producing the DSB-SC modulated signal s(t). The modulated signal is next appled to a coherent detector. Assuming perfect synchronization between the carrier waves in the modulator and detector. Determine the spectrum of the detector output where: (C.O.NO.1)[Application]

   i. f_c=1.25KHz   ii. f_c=0.75KHz

8. A DSB SC wave simply consists of the product of the modulating signal and carrier signal. Show that DSB wave can be generated by adding 2 such products using a Balance modulator? (C.O.NO.1)[Comprehension]

PART C [Problem Solving Questions]

Answer both the Questions. Each Question carries ten marks. **(2Qx10M =20M)**

9. a. Why QAM is named as Bandwidth Conservative Scheme.With equations, functional block diagram of QAM transmitter and receiver prove the same. [7M]
   (C.NO.1)[Comprehension]

   b. Write the time domain equation and frequency domain spectrum of SSB wave [3M]
   (C.NO.2)[Comprehension]

10. A message m(t) is used to amplitude modulate a carrier c(t) = 10 cos ($2\pi 1000t$). Assume the modulation index is 0.4 and the load resistance is 5Ω.

    a. Find the total radiated power in an AM transmission system. [5M]

    b. Find the total radiated power in a DSB-SC Transmission system [4M]

    c. Compare the results and identify which transmission system is more power efficient. [1M]

(C.O.NO.2)[Comprehension]

SCHOOL OF ENGINEERING

Semester: ODD

Course Code: ECE 210

Course Name: **Analog Communication**
Branch & Sem: ECE & 5th

Date: 30th September 2019

Time: 1 Hour

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
1	C.O.1	1/ DSB-SC	1									1
2	C.O.1	1/ AM	1									1
3	C.O.1	1/ DSB-SC Generation	1									1
4	C.O.1	1/ Need for Modulation	1									1
5	C.O.1	1/ AM	1									1
6	C.O.1	1/ Detection of AM				5						5
7	C.O.1	1/ DSB-SC							5			5
8	C.O.1	1/ DSB-SC				5						5
9.a	C.O.1	1/ QAM				7						10
9.b	C.O.2	1/ SSB				3						

10	C.O.1	1/AM,DSB-SC	1						5	4		10
	Total Marks		6			20			10	4		40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

Sign

[I hereby certify that All the questions are set as per the above guide lines. Aruna M]

Reviewers' Comments

1. Marks should be alloted evenly
2. 9(b) Full Answer not given.
3. Question paper little bit lengthy.
4. Timing should be taken care of.
5. Some more steps can be included.

Dr. M. Lavy

Annexure- II: Format of Answer Scheme

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE REACH GREATER HEIGHTS

SOLUTION

Semester: ODD

Course Code: ECE 210

Course Name: Analog Communication

Branch & Sem: ECE & 5th

Date: 30th September 2019

Time: 1 Hour

Max Marks: 40

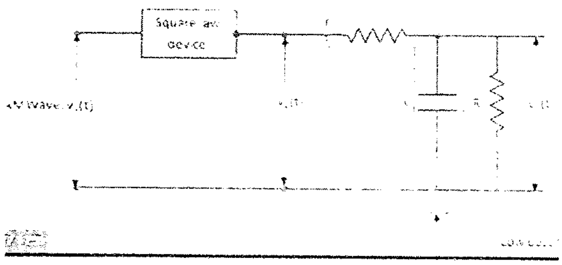
Weightage: 20%

Part A (1Q x5 M =5 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	c. SSB	1M	1 min
2	c. 2W	1M	1 min
3	b. DSB-SC	1M	1 min

4			
5	a. fc±fm, fc	1M	1 min

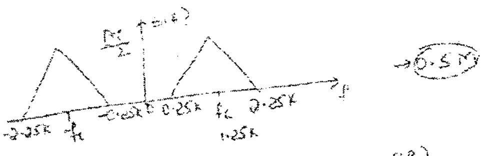
Part B (3Q x5 M = 15 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
6	 $V_2(t)=a_1 V_2(t)+ a_2V_1^2(t)$	2+3=5M	7 min

<table>
<tr><td></td><td>[illegible]

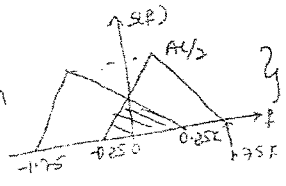
* [illegible] $a_2 A_c^2 k_a m(t)$ [illegible] the $a_2 v_1^2$ term. Hence the name of the device is square law detector.
* The desired term is extracted by using a LPF. The o/p of LPF is $\boxed{V_o(t) = a_2 A_c^2 k_a m(t)}$
Thus the message signal m(t) is recovered at the o/p of the message signal.

<u>Distortion in the detector o/p:-</u>
* The other term which pass through the LPF [illegible] it is as follows: $\frac{1}{2} a_2 A_c^2 k_a^2 m^2(t)$.</td><td></td><td></td></tr>
<tr><td>7</td><td><u>Solution</u> : ω = 1KHz, f_c = 1.25KHz
f_m = ω = 1KHz
i) f_c = 1.25KHz ; $f_c + f_m$ = 1.25K + 1K = 2.25 KHz
$f_c - f_m$ = 1.25K − 1K = 0.25 KHz
$-f_c + f_m$ = −0.25 KHz
$-f_c - f_m$ = −2.25 KHz } (2)M

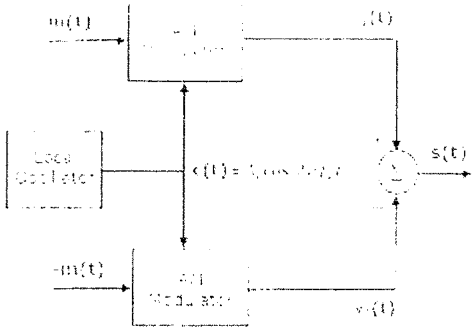


→ (0.5M)

ii) f_c = 0.75K
$f_c + f_m$ = 1.75 K
$f_c - f_m$ = −0.25 K
$-f_c + f_m$ = 0.25 K
$-f_c - f_m$ = −1.75 K } (2)M

