KONGU ENGINEERING COLLEGE, PERUNDURAI 638 060

EVEN SEMESTER 2022-2023

CONTINUOUS ASSESSMENT TEST 1 - MARCH 2023

(Regulations 2020)

Programme : B.E.,/B.Tech., Branch : IT Semester: IV	Date : 07.03.2023 Time : 02:30 PM to 04:00 PM
Course Code : 20ITT41 Course Name: Principle of Communication	Duration: 1 ½ Hours Max. Marks: 50

PART - A ($10 \times 2 = 20$ Marks)

ANSWER ALL THE QUESTIONS

1. Indicate the need for modulation in communication systems. [CO1,K1]
2. Draw the pattern of AM envelope of modulated output. [CO1,K1]
3. Determine bandwidth of AM waveform if carrier frequency is 5kHz and frequency of modulating frequency is 500Hz. [CO1,K3]
4. For an AM envelope with Vmax = 30 Vp and Vmin = 10 Vp, determine percentage modulation. [CO1,K3]
5. Classify the types of amplitude modulator circuits. [CO1,K3]
6. Mention the function of super heterodyne receivers in communication systems. [CO1,K1]
7. Compare frequency modulation and phase modulation. [CO2,K2]
8. Define direct FM and indirect FM in modulation circuits. [CO2,K1]
9. Express the equation for frequency modulated signals. [CO2,K3]
10. Determine peak frequency deviation (Δf) for an FM modulator with a deviation sensitivity $K_1 = 5$ kHz/V and modulating signal $v_m(t) = 2\cos(2\Pi 2000t)$ [CO2,K2]

Part – B ($3 \times 10 = 30$ Marks)

ANSWER ANY THREE QUESTIONS

11. With principle of amplitude modulation and necessary diagram, derive the expression for the AM wave and draw its spectrum. (10) [CO1,K1]
12. A modulating signal of 2 cos 5000t is amplitude modulated over a carrier signal of 5 cos 20000t. Determine expression and values for modulation index, LSB and USB frequencies, bandwidth and the ratio of sideband power in the total power of AM wave. (10) [CO1,K3]
13. Discuss the operation and components of low level AM circuit with relevant circuit diagrams (10) [CO1,K2]
14. Calculate frequency of carrier signal, baseband modulating frequency, modulation index and peak phase deviation for the given phase modulated signal : (10) [CO2,K3]

    $e(t) = 40 \sin(6.28\text{x}10^6 t + 20\sin 6.283\text{x}10^3 t)$

Bloom's Taxonomy Level	Remembering (K1)	Understanding (K2)	Applying (K3)	Analysing (K4)	Evaluating (K5)	Creating (K6)
Percentage	30	23.33	46.67			

20ITT41 Principles of Communication

CA Test I

Answer key

Part_A

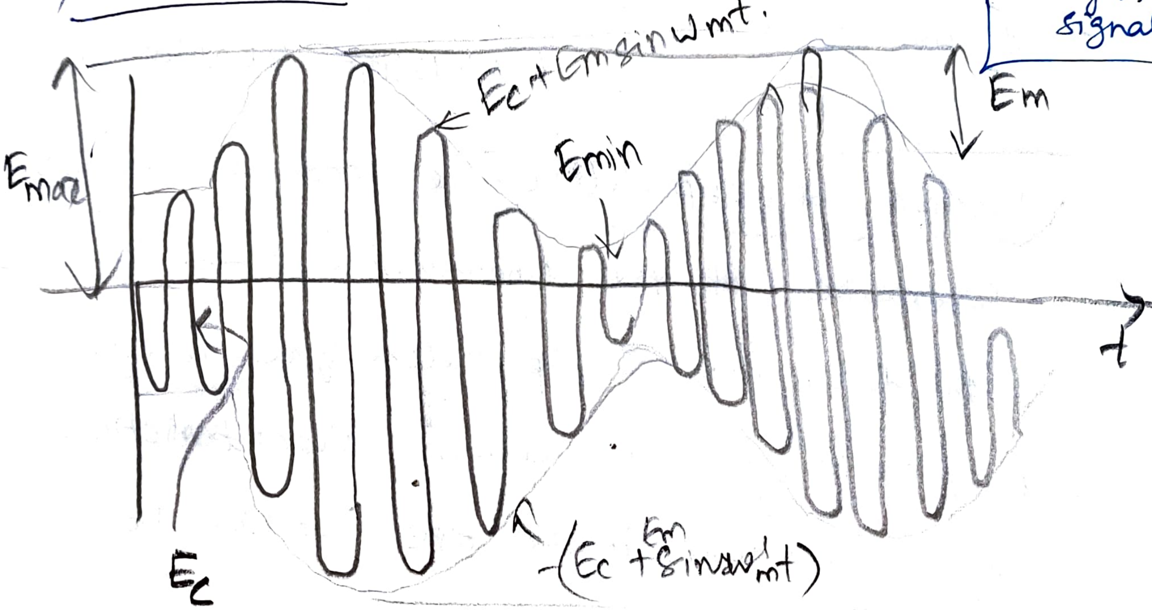
1) Need for modulation.

