53 (IE 603) CMEN

2014

COMMUNICATION ENGINEERING

Paper : IE 603

Full Marks : 100

Time : Three hours

The figures in the margin indicate full marks for the questions.

*Answer **any 5 (five)** questions.*

1. *(a)* With relevant mathematical relations and a block diagram, explain the demodulation of DSB-SC waveform using Coherent Detector. 5

(b) A message signal $m(t)=cos(2000\pi t)+2cos(4000\pi t)$ modulates the carrier $C(t)=100cos(2\pi f_c t)$ where $f_c=1MHz$ to produce the DSB signal $m(t)c(t)$. Determine :

(i) The expression for the upper sideband (USB) signal

(ii) Sketch the spectrum of the USB signal. 4

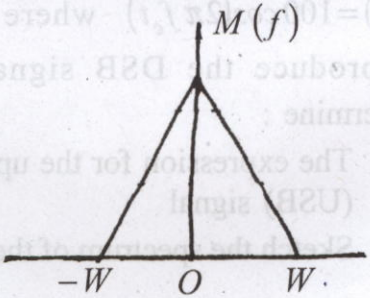
(c) Explain in brief with necessary circuit diagram, the generation of DSB-SC waveform using balanced modulator. Write the mathematical relations involved in the circuit. 6

(d) Consider a message signal $m(t)$ with the spectrum shown in the figure below. The message bandwidth $W = 1KHz$. This signal is modulated with a carrier wave $A_c \cos(2\pi f_c t)$ to produce a DSB-SC modulated signal $S(t)$. The modulated signal is next applied to a coherent detector. Assuming perfect synchronism between the carrier waves in the modulator and detector, determine the spectrum of the detector output when : 5

(i) the carrier frequency $f_c = 1 \cdot 25KHz$

(ii) the carrier frequency $f_c = 0 \cdot 75KHz$.

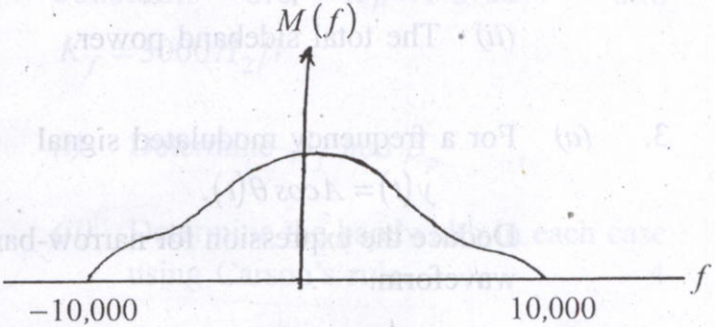
What is the lowest carrier frequency for which each component of the modulated signal $S(t)$ is uniquely determined by $m(t)$?



2. *(a)* Show that the faithful demodulation of VSB waveform is possible when the VSB filter characteristic satisfy the condition.

$$H(f-f_c)+H(f+f_c)=\text{constant}.$$ 6

(b) The signal $m(t)$ whose Fourier transform $M(f)$ is shown in the figure below, is to be transmitted from a transmitter. 5



Calculate :

(i) If USSB is employed, what is the bandwidth of the modulated signal ?

(ii) If DSB is employed, what is the bandwidth of the modulated signal ?

(iii) If an AM modulation scheme with $a = 0{\cdot}8$ is used, what is the bandwidth of the modulated signal ?

(iv) If an FM signal with $k_f = 60KHz$ is used, what is the bandwidth of the modulated signal ?

(c) Deduce that the figure of merit for amplitude modulation is equal to $\frac{ka^2P}{1+ka^2P}$ 6

(d) An AM transmitter has a carrier power of 60*watt*. The % of modulation is 80%. 3
Calculate :
(i) The total power
(ii) The total sideband power.

3. (a) For a frequency modulated signal
$y(t)=A\cos\theta(t)$.
Deduce the expression for narrow-band F.M waveform. 6

(b) The message signal $m(t)=10\sin(2\pi 40t)$ frequency modulates the carrier $C(t)=100\cos 2\pi f_c t$. The modulation index is 6.

(i) Write an expression for the modulated signal $u(t)$.