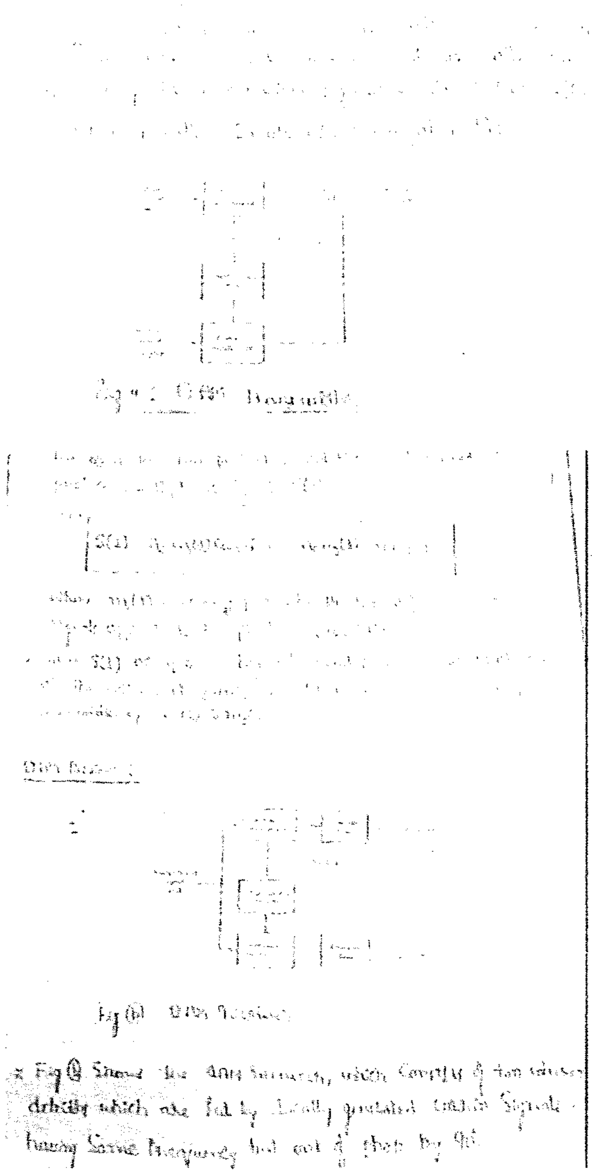


} overlapping ← 0.5M</td><td>2.5*2=5M</td><td>6 min</td></tr>
</table>

8	 $s(t) = 2 A_c k_a m(t) \cos 2\pi f_c t$ → (1) the balanced modulator o/p is equal to the product of the modulating signal m(t) & carrier c(t) except the scaling factor 2 taking Fourier transform on both side of equation (1), we get $S(f) = A_c K_a [M(f - f_c) + M(f + f_c)]$		

Part C (2Q x 10M =20 Marks)

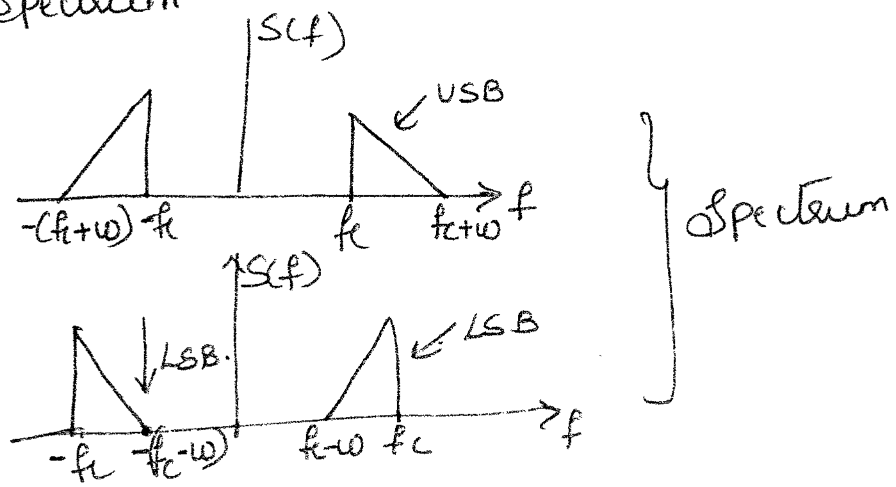
Q No	Solution	Scheme of Marking	Max. Time required for each Question

9.a		5+5=10 M	13 min
9.b.	Equation+Spectrum	1+2=3M	

SSB time domain.

$$s(t)=\left(m(t)\cos 2\pi f_c t \pm \hat{m}(t)\sin 2\pi f_c t\right)\frac{A_c}{2}.$$

Spectrum



10.	b) [illegible] c) [illegible]	5+4+1=10 M	12 min

Roll No.													

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

TEST – 2

Sem & AY: Odd Sem 2019-20
Course Code: ECE 210
Course Name: ANALOG COMMUNICATION
Program & Sem: B.Tech. (ECE) & V

Date: 18.11.2019
Time: 11.00 AM to 12.00 PM
Max Marks: 40
Weightage: 20%

Instructions:

(i) No explanation is needed in part-A
(ii) Part-B and Part-C require explanation wherever necessary.

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries one mark. (5Qx1M=5M)

1. Bandwidth required for the transmission of a FM signal ______.
(C.O.NO.3) [Knowledge]

2. Write the time domain expression for a PM signal. .
(C.O.NO.3) [Knowledge]

3. Antenna can also be used as a receiver a. True b. False
(C.O.NO.2) [Knowledge]

4. To reduce the effect of noise from image frequencies, _______ is employed in super heterodyne receivers.
(C.O.NO.2) [Knowledge]

5. In PM the ________ of information signal modulates the phase of the carrier signal.
(C.O.NO.3) [Knowledge]

Part B [Thought Provoking Questions]

Answer the Question. Each Question carries five marks. (3Qx5M=15M)

6. Explain demodulation of FM using Phase Locked Loop
(C.O.NO.3) [Comprehension]

7. Derive the time domain expression for a single tone frequency modulated signal.

(C.O.NO.3) [Comprehension]

8. Compare DSB SC, SSB & VSB

(C.O.NO.3) [Comprehension]

Part C [Problem Solving Questions]

Answer both the Questions. Each Question carries ten marks. (2Qx10M=20M)

9. With the help of a neat diagram explain the working of a super heterodyne receiver

[10M](C.O.NO.2) [Comprehension]

10. A. An FM wave is defined by $S(t)=A_c \cos[10\pi t + \sin(4\pi t)]$. Find the Instantaneous frequency of S(t) [3M](C.O.NO.3) [Application]

B. An unmodulated carrier wave has amplitude 10 volts and frequency 100MHz. A sinusoidal waveform of frequency 1 kHz, frequency modulates this carrier such that the frequency deviation is 75kHz. The modulated wave form passes through zero and is increasing at time t=0. Write the time domain expression for the modulated carrier waveform.(Hint: Sine wave is the sinusoidal waveform that passes through zero and is increasing at time t=0).

[7M](C.O.NO.3) [Comprehension]

SCHOOL OF Engineering

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: V

Course Code: ECE-210

Course Name: Analog Communication

Date: 18-11-2019

Time: 1 Hour

Max Marks: 40

Weightage: 20%

Extract of question distribution [outcome wise & level wise]

Q.NO	C.O.NO	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels			Thought provoking type [Marks allotted] Bloom's Levels			Problem Solving type [Marks allotted]			Total Marks
			K			C			A			
3,4	2	2	1	1								2
1,2,5	3	3	1	1	1							3
6,7	3	3				5	5					10
8	2	2				5						5
9	2	2	10									10
10A, B	3	3							7	3		10
	Total Marks		12	2	1	10	5		7	3		40

K =Knowledge Level C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Reviewer Comments:

1. The steps marks are not clearly mentioned.

2. Some of the answers are not clearly ~~l~~egible, and visible.

3 10 b looks like a simple problem but much mark is alloted.

[signature]

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

Annexure- II: Format of Answer Scheme

SCHOOL OF Engineering

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

SOLUTION

Date:18-11-2019

Semester: V

Time: 1 Hour

Course Code: ECE-210

Max Marks: 40

Course Name: Analog Communication

Weightage: 20

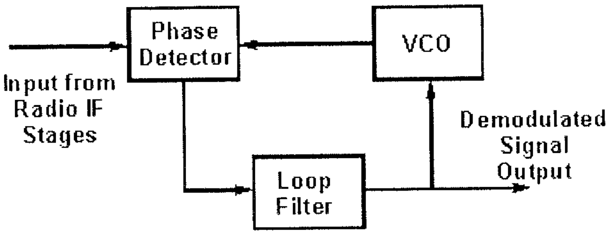
Part A (1Q x1 M = 5 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	**2Fm or 2(Δf+Fm)**	1	1m
2	**Ac Cos[2pif$_c$t+k$_p$m(t)]**	1	1m
3	**a. True**	1	1m
4	**Tuning**	1	1m
5	**amplitude**	1	1m

Part B

(3Q x5 M = 15 Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time required for each Question</th></tr>
<tr><td>6.</td><td>



</td><td>3</td><td>8 m</td></tr>
<tr><td></td><td>A commonly used FM demodulation technique is based in the PLL (Phase-locked loop). The input signal to the PLL is the one to be demodulated, and the demodulated low frequency signal appears in the output of the loop filter, which is the VCO control voltage</td><td>2</td><td></td></tr>
<tr><td>7</td><td>

Single Tone FM

$$\boxed{f_i(t) = f_c + \Delta f \cos(2\pi f_m t)} \longrightarrow (3)$$

Where, $\Delta f = K_f A_m$ & it is called as Frequency deviation

{ The quantity Δf is called the frequency deviation. The frequency deviation Δf is proportional to the amplitude of the modulating signal & is independent of the modulating frequency. }

W.K.T the angular velocity $\omega_i(t)$ is the rate of change of $\theta(t)$.

$$\omega_i(t) = \frac{d}{dt}\theta(t)$$

$$2\pi f_i(t) = \frac{d}{dt}\theta(t) \longrightarrow (4)$$

Integrating eq (4) w.r.to dt

$$\int_0^t \frac{d}{dt}\theta(t)\,dt = \int_0^t 2\pi f_i(t)\,dt$$

$$\theta(t) = \int_0^t 2\pi f_i(t)\,dt \longrightarrow (5)$$

Substituting eq (3) in eq (5)

$$\theta(t) = \int_0^t 2\pi\left[f_c + \Delta f \cos(2\pi f_m t)\right] dt$$

$$= \int_0^t 2\pi f_c\,dt + \int_0^t 2\pi \Delta f \cos(2\pi f_m t)\,dt$$

$$= 2\pi f_c t + 2\pi\Delta f \cdot \frac{\sin 2\pi f_m t}{2\pi f_m}$$

$$\theta(t) = 2\pi f_c t + \frac{\Delta f}{f_m}\sin 2\pi f_m t$$

$$\boxed{\theta(t) = 2\pi f_c t + \beta \sin(2\pi f_m t)} \longrightarrow (6)$$

W.K.T

$$\boxed{\int_0^t \cos at\,dt = \frac{\sin at}{a}}$$

Where $\beta = \frac{\Delta f}{f_m}$

</td><td>2

3</td><td>8 m</td></tr>
</table>

Q No	Solution	Scheme of Marking	Max. Time required for each Question
8	(see table below)	5	8 m