* practical length of antenna
* Narrow banding of signal
* Frequency multiplexing
* Effective power radiated by antenna.

(OR)

* Improves quality of reception
* multiplexing is possible
* Increases the range of comm.
* Avoids mixing of signal.

2) AM Envelope.



3) Bandwidth

$f_c = 5kHz$,

$f_m = 500 Hz$.

$B.W = (f_c + f_m) - (f_c - f_m) = 2f_m$

$= 2 \times 500$

$= 1000 Hz = \cancel{1kHz}$ 1 kHz

④ $V_{max} = 30\ V_p$

$V_{min} = 10\ V_p$.

$$\%\ \text{modulation} = \left(\frac{V_{max} - V_{min}}{V_{max} + V_{min}}\right) \times 100$$

$$= \left(\frac{30-10}{30+10}\right) \times 100 = \left(\frac{20}{40}\right) \times 100 = (0.5 \times 100) = \underline{\underline{50\%}}$$

⑤ Types of modulator circuits.

* Low Level
* medium level
* High level

(OR)

1) plate modulator
2) Grid modulator
3) Cathode modulator
4) Base modulator
5) Emitter modulator.

⑥ Function of superheterodyne receiver circuits.

The drawback of TRF is non-uniform selectivity which led to the development of superheterodyne receiver. The gain, sensitivity, and selectivity characteristics of super heterodyne receiver are superior to other receiver configurations.

Heterodyne - mixing 2 frequencies in a non-linear device

- To translate one frequency to another using non-linear mixing.

⑧

7. Frequency Modulation Vs phase modulation

Frequency modulation	Phase modulation
→ Minimum frequency deviation (change in carrier frequency) occur during +Ve and −Ve peaks of modulating signal.	→ Minimum frequency deviation occur during zero crossing of modulating signal.
* Instantaneous frequency is directly proportional to amplitude of modulating signal	* Instantaneous phase is directly proportional to amplitude of modulating signal.

8. Direct Fm: This can be achived by directly feeding the message into the input of voltage controlled osc.

Indirect Fm: The message signal is integrated to generate a phase-modulated signal.