(ii) What is the maximum frequency deviation of the modulated signal ?

(iii) What is the power content of the modulated signal ? 6

(c) Draw the block diagram of super-heterodyne receiver and explain its operation in brief. 4

(d) The carrier $c(t) = A\cos\left(2\pi 10^6 t\right)$ is angle modulated (PM or FM) by the sinusoid signal $m(t) = 2\cos 2000\pi t$. The deviation constants are $K_P = 1 \cdot 5 rad/V$ and $K_f = 3000 H_2/V$

(i) Determine β_f and β_p

(ii) Determine the bandwidth in each case using Carson's rule. 4

4. (a) Prove with relevant mathematical relations that the demodulation of F.M waveform can be done by using P.L.L. 8

(b) Explain the generation of F.M waveform using varactor diode. 4

(c) What do you mean by preemphasis and De-emphasis in F.M ? 2

(d) How white noise and narroband noise effect the communication system ? 2

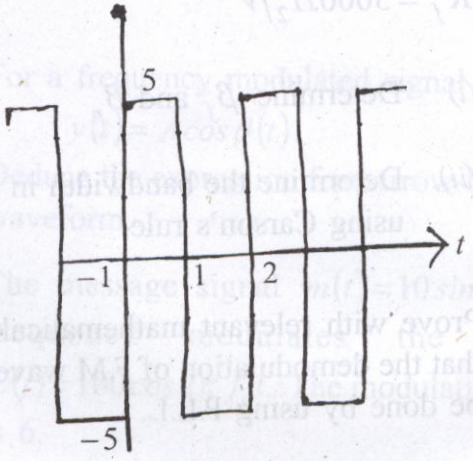
(e) An F.M signal is given as

$$u(t)=100\cos\left[2\pi f_c t+100\int_{-\alpha}^{t} m(\tau)\,d\tau\right]$$

where $m(t)$ is shown in the figure below.

(i) Sketch the instantaneous frequency as a function of time

(ii) Determine the peak-frequency deviation. 4



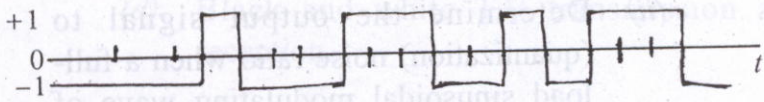
5. (a) Specify the Nyquist rate and the Nyquist interval for each of the following signals :

(i) $g(t)=sinc(200t)$

(ii) $g(t)=sinc^2(200t)$

(iii) $g(t)=sinc(200t)+sinc^2(200t)$ 5

(b) The following figure shows a PCM signal in which the amplitude levels of +1 *volt* and –1 *volt* are used to represent binary symbols 1 and 0, respectively. The code word used consists of three bits. Find the sampled version of an analog signal from which this PCM signal is derived. 4



(c) Give the data stream 1100010101, sketch the transmitted sequence of pulses for each of the following line codes : 7

(i) Unipolar NRZ

(ii) Polar NRZ

(iii) Unipolar RZ

(iv) Bipolar RZ

(v) Manchester code.

(d) What is ASK and FSK ? Write the expressions and sketch the waveforms for each of them. 4

6. *(a)* A PCM system uses a uniform quantizer followed by a 7-*bit* binary encoder. The bit rate of the system is equal to $50\times10^{6}\ b/s$.

(i) What is the maximum message bandwidth for which the system operates satisfactorily ?

(ii) Determine the output signal to (quantization) noise ratio when a full-load sinusoidal modulating wave of frequency $1MHz$ is applied to the input. 5

(b) Consider a sine wave of frequency f_m and amplitude A_m, which is applied to a delta modulator of step size Δ. Show that slope-overload distortion will occur if 4

$$A_m > \frac{\Delta}{2\pi f_m T_S}.$$

(c) Explain the process of differential Pulse Code Modulation with a block diagram. 6

(d) What do you mean by Quantization and Companding in P.C.M ? Explain in brief the μ-law compander. 5

7. Write short notes on : ***(any two)*** 10×2=20

(a) Noise in F.M.

(b) Wideband F.M.

(c) Sampling and Reconstruction of an arbitrary signal

(d) Black and white T.V transmission and reception.