Sl No	parameter	DSB-FC Standard AM	DSB-SC	SSB	VSB
1)	Power	High	Medium	Less	Less than DSB-SC but greater than SSB
2)	Bandwidth	$2f_m$	$2f_m$	f_m	$f_m < BW < 2f_m$
3)	Carrier Suppression	NO	Yes	Yes	No
4)	Sideband Transmission	NO	NO	one Sideband Completely	one Sideband Suppressed partly
5)	Transmission efficiency	Minimum	Moderate	Maximum	Moderate
6)	Receiver	[illegible]			

Part C (2Q x10 M =20 Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
9	(see below)	5	15 m

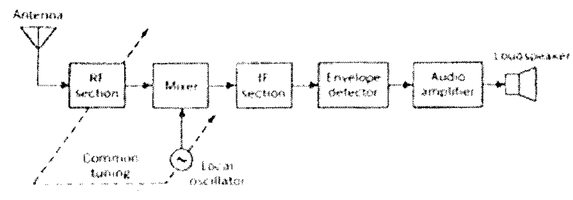


Figure
Basic elements of an AM receiver of the superheterodyne type

* The receiver consists of a Radio frequency section, Mixer, Local oscillator, Intermediate Section (IF) & a demodulator.

* The frequency parameters of commercial AM radio are:

> RF carrier range = 0.535 - 1.605 MHz
> Mid-band frequency of IF section = 455 KHz
> IF bandwidth = 10KHz

* The incoming amplitude modulated wave is picked up by the receiving antenna & amplified in the RF section. The combination of mixer & local oscillator provides a frequency conversion or heterodyning function, whereby the incoming signal is converted to a pre-determined fixed Intermediate frequency i.e.

$$f_{IF} = f_{RF} - f_{LO}$$

Where,

f_{LO} is the frequency of the local oscillator.

f_{RF} is the carrier frequency of the incoming RF signal.

* 'f_{IF}' is called Intermediate frequency (IF), because the signal is neither at the original I/p frequency nor at the final baseband frequency.

* The IF section consists of one or more stages of tuned amplifiers provides most of the amplification & selectivity in the receiver.

* The o/p of the IF section is applied to an envelope detector to recover the base band signal.

* The recovered message signal is amplified by an audio power amplifier & finally fed to loudspeaker.

* The superheterodyne operation refers to the frequency conversion from the variable carrier frequency of the incoming RF signal to the fixed IF signal.

5

10.A	❖ **An FM wave is defined by**	3	15 m

$s(t) = A_c \cos[10\pi t + \sin(4\pi t)]$

find the instantaneous frequency of $s(t)$.

Sol:-

W.K.T $f_i(t) = \frac{1}{2\pi} \frac{d}{dt} \theta(t)$ Hz &

$S(t) = A_c \cos[\theta(t)]$

$\therefore \theta(t) = 10\pi t + \sin 4\pi t$

$f_i(t) = \frac{1}{2\pi} \frac{d}{dt}[10\pi t + \sin 4\pi t]$ Hz

$= \frac{1}{2\pi}[10\pi + \cos(4\pi t) \cdot 4\pi]$ Hz

$$\boxed{f_i(t) = 5 + 2\cos(4\pi t) \text{ Hz}}$$

10.B. (Marks: 4)

$A_c = 10$ volts

$f_c = 100$ MHz $= 10^8$ Hz

$f_m = 1$ kHz $= 10^3$ Hz

[illegible]

$\beta = \frac{\text{frequency deviation}}{\text{Modulating Signal frequency}} = \frac{75}{1}$

$s(t) = 10 \sin[2\pi \times 10^8 t + 75 \sin 2\pi \times 10^3 t]$ (Marks: 3)

Roll No.													

PRESIDENCY UNIVERSITY
BENGALURU

SCHOOL OF ENGINEERING

END TERM FINAL EXAMINATION

Semester: Odd Semester: 2019-20
Date: 24 December 2019

Course Code: ECE 210
Time: 9.30 AM to 12.30 PM

Course Name: ANALOG COMMUNICATION
Max Marks: 80

Program & Sem: B.Tech (ECE) & V
Weightage: 40%

Instructions:

(i) All questions are compulsory
(ii) Non- Programmable calculators are permitted

Part A [Memory Recall Questions]

Answer all the Questions. Each Question carries 2 marks **(10Qx2M=20M)**

1.

a. Define modulation. Which are the different types of modulation? (C.O.No.1) [Knowledge]

b. Explain how antenna height can be reduced with modulation? (C.O.No.1) [Knowledge]

c. Draw the time domain waveform for an amplitude and frequency modulated sine wave. (C.O.No.2) [Knowledge]

d. Write the time domain expression for DSB-SC and SSB-SC waveform. (C.O.No.2) [Knowledge]

e. Write the expression for total transmitted power of AM wave. (C.O.No.1) [Knowledge]

f. Define pre-emphasis and de- emphasis. (C.O.No.3) [Knowledge]

g. Which are the direct and indirect methods of FM demodulation. (C.O.No.3) [Knowledge]

h. With the help of tree diagram depict the classification of pulse modulation techniques. (C.O.No.4) [Knowledge]

i. State two advantages of PWM. (C.O.No.4) [Knowledge]

j. Compare PAM, PWM and PPM in terms of noise immunity and transmission bandwidth. (C.O.No.4) [Knowledge]

Part B [Thought Provoking Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

2. A PWM signal can be generated using a comparator circuit with saw tooth signal fed to the inverting and message signal to the non-inverting terminal. Can a PPM signal be generated from PWM? Explain with the help of block diagram and necessary waveforms (C.O.No.4) [Comprehension]

3. The specified voice spectrum is 300 to 3400Hz. The sampling frequency used is 8kHz. In practice, the frequency spectrum of human voice extends much beyond the highest frequency necessary for communication. Let the input analog information signal contains 5kHz frequency component also. What would happen at the output of the sampler? How can this problem be prevented. Describe with the help of suitable spectral representations. (C.O.No.4) [Comprehension]

4. The SNR is low at high frequencies for a voice signal. This issue seriously affects systems which uses frequency modulation. In order to overcome the problem, what should be done at transmitter and receiver side of a FM system? Explain with neat diagrams. (C.O.No.3) [Comprehension]

Part C [Problem Solving Questions]

Answer all the Questions. Each Question carries 10 marks. (3Qx10M=30M)

5. A message signal m(t) = 10 cos (20πt)+cos(200πt). It is sampled by three different signals of frequency 150Hz, 200Hz and 250 Hz.

   a. Draw the spectrum of the sampled signal in all three cases. [6M] (C.O.No.4) [Comprehension]

   b. Among the three, which frequency is most suitable for sampling the given message signal and justify your reason. [2M] (C.O.No.4) [Comprehension]

   c. State the theorem for reconstructing the message signal back from its samples. [2M] (C.O.No.4) [Knowledge]

6. a. Find the Nyquist rate and Nyquist interval for the signal

$$s(t) = 10\cos(4000\pi t)\cos(1000\pi t).$$

   [5M] (C.O.No.4) [Comprehension]

   b. Show mathematically coherent detection is essential for DSB-SC signal.

   [5M] (C.O.No.1) [Comprehension]

7. Amplitude modulation of a carrier pulse with a message signal is termed as Pulse Amplitude Modulation (PAM). Explain with a neat block diagram and necessary waveforms the generation and detection of PAM.

   [10M] (C.O.No.4) [Comprehension]

SCHOOL OF ENGINEERING

GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

END TERM FINAL EXAMINATION

Extract of question distribution [outcome wise & level wise]

Q.NO.	C.O.NO (% age of CO)	Unit/Module Number/Unit /Module Title	Memory recall type [Marks allotted] Bloom's Levels	Thought provoking type [Marks allotted] Bloom's Levels	Problem Solving type [Marks allotted]	Total Marks
			K	C	A	
1,2,5	1	1	2,2,2			6
3,4	2	2	2,2			4
6,7	3	3	2,2			4
8,9, 10	4	4	2,2,2			6
11,12	4	4		10,10		20
13	3	3		10		10
14a,b	4	4		6,2		8
14c	4	4	2			2
15a	4	4		5		5
15b	1	1		5		5
16	4	4		10		10
	Total Marks		22	58		

K =Knowledge Level   C = Comprehension Level, A = Application Level

Note: While setting all types of questions the general guideline is that about 60%

Of the questions must be such that even a below average students must be able to attempt, About 20% of the questions must be such that only above average students must be able to attempt and finally 20% of the questions must be such that only the bright students must be able to attempt.

I hereby certify that all the questions are set as per the above guidelines.

Faculty Signature: All Q Limited to K & C Level - Problem Solving ?.

Reviewer Commend: [signature]

Format of Answer Scheme

SCHOOL OF ENGINEERING

SOLUTION

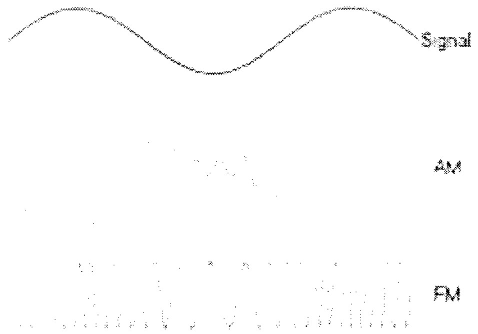
GAIN MORE KNOWLEDGE
REACH GREATER HEIGHTS

Semester: Odd Sem. 2019-20
Course Code: ECE-210
Course Name: ANALOG COMMUNICATION
Program & Sem:B TECH & V

Date: 24 December 2019
Time: 9.30 AM to 12.30 PM
Max Marks: 80
Weightage: 40%

Part A (10Q x 2M = 20Marks)

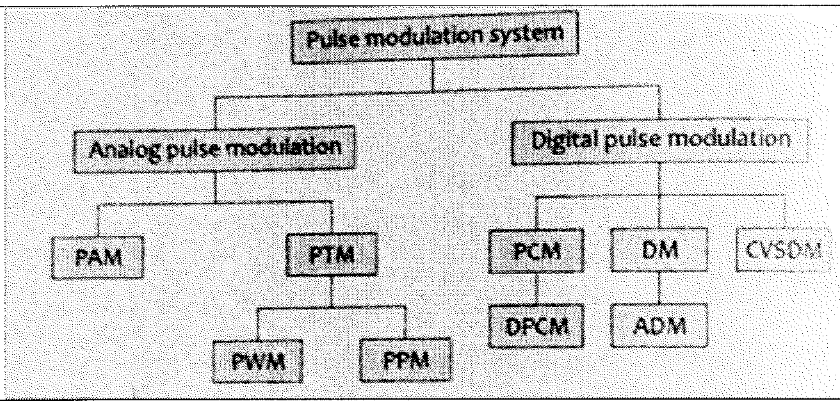
Q No	Solution	Scheme of Marking	Max. Time required for each Question
1	Modulation is the process of changing some characteristics (amplitude, frequency & phase) of a carrier wave in accordance with the instantaneous value of the modulating signal. There are 3 types of modulations: i) Amplitude modulation ii) Frequency modulation and iii) phase Modulation.	1/2 1/2	5m

