B.Sc. in EEE, 4th Semester March 07, 2024 **(Afternoon)**

ISLAMIC UNIVERSITY OF TECHNOLOGY (IUT)
ORGANISATION OF ISLAMIC COOPERATION (OIC)
**DEPARTMENT OF ELECTRICAL AND ELECTRONIC ENGINEERING**

Mid-Semester Examination
Course No.: EEE 4403
Course Title: Communication Engineering I

Summer Semester, A. Y. 2022-2023
Time: 90 Minutes
Full Marks: 75

There are 3 **(three)** questions. Answer all 3 **(three)** questions. The symbols have their usual meanings. Programmable calculators are not allowed. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Consider a message signal $m(t)$ with spectrum shown in Figure 1(a), with W = 1 kHz. This message is DSB-SC modulated using a carrier of the form $A_c \cos(2\pi f_c t)$, producing the signal $s(t)$. The modulated signal is next applied to a coherent detector with carrier $A_0 \cos(2\pi f_c t)$. Determine the spectrum of the detector output when the carrier $f_c$ is 1.25 kHz. Assume that the LPF in the demodulator is ideal with unity gain. Find the lowest carrier frequency for which there is no aliasing (no overlap in the frequency spectrum) in the modulated signal $s(t)$. **10** CO1, PO1

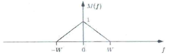


Figure 1(a): Spectrum of the message signal

b) The message signal $m(t)$ whose spectrum is shown in Figure 1(b) is passed through the system shown in the same figure. The bandpass filter has a bandwidth of $2W$ centered at $f_0$ and the lowpass filter has a bandwidth of $W$. Plot the spectra of the signals $x(t)$, $y_1(t)$, $y_2(t)$, $y_3(t)$ and $y_4(t)$. Find the bandwidths of these signals. **10** CO1, PO1

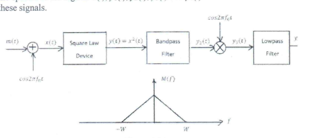


Figure 1(b)

c) Describe the mechanism of envelope detection for AM modulation and detail how changes in the time constant of the capacitor affect the performance of the envelope detector. **5** CO1, PO1

2\. a) Compare and contrast single sideband (SSB) modulation with double sideband (DSB) modulation in terms of bandwidth utilization and power efficiency. **5** CO1, PO1

b) Examine the consequences on an AM scenario if a user relocates from the transmitter, along with methods to alleviate these effects. **10** CO1, PO1

c) A signal $x(t)$ of finite energy is applied to a square-law device whose output $y(t)$ is given by $y(t) = x(t)$. The spectrum of $x(t)$ is limited to the frequency interval $W \leq f \leq W$. Show that the spectrum of $y(t)$ is limited to $2W \leq f \leq 2W$. **10** CO1, PO1

3\. a) Consider the quadrature carrier multiplex system shown in Figure 3(a). The multiplexed signal $s(t)$ is applied to a communication channel of frequency response $H(f)$. The channel output is then applied to the receiver input. Here $f_c$ denotes the carrier frequency and the message spectra extends over $[-W, W]$. Find **10** CO1, PO1

i) the relation between $f_c$ and $W$,

ii) the condition on $H(f)$, and

iii) the frequency response of the LPF that is necessary for recovery of the message signals $m_1(t)$ and $m_2(t)$ at the receiver output. Assume a real-valued channel impulse response and $A_c$=1.

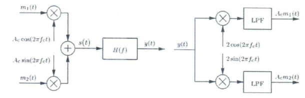


Figure 3(a): Quadrature carrier multiplexing system

b) Define the criteria that must be met for the characteristics of the VSB filter. **10** CO1, PO1

c) Describe the working principle of a Costas receiver and its importance in phase synchronization. **5** CO1, PO1