9. Equation for Fm modulated signal,

$$V_c \cos\left[w_c t + \frac{K_1 V_m}{\omega_m} \sin(wt)\right]$$

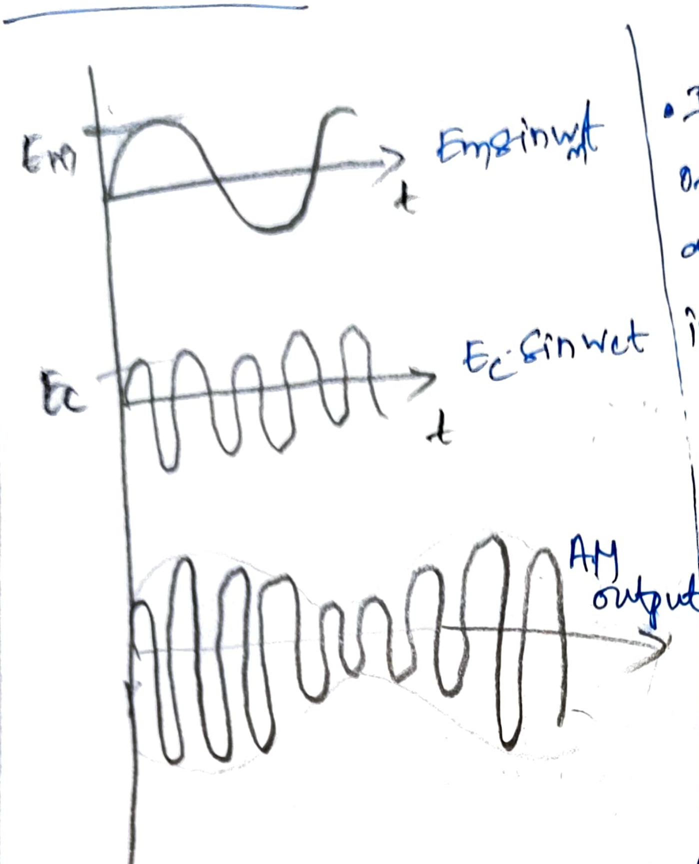
10. $K_1 = 5\,kHz/V$

$V_m(t) = 2\cos(2\pi\, 2000t)$

$$\Delta f = \underset{\substack{\downarrow\\5}}{K_1} \cdot \underset{\substack{\downarrow\\2}}{V_m} = 5 \times 2 = 10\,kHz$$

Part-B

(11) ## Am Modulation



• In Am, the amplitude of carrier is varied according to the variation in the amplitude of message signal.

Modulating signal

$e_m = E_m \sin w_m t$

carrier signal

$e_c = E_c \sin w_c t.$

From above figure and equations, we can create new mathematical expression for complete modulated wave,

$$E_{Am} = E_c + e_m$$
$$= E_c + E_m \sin w_m t$$

Instantaneous output is

$$e_{Am} = E_{Am} \sin w_c t$$
$$= (E_c + E_m \sin w_m t) \sin w_c t.$$

wkt $\sin(A) \cdot \sin B = \frac{1}{2}\cos(A-B) - \frac{1}{2}\cos(A+B)$

Hence,

$$e_{Am} = E_c \sin w_c t + \frac{mE_c}{2}\cos(w_c - w_m)t - \frac{mE_c}{2}\cos(w_c + w_m)t.$$

$$\Rightarrow E_c \sin 2\pi f_c t + \frac{mE_c}{2}\cos 2\pi(f_c - f_m)t - \frac{mE_c}{2}\cos 2\pi(f_c + f_m)t.$$

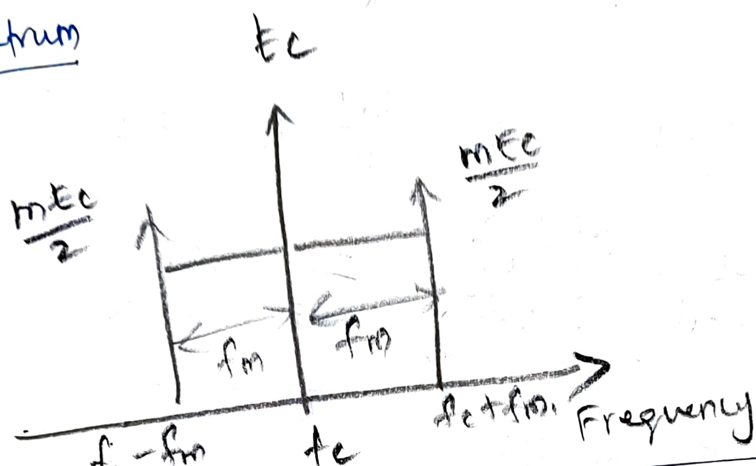
$$\Rightarrow e_{AM}(t) = E_c \sin 2\pi f_c t + \frac{mE_c}{2} \cos 2\pi f_{LSB} t + \frac{mE_c}{2} \cos 2\pi f_{USB} t.$$

Band width $= BW = f_{USB} - f_{LSB}$

$= (f_c + f_m) - (f_c - f_m)$

$= \underline{\underline{2f_m}}$

<u>spectrum</u>



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(12) <u>Solution</u>

$e_m = 2 \cos 5000t$

$e_c = 5 \cos 20000t$

$\therefore E_m = 2V, \quad E_c = 5V, \quad \omega_c = 20000$ rad/sec

$\omega_m = 5000$ rad/sec

i) modulation index

$m = \frac{E_m}{E_c} = \frac{2}{5} = 0.4.$

ii) LSB & USB frequencies

$\omega_{LSB} = \omega_c + \omega_c = 20{,}000 + 5000 = 25000$ rad/sec.

$\omega_{USB} = \omega_c - f_c = 20000 - 5000 = 15000$ rad/sec.

iii) Bandwidth $= 2\omega_m = 2 \times 5000 = 10000$ rad/sec.