2	i.e. height of antenna $= \frac{\lambda}{4} = \frac{c}{4f}$ $\quad \because \lambda = \frac{c}{f}$ Where, $\lambda = \frac{c}{f}$, $c = 3\times10^8$, velocity of light f = Transmitting frequency. ex:- i) $f = 15\,KHz$, height of antenna $= \frac{\lambda}{4} = \frac{c}{4f} = \frac{3\times10^8}{4\times15\times10^3} = 5000$ meters ii) $f = 1\,MHz$, height of antenna $= \frac{\lambda}{4} = \frac{c}{4f} = \frac{3\times10^8}{4\times1\times10^6} = 7$ meters. From above two examples it is clear that as the transmitting frequency is increased, height of the antenna is decreased.	~~1~~ ✓ 1	5m
3		1 1	5m
4	DSB-SC $S(t) = m(t)\,c(t)$ SSB-SC $S(t) = \frac{A_m A_c}{2}\cos 2\pi(f_c - f_m)t + \frac{A_m A_c}{2}\cos 2\pi(f_c + f_m)t$	1 1	5m
5	$P_t = P_c + P_{USB} + P_{LSB}$	2	5m
6	The noise suppression ability of FM decreases with the increase in the frequencies. Thus increasing the relative strength or amplitude of the high frequency components of the message signal before modulation is termed as Pre-emphasis. In the de-emphasis circuit, by reducing the amplitude level of the received high frequency signal by the same amount as the increase in pre-emphasis is termed as De-emphasis.	1 1	5m

<table>
<tr><td>7</td><td>The FM demodulators are classified into:

1.Direct method
i. Frequency discriminator
ii. Zero crossing detector.

2. Indirect method
i. Phase-Locked Loop.</td><td>1

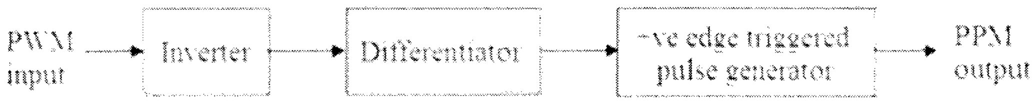
1</td><td>5m</td></tr>
<tr><td>8</td><td>
</td><td>2</td><td>5m</td></tr>
<tr><td>9</td><td>It is easier to detect.

It is very immune to noise</td><td>1

1</td><td>5m</td></tr>
<tr><td>10</td><td><table><tr><th>Parameter</th><th>PAM</th><th>PWM</th><th>PPM</th></tr><tr><td>Noise Immunity</td><td>Very less</td><td>Quite high</td><td>Quite high</td></tr><tr><td>Transmission bandwidth</td><td>Depends on width of pulse</td><td>Depends on rise time of pulse</td><td>Depends on rise time of pulse</td></tr></table></td><td>1

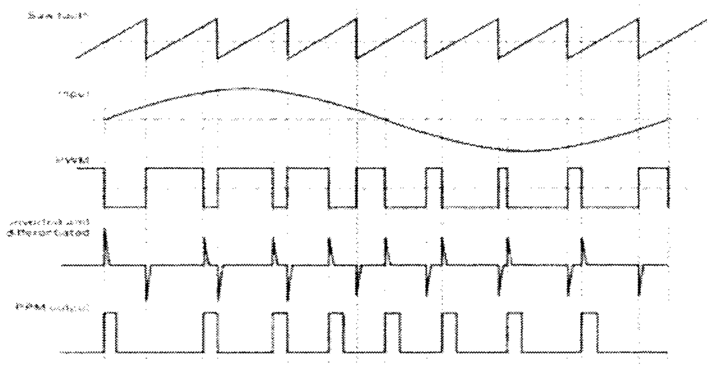
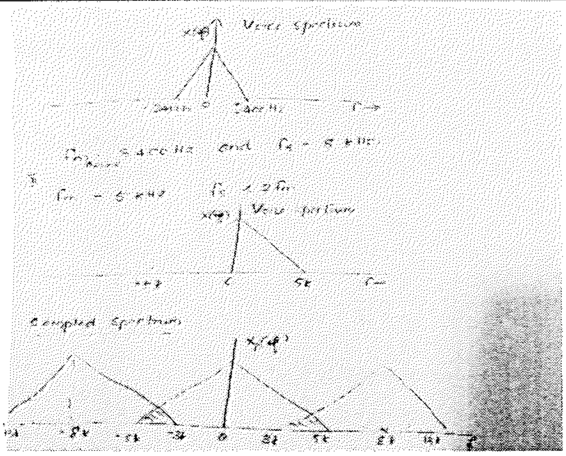
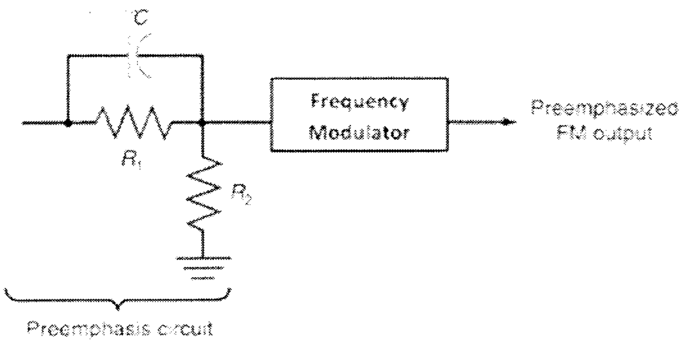
1</td><td>5m</td></tr>
</table>

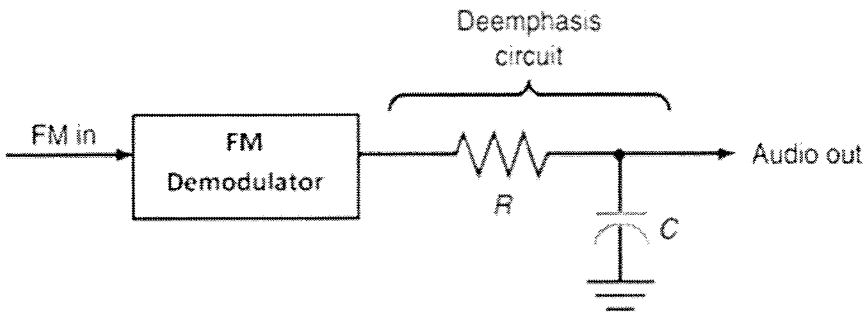
Part B (3Q x10M = 30Marks)

<table>
<tr><th>Q No</th><th>Solution</th><th>Scheme of Marking</th><th>Max. Time requir for eac Q[illegible]sti [illegible]m</th></tr>
<tr><td>11</td><td>

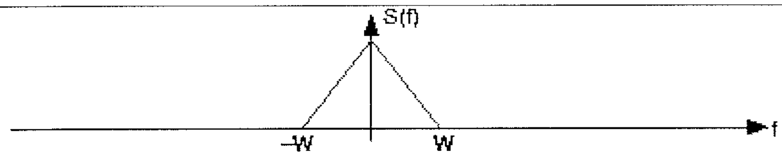
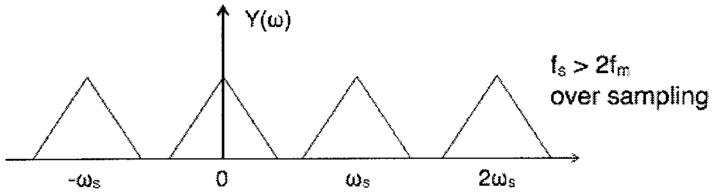
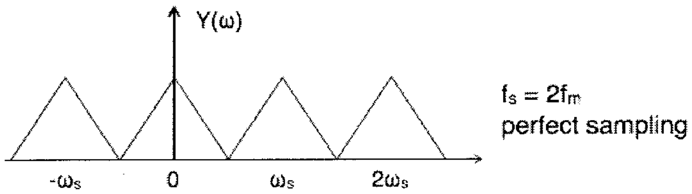
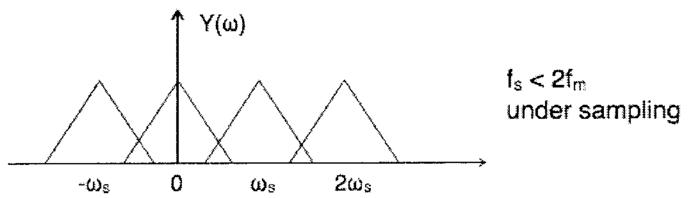
PPM generation from PWM
The PWM signal generated above is sent to an inverter which reverses the polarity of the pulses.
This is then followed by a differentiator which generates +ve spikes for PWM signal going from High to Low and -ve spikes for Low to High transistion. The spikes generated are shown in the fourth waveform of Fig8.
These spikes are then fed to the positive edge triggered pulse generator which generates fixed width pulses when a +ve spike appears, coinciding with the falling edge of the PWM signal.</td><td>3

2</td><td></td></tr>
</table>

	• Thus PPM signal is generated at the output which is shown in the fifth waveform of Fig8.where pulse position carry the message information. 	5	
12	 Due to oversampling , aliasing occurred. To overcome fs>10kHz	6 2 2	15m
13	Pre-emphasis at transmitter and De-emphasis at receiver should be done to overcome the problem Pre-emphasis: The noise suppression ability of FM decreases with the increase in the frequencies. Thus increasing the relative strength or amplitude of the high frequency components of the message signal before modulation is termed as Pre-emphasis. The Fig below shows the circuit of pre-emphasis. 	2 2 2	20m

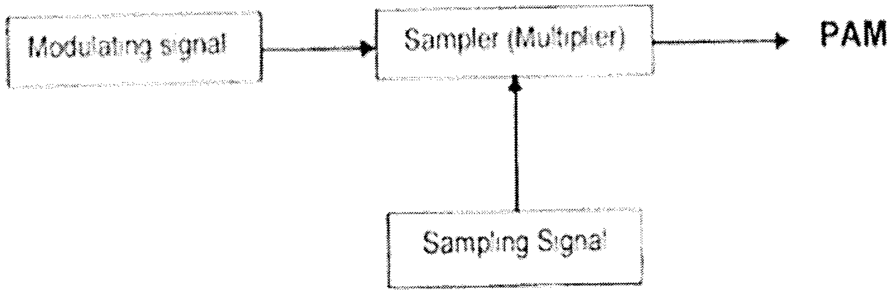
	De-emphasis: In the de-emphasis circuit, by reducing the amplitude level of the received high frequency signal by the same amount as the increase in pre-emphasis is termed as De-emphasis.	2	
		2	

Part C (3Q x 10M = 30Marks)

Q No	Solution	Scheme of Marking	Max. Time required for each Question
14a	 message spectrum Case1:undersampling,fs=150Hz Case2: perfect sampling, fs=200Hz Case3: oversampling, fs=250 Hz		10m
		2	
		2	
		2	
B	Case3: Over sampling is best suited as it is more convenient to use LPF	2	5m
C	Sampling Theorem: A band limited continuous time signal can be represented in its samples and can be recovered back when		

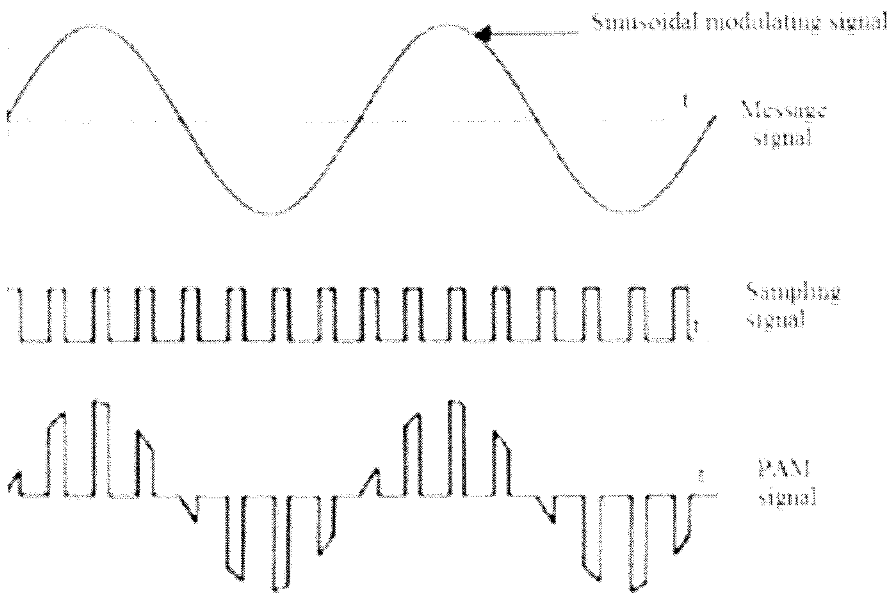
	sampling frequency f_s is greater than or equal to the twice the highest frequency component of message signal.	2	5m
15a	$s(t) = 10\cos(4000\pi t)\cos(1000\pi t)$ $= \frac{10}{2}\left(\cos[2\pi(2000+500)t] + \cos[2\pi(2000-500)t]\right)$ $= 5\cos[2\pi 2500t] + 5\cos[1500 \times 2\pi t]$ $f_m = 2500$ Hz Nyquist rate, $f_s = 2f_m = 2500$ Hz $\times 2 = 5000$ Hz Nyquist interval, $T_s = \frac{1}{f_s} = 0.2$ ms	2 2 1	10m 10m
b	* For faithful recovery of modulating signal $m(t)$, the local oscillator o/p should be exactly coherent or synchronized in both frequency and phase with the carrier wave $c(t)$ used in the product modulator to generate $V_0(t)$ with the local oscillator o/p equal to $\cos(2\pi f_c t + \phi)$. The product modulator o/p can be given as: $V(t) = S(t)\cdot\cos(2\pi f_c t + \phi) \longrightarrow (1)$ W.K.T $S(t) = A_c\cos 2\pi f_c t \cdot m(t) \longrightarrow (2)$ Substituting equation (2) in equation (1), we get $V(t) = A_c\cos(2\pi f_c t + \phi)\cos(2\pi f_c t)\cdot m(t)$ W.K.T $\boxed{\cos A\cdot\cos B = \frac{1}{2}\cos(A-B) + \frac{1}{2}\cos(A+B)}$ $V(t) = \frac{A_c m(t)}{2}\left[\cos(2\pi f_c t + \phi - 2\pi f_c t)\right] + \frac{A_c m(t)}{2}\left[\cos(2\pi f_c t + \phi + 2\pi f_c t)\right]$ $V(t) = \frac{A_c m(t)}{2}\cos\phi + \frac{A_c m(t)}{2}\cos(4\pi f_c t + \phi) \longrightarrow (3)$ { Taking Fourier transform on both sides of equation (3), we get $V(f) = \frac{A_c}{2}M(f)\cos\phi + \frac{A_c}{4}\left[M(f-2f_c) + M(f+2f_c)\right]$	2 2 1	
16	• Pulse amplitude modulation is the basic form of pulse modulation in which the signal is sampled at regular and each sample is made proportional to the amplitude of the modulating signal at the sampling instant.		15m

- The Fig shows generation of PAM signal from the sampler which has two inputs i.e. modulating signal and sampling signal or carrier pulse. 2



Generation of PAM signal

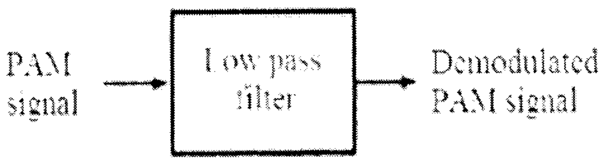
- Thus the amplitude of the signal is proportional to the modulating signal through which information is carried. This is Pulse amplitude modulation signal.
- Fig2 shows the spectrum of pulse amplitude modulated signal along with the message signal and the sampling signal which is the carrier train of pulses with the help of the waveform plotted in time domain. 3
- Pulse Modulation may be used to transmitting analog information, such as continuous speech signal or data.



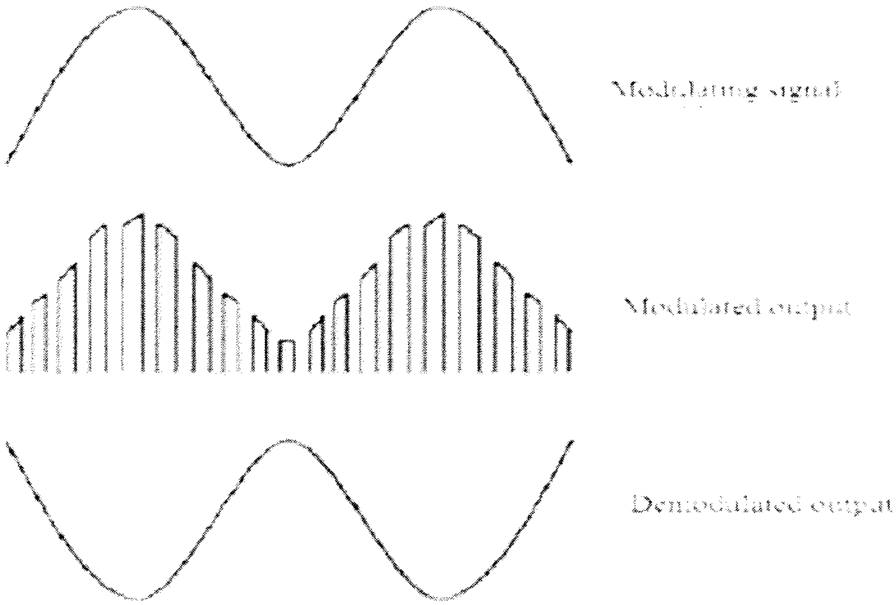
2

Demodulation of PAM

- For Demodulation of the Pulse Amplitude Modulated signal, PAM is fed to the low pass filter as shown in figure below.



PAM detector 2

	• The low pass filter eliminates high frequency ripples and generates the demodulated signal which has its amplitude proportional to PAM signal at all time instant. • This signal is then applied to an inverting amplifier to amplify its signal level to have the demodulated output with almost equal amplitude with the modulating signal.  	1	