RAN-2303080102040002

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M.Sc. (Sem.-II) Examination September - 2025

Physics - Electronic Communication (PH-424 Elective 1)

Time: 3 Hours] **[Total Marks: 70**

સૂચના : / Instructions

(1) ઉપરોક્ત દર્શાવેલ વિગતો ઉત્તરવહી પર અવશ્ય લખવી.
Fill up strictly the above details on your answer book

(2) Assume the data if required.

(3) Figures to right hand side indicate marks of each question.

(4) Attempt any two of each question

Seat No.:

Student's Signature

Q.1. (a) (i) What is normalized power? Obtain an expression for normalized power in a Fourier expansion. **4**

(ii) Determine the Fourier transform of the signal $v(t) = t \cos At$. **2**

(iii) Define cumulative distribution function and probability density function. **3**

(b) (i) Find the autocorrelation function of the signal $v(t) = \sum_{n=-\infty}^{n=\infty} V_n \exp(j2\pi nt/T_0)$ **2**

(ii) Discuss the effect of transfer function on the power spectral density and derive the relation between the input power spectral density and the output power spectral density. **4**

(iii) If $v(t) = \sin\omega_0 t$, Find $R(\tau)$. **3**

(c) (i) Find the Fourier transform of $v(t)=m(t)\cos 2\pi f_c t$. Where $m(t)=m \cos 2\pi f_m t$ **2**

(ii) Define the convolution integral. Write its properties and prove all the properties. **5**

(iii) Define the conditional probability. **2**

Q.2. (a) (i) Describe the techniques for generation of SSB signals. **5**

(ii) The total power content of an AM wave is 600 W. Determine the percent modulation of the signal if each of the sidebands contains 75 W. **2**

(iii) A signal $V_m(t)$ is bandlimited to the frequency range 0 to f_m. It is frequency translated by multiplying it by the signal $V_c(t) = \cos 2\pi f_c t$. Find f_c so that the bandwidth of the translated signal is 5% of the frequency f_c. **2**

(b) (i) Explain the central limit theorem. **3**

(ii) Explain the following methods for demodulation of AM signals. **6**
(1) Rectifier detector
(2) Envelope detector

(c) (i) Describe the technique for generation of DSB-SC signal using switching modulator. **6**

(ii) An audio signal is given as $15 \sin 2\pi(1500t)$ amplitude modulates a carrier given as $60 \sin 2\pi(100000t)$, determine the following: **3**
(1) The modulation index and percentage modulation.
(2) What are the frequencies of the audio signal and the carrier?
(3) What frequencies would present in a spectrum analysis of the modulated wave?

Q.3. (a) Describe the techniques for generation of frequency modulated signals. **9**

(b) (i) The first stage of a two stage amplifier has output resistance of 25 kΩ, **6**

voltage gain of 12, input resistance of 600 Ω. and equivalent noise resistance of 2400 Ω. The second stage has output resistance of 300 kΩ, voltage gain of 25, input resistance of 100 kΩ, and equivalent noise resistance of 8 kΩ. The amplifier is driven by a generator of output resistance 50 Ω. Compute for this two stage amplifier:

(1) Equivalent input noise resistance
(2) Equivalent input noise voltage given that the bandwidth of the amplifier is 10 kHz and the ambient temperature is 330 ^{0}K.
(3) Noise figure of the complete system in dB.

(ii) Show that in a parallel tuned circuit, the equivalent parallel impedance at resonance equals its equivalent resistance for noise generation. **3**

(c) (i) Draw the block diagram of stereophonic FM broadcasting transmitter and receiver system and explain the operation of it. **5**

(ii) Define the following terms: **4**

(1) Thermal noise
(2) Shot noise
(3) Transit time noise
(4) Flicker noise

Q.4. (a) (i) State and prove the sampling theorem. **5**

(ii) 10 channels are sampled, quantized, binary coded and time division multiplexed. Each channel bandwidth is 100 Hz. The maximum acceptable error in sample amplitudes is 0.25% of the peak signal amplitude m_p. The sampling rate must be at least twice the Nyquist rate. Determine the minimum cable band width. **3**

(b) (i) The signal $v(t) = \cos 5\pi t + 0.5 \cos 10\pi t$ is instantaneously sampled. The interval between samples is T_s. **5**

(a) Find the maximum allowable value for T_s.

(b) If the sampling signal is $S(t) = 5\sum_{k=-\infty}^{\infty} \delta(t - 0.1k)$, the sampled signal $v_s(t) = v(t)S(t)$ consists of a train of impulses, each with a different strength $v_s(t) = \sum_{k=-\infty}^{\infty} 1_k \delta(t - 0.1k)$. Find 1_0, 1_1, 1_2, 1_3, 1_4 and 1_5.

(ii) Five telemetry signals, each of bandwidth 1 KHz are to be transmitted simultaneously by binary PCM. The maximum tolerable error in sample amplitude is 0.5% of the peak amplitude. The signal is sampled at least 20% above the Nyquist rate. Framing and synchronizing requires an additional 0.5% extra bits. Determine the minimum possible data rate (bits/sec) that must be transmitted and the minimum bandwidth required to transmit this signal. **3**

(c) (i) Discuss the disadvantages of Delta modulator and how can it be corrected using Adaptive delta modulation technique. Draw the block diagram of continuous Adaptive delta modulation and describe it. **5**

(ii) A signal m(t) is transmitted by binary PCM without compression. If the signal to quantization noise ratio (SNR) is required to be at least 47 dB. Determine the minimum value of L required, assuming that m(t) is sinusoidal. Determine the SNR obtained with this minimum L. **3**

Use the following data if required:
$K_B = 1.38 \times 10^{-23}$ J/°K
$h = 6.62 \times 10^{-34}$J.sec
Electron mass $= 9.1 \times 10^{-31}$ Kg
$C = 3 \times 10^8$m/sec
$1eV = 1.6 \times 10^{-19}$ Joule