(iv) side band power to the total power

$$\frac{P_{SB}}{P_{Total}} = \frac{P_{LSB} + P_{USB}}{P_{Total}}$$

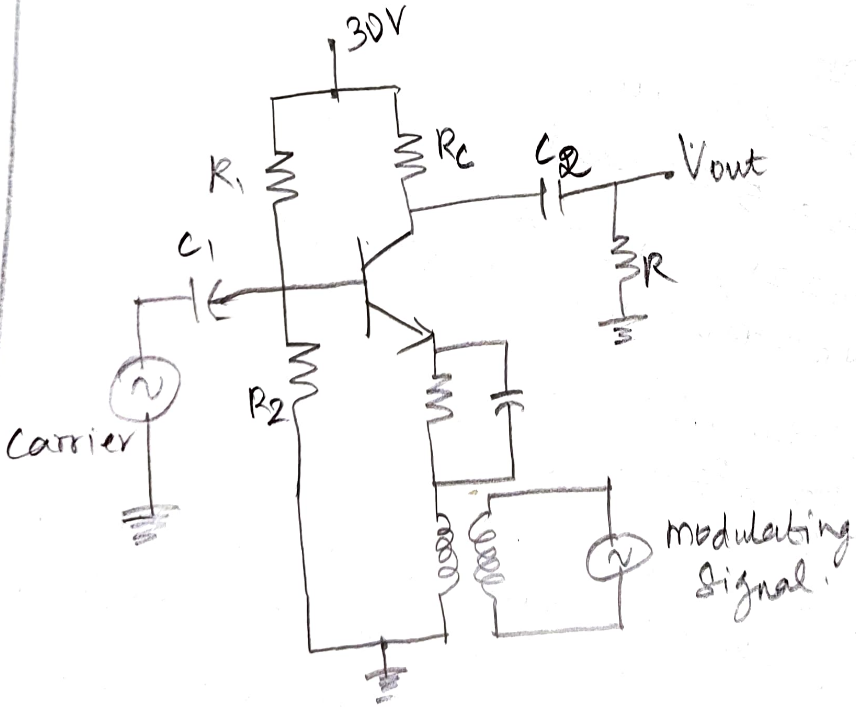
$$P_C = \frac{E_c^2}{2R} = \frac{5^2}{2R} = \frac{12.5}{R} \text{ Watts.}$$

$$P_{USB} = P_{LSB} = \frac{m^2 E_c^2}{8R} = \frac{0.4^2 \times 5^2}{8R} = \frac{0.5}{R} \text{ watts.}$$

$$P_{Total} = \frac{12.5}{R} + \frac{0.5}{R} + \frac{0.5}{R} = \frac{13.5}{R} \text{ W}, \quad P_{SB} = \frac{0.5}{R} + \frac{0.5}{R}$$

$$\text{Ratio} = \frac{P_{SB}}{P_{total}} = \frac{\left(\cancel{0.5}\ 1/R\right)}{\left(13.5/R\right)} = \frac{1}{13.5} = \underline{\underline{0.074}}$$

13) Low Level AM circuits



→ A class A amplifier can be used to perform amplitude modulation by providing two inputs one is carrier signal and the other is modulating signal.

→ The carrier is applied to the base and modulating signal to the emitter of the transistor. So this, configuration is emitter modulation.

→ The depth of modulation is proportional to the amplitude of modulating signal. The emitter modulator voltage gain is given by

$$A_v = A_q(1 + m \sin(2\pi f_m)t)$$

$$\Rightarrow A_v = A_q(1 \pm m).$$

If $m = 1$, $A_{v_{max}} = 2A_q$. $A_{v_{min}} = 0$.

(14) $e(t) = 40 \sin(6.28 \times 10^6 t + 20 \sin 6.283 \times 10^3 t)$

Sol:

$$\omega_c = 6.28 \times 10^6 \text{ rad/sec.}$$

i) Carrier frequency $= f = \frac{W}{2\pi} = \frac{6.28 \times 10^6}{2\pi}$

$$= 10^6 \text{ Hz}$$

$$= 1 \text{ MHz}$$

ii) Modulating frequency,

$$\omega_m = 6.283 \times 10^3$$

$$f_m = \frac{\omega_m}{2\pi} \; \frac{6.283 \times 10^3}{2\pi} = 1 \text{ kHz}.$$

iii) modulation index =

From eqn. $m = 20$.

iv) peak phase deviation

$$\Delta\theta = m \text{ rads} = 20 \text{ rad}$$

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