BETCE Examination 2025
2nd Year 2nd Semester
Subject: Analog Communication Systems
Full Marks: 100
Time: 3 hours

Answer all parts & sub-parts of a question in the same place

CO 1 (Marks: 10)

Q1. Draw the channel model for multi-path transmission of signals. Hence, derive the expressions of magnitude and phase responses of the channel. What type of distortion does it produce? How this channel causes frequency selective fading of transmitted signals? [1+5+1+3]

CO 2 (Marks: 30)

(Answer any two questions)

Q2. a) i) Vestigial Side Band (VSB) modulation is a trade-off between Single Side Band (SSB) and Double Side Band (DSB) modulations-explain. [2]

ii) Draw a neat sketch of Vestigial Side Band (VSB) spectrum of TV signal and label its different parts. [2]

iii) Explain the spectrum in terms of the following: [5]

Picture carrier and its side bands

Sound carrier and its side bands

iv) Hence calculate the bandwidth corresponding to this spectrum. [1]

b) In case of Amplitude Modulation (AM), the amplitude of the carrier signal is independent of modulation index; whereas, for Frequency Modulation (FM), it is highly dependent on modulation index-justify. [3]

c) Draw a labelled phasor diagram for Narrow Band FM signal. [2]

Q3. a) Derive the time domain expression of Frequency Modulated (FM) signal stating the significance of frequency deviation and phase deviation. [7]

b) Use above expression to show that Narrow Band FM signal essentially requires the same bandwidth as of the Amplitude Modulated (AM) signal. [4]

c) Draw the neat sketches of FM spectra for two different values the modulation index β under the following conditions: [4]

i) varying frequency deviation (Δf) keeping modulating frequency (f_m) constant

ii) varying modulating frequency (f_m) keeping frequency deviation (Δf) constant.

Q4. a) Derive the expression of Power Efficiency of AM signal. Use this expression to justify the need for the suppression of carrier. [4+2]

b) Consider an arbitrary signal g(t) and a sinusoidal carrier c(t). Demonstrate Double Side Band Suppressed Carrier (DSB-SC) modulation and demodulation with the necessary sketches of time domain signals and corresponding spectra. [6]

c) Point out the difficulties faced while removing one of the side bands of Double Side Band Suppressed Carrier (DSB-SC) Amplitude Modulated (AM) signal using Filtering Technique. [3]

CO 3 (Marks: 30)

(Answer any two questions)

Q5. a) Draw the circuit of a Ring Modulator. Explain the principle of operation of this circuit with necessary mathematical expressions and diagrams. State the necessary assumptions made in this regard. [2+6+2]

b) Draw and explain the Phase Shifting technique to suppress the Upper Side Band (USB) from a DSB signal. [5]

Q6. Answer the following questions in regard to Phase Locked Loop (PLL):

a) Sketch the block diagram and identify its basic components. [3]

b) Discuss the principle of operation of a PLL and derive its equivalent model. [7]

c) Explain the terms, 'Capture range' and 'Lock range'. [5]

Q7. a) Draw the neat sketch of a Superheterodyne Receiver and identify its each section. [3]

b) How are ganged tuning and Superheterodyning achieved in the above case? How do they help in the proper functioning of the receiver? [7]

c) What do you mean by Superheterodyning tracking? [2]

d) How does image station appear corresponding to a desired station in the above receiver? [3]

CO 4 (Marks: 20)

(Answer any two questions)

Q8. Consider the case of multipath distortion caused by two different paths in parallel between the transmitter and the receiver of a radio system. The received signal r(t) corresponding to the transmitted signal g(t) is represented as $r(t) = K_1 g(t-t_1) + K_2 g(t-t_2)$. Here, K_1 and K_2 are the attenuation of the path 1 and 2 respectively; whereas, t_1 and t_2 denote the time delay of the path 1 and 2 respectively. Find the expressions of the magnitude and phase responses of the channel assuming $(K_2/K_1)^2 << 1$. [10]

Q9. a) Consider the following message signal m(t) and carrier signal c(t): [4]

$m(t) = \cos 1000\pi t \cos 3000\pi t$; $c(t) = \cos 10{,}000\pi t$

i) Sketch the spectrum of m(t)

ii) Sketch the spectrum of DSB-SC signal

b) For an Angle Modulated signal, the message signal is given by $m(t) = \sin 2000\pi t$. The frequency sensitivity and phase sensitivity are provided as $K_f = 200{,}000\pi$ and $K_p = 10$ respectively.

Use Carson's rule to calculate the bandwidth of the Angle Modulated signal considering i) it is a Phase Modulated (PM) signal and ii) Frequency Modulated (FM) signal. [3+3]

Q10. Design an Armstrong indirect FM modulator to generate an FM carrier with a carrier frequency of 96 MHz and frequency deviation (Δf) of 20 KHz. A narrowband FM generator with carrier frequency (f_c) of 200 KHz and adjustable Δf in the range of 9 to 10 Hz is available. You are provided with an oscillator with adjustable frequency in the range of 9 to 10 MHz. There is a bandpass filter with any center frequency, and only frequency doublers are available. Show the design using the block diagram, mentioning the necessary values wherever required. [10]

CO 5 (Marks: 10)

Q11. a) Consider that small amplitude interference signal is present in an Angle Modulated system. Show graphically, the effect of this interference in Frequency Modulated (FM) and Phase Modulated (PM) systems. No derivation is required. [2]

b) Hence explain, how, the Pre-emphasis De-emphasis (PDE) technique greatly reduces the white noise present in the channel in an FM system. [8]