

PART B — (5 × 13 = 65 marks)

11. (a) An AM signal is generated by modulating the carrier $f_c = 800$ kHz by the signal $m(t) = \sin(2000 \pi t) + 5 \cos(4000 \pi t)$. The AM signal $s(t) = 100[1 + m(t)]\cos(2\pi f_c t)$ is fed to a 50Ω load. Determine the following :
- Average power in the carrier and in the sidebands.
 - Modulation index
 - Bandwidth of the modulated signal
 - Peak power delivered to the load.
 - Carrier power if AM broadcast radio radiates 10 kW of power if modulation index is 60%.

Or

- (b) An angle-modulated signal has the form : $s(t) = 100 \cos[2\pi f_c t + 4 \sin 2\pi f_m t]$, where $f_c = 10$ MHz and $f_m = 1000$ Hz. Determine the following :
- Assuming that this is an FM signal, determine the modulation index and the transmitted-signal bandwidth.
 - Repeat part (i) if f_m is doubled.
 - Assuming that this is a PM signal, determine the modulation index and the transmitted-signal bandwidth.
 - Repeat part (iii) if f_m is doubled.

12. (a) (i) Derive the output signal-to-noise ratio of FM receiver using slope-detection and assuming that the noise is additive, white and Gaussian. (10)
- (ii) What is need for pre-emphasis and de-emphasis circuits? (3)

Or

- (b) (i) Find the Nyquist rate and the Nyquist Interval for the following signals :
- (1) $S_1(t) = \sin c(300t) + \sin c(500t)$ (4)
- (2) $S_2(t) = 2 \sin(4\pi t) \cos(2\pi t)$. (4)
- (ii) Compare and distinguish following pulse modulation schemes : PAM, PWM/PDM and PPM. (5)

13. (a) Consider a Delta Modulation (DM) system subjected to a 5 kHz sinusoidal input signal characterized by peak-to-peak amplitude of 2 V. The system operates at a sampling frequency that is tenfold the Nyquist rate, significantly oversampling the input. Based on these parameters, determine
- (i) The required step size to ensure the system does not experience slope overload. (5)
 - (ii) The resulting Signal-to-Noise Ratio (SNR) for the system under these conditions. (5)
 - (iii) How the limitations are resolved in Adaptive Delta Modulation (ADM)? (3)

Or

- (b) Explain the various noise considerations in a PCM system.

14. (a) Draw and explain the BFSK transmitter and receiver system. Also, derive its probability of error under coherent receiver. (9 + 4)

Or

- (b) Draw and explain the BPSK transmitter and receiver system. Also, derive its probability of error under coherent receiver. (9 + 4)

15. (a) Derive the probability of error for digital communication system which uses amplitude shift keying. Also write the formulae for its bandwidth requirement. (10 + 3)

Or

- (b) Explain the Nyquist's criterion for distortionless baseband binary transmission.

PART C — (1 × 15 = 15 marks)

16. (a) Design a digital Telemedicine system that uses a heart beat ECG signal sampled at the rate of 32,000 samples/sec and characterized by peak value of 2 volts. Assume bandwidth of signal is 4 kHz.

- (i) Determine the value of step size to avoid slope-overload. (7)
- (ii) What is quantization noise power N_q and corresponding SNR? (8)

Or

- (b) Develop a Mission Critical *Chandrayaan-4 Geo-synchronous Satellite* signal having a bandwidth of 4.2 MHz is transmitted using a binary PCM system. Given that the number of quantization levels is 512. Determine the following :

- (i) Code word length (4)
- (ii) Transmission bandwidth (4)
- (iii) Final bit rate (4)
- (iv) Output signal to quantization noise ratio (3)

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