B.Sc. in EEE, 8th Semester March 06, 2024 **(Afternoon)**

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

Mid-Semester Examination
Course No.: EEE 4851
Course Title: Advanced Communication Techniques

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

There are **4 (four)** questions. **Question 1** and **Question 2** are compulsory. Answer any **1 (one)** from **Question 3** and **Question 4**. The symbols have their usual meanings. Marks of each question and corresponding COs and POs are written in the brackets.

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1. a) Showing proper diagram, discuss the concept of frequency reuse in cellular systems. **5 (CO1, PO1)**

   b) Consider a channel with bandwidth of 1 MHz and an SNR of 63. **7 (CO1, PO1)**
   i) Determine the maximum theoretical limit of the data rate that the channel can carry.
   ii) The result of part (i) is the maximum theoretical limit. However, as a practical matter, better error performance will be achieved at a lower data rate. Assume we choose a data rate which is 2/3 of the maximum theoretical limit. Calculate the required modulation order to achieve this data rate.

   c) Explain quadrature modulation and demodulation process of an QPSK scheme, where mapping between QPSK symbols and its equivalent digital bit sequence can be shown in mathematical form as – **13 (CO1, PO1)**

$$s(t) = \begin{cases} A\cos(2\pi f_c t + 45°) & \rightarrow 11 \\ A\cos(2\pi f_c t + 135°) & \rightarrow 01 \\ A\cos(2\pi f_c t - 135°) & \rightarrow 00 \\ A\cos(2\pi f_c t - 45°) & \rightarrow 10 \end{cases}$$

2. a) Consider a wireless channel which has L multipath components due to the effect of fading, as shown in Fig. 2(a). **13 (CO2, PO2)**

   Where,
   $s(t)$ = Transmitted passband signal
   $h(t)$ = Impulse response of the channel
   $y(t)$ = Received signal

   Develop an analytical model for this wireless channel considering the effect of multipath fading.

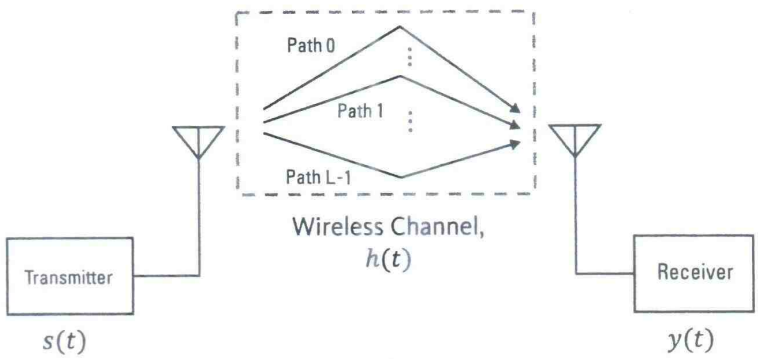

Fig. 2(a)

b) Define coherence bandwidth. Explain how variation in delay spread can affect the frequency response of the channel using suitable graphical examples. **12 (CO2, PO2)**

3. a) Define cyclic prefix. Explain why cyclic prefix is necessary in OFDM. **5 (CO3, PO2)**

b) Explain how orthogonality property is utilized in OFDM with a practical example. Discuss the benefits OFDM achieves by utilizing orthogonality property. **10 (CO3, PO2)**

c) Briefly explain the working principle of the following techniques used in modern wireless communications. **10 (CO3, PO2)**

i) Code Division for Multiple Access (CDMA)
ii) Multiple-Input Multiple-Output (MIMO)

4. Morty built a BPSK based wireless communication device for his school project. To test his device, he transmitted a signal $x(t)$ to his sister Summer's phone. Now, this device uses a single carrier modulation (SCM) technique for modulation. However, as the signal $x(t)$ had a very high data rate of 10 Mbps, it was causing a severe intersymbol interference at the receiver. Morty's grandfather, Rick suggested that multicarrier modulation (MCM) can be used here instead of SCM to minimize the effect of intersymