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Paper Code : EC401 Analog Communication

UPID : 004451

Time Allotted : 3 Hours

Full Marks : 70

The Figures in the margin indicate full marks.

Candidate are required to give their answers in their own words as far as practicable

## Group-A (Very Short Answer Type Question)

1. Answer any ten of the following :

[ 1 x 10 = 10 ]

- (I) An Amplifier generating no noise should have a Noise Figure of \_\_\_\_\_
- (II) Which component is not common between a tuned radio frequency (TRF) receiver and Super-heterodyne receiver?
- (III) The FCC assigned frequency range for AM broadcasting is \_\_\_\_\_
- (IV) FM signal is a narrow band FM (NBFM), if modulation index is \_\_\_\_\_
- (V) When Gaussian noise passed through the IF amplifier, then the PDF of the output envelope is given by \_\_\_\_\_
- (VI) What is quadrature null effect in synchronous detection technique?
- (VII) What is PSD of White Noise?
- (VIII) What is the low-level carrier called that is sometimes transmitted along with the two sidebands in DSB?
- (IX) A Super heterodyne receiver with I.F of 450 kHz is tuned to a signal at 1200 kHz. Calculate the Image Frequency.
- (X) In order to get good S/N ratio at the destination, the practical FM broadcasting stations use modulation indices (i.e.,  $\beta$  values) of the order of \_\_\_\_\_
- (XI) The image channel rejection in a super heterodyne receiver comes from \_\_\_\_\_ stage only.
- (XII) In a modulation system, on doubling the modulation frequency, the modulation index gets halved while the modulating voltage needed remains unaltered. The modulation system is \_\_\_\_\_

## Group-B (Short Answer Type Question)

Answer any three of the following :

[ 5 x 3 = 15 ]

2. What are the advantages of modulation in communication systems? Explain three main reasons with proper example. [5]
3. How AM signal can be detected with Synchronous Detector. [5]  
Sketch the time and frequency domain representation of baseband, carrier, DSB-SC, DSB+C signal.
4. A diode detector has a load of 1 k $\Omega$  shunted by a 10000 pF capacitor. The diode has a forward resistance of 1  $\Omega$ . Find the maximum permissible depth of modulation, so as to avoid diagonal clipping, with modulating signal frequency 10 kHz. [5]
5. Explain the demodulation of FM signal using a Dual-Slope Detector Circuit. [5]  
(use necessary circuit diagram & graphical representation of circuit response with frequency)
6. 24 voice signals are sampled uniformly and then time division multiplexed (TDM). The sampling operation uses flat top samples with 1 $\mu$ s duration. The multiplexing operation includes provision for synchronization by adding an extra pulse of appropriate amplitude and 1 $\mu$ s duration. The highest frequency component of each voice signal is 3.4 kHz. Assuming sampling rate of 8 kHz, Calculate the spacing between successive samples of multiplexed signals. [5]

## Group-C (Long Answer Type Question)

Answer any three of the following :

[ 15 x 3 = 45 ]

7. (a) Prove that Fourier transform of  $f(t)\cos(\omega_0 t)$  is  $\frac{1}{2}[F(\omega - \omega_0) + F(\omega + \omega_0)]$ , where  $F(\omega)$  is the Fourier transform of  $f(t)$  [ 5 ]
- (b) Show that:  $\mu = (E_{\max} - E_{\min}) / (E_{\max} + E_{\min})$ , for single tone AM signal. Where,  $E_{\max}$  &  $E_{\min}$  are the max and min amplitude of the AM wave envelope. [ 5 ]
- (c) A 2 MHz carrier is amplitude modulated by a 500 Hz modulating signal to a depth of 70%. If the unmodulated carrier power is 2 kW, then calculate the power of the modulated signal. [ 5 ]
8. (a) [ 5 ]

- What is VSB? Draw the block diagram of VSB modulator and demodulator. What are the advantages of VSB over DSB and SSB? [ 5 ]
- (b) What is the function of AGC in Superheterodyne receiver? What is Delayed AGC? Why it is required? [ 5 ]
- (c) A super heterodyne receiver is designed to receive transmitted signals between 5 and 10 MHz. High-side tuning is to be used. Find the tuning range of the local oscillator (LO) for IF frequency 500 kHz. [ 5 ]
9. (a) Draw the phasor diagram of a typical AM, DSB-SC and SSB-SC signals with explanation. [ 5 ]
- (b) Draw the Spectral representation of DSB-SC, DSB-FC, SSB-SC, SSB-FC and VSB-SC signals. [ 5 ]
- (c) A certain transmitter (AM) is radiating 132kW when a certain audio sine wave is modulating it to a depth of 80% and 150kW when a second sinusoidal audio wave also modulates it simultaneously. What is the depth of modulation for the second audio wave? What is the overall % of modulation? [ 5 ]
10. (a) Show that the envelope detector output will follow the envelope if it satisfies  $RC \leq \sqrt{1-\mu^2} / (\mu\omega_m)$ , where the symbols carry their usual meaning. [ 5 ]
- (b) A diode detector load consists of 0.01 $\mu$ F capacitor in parallel with a 5Kohms resistor. Calculate the maximum depth of modulation without diagonal clipping at modulating frequency of 1000 Hz and 10 KHz. [ 5 ]
- (c) Compare the merits and demerits of Filter method of SSB-SC generation. How do you overcome the limitations of the above mentioned method? [ 5 ]
11. (a) Describe the effect of variation of modulation index,  $\beta$  on the spectrum of FM signal. [ 5 ]
- (b) Derive Carson's Rule regarding FM signal bandwidth. [ 5 ]
- (c) A modulating signal  $5 \cos 2\pi 15 \times 10^3 t$ , angle modulates a carrier  $A \cos \omega_c t$ . [ 5 ]
- (i) Find modulation index ( $\beta$ ) and bandwidth for both FM and PM signal.
- (ii) Determine the change in the bandwidth and the modulation index for both FM and PM, if  $f_m$  is reduced to 5 kHz.
- Assume:  $K_p = K_f = 15 \text{ kHz/V}$ .

\*\*\* END OF PAPER \*\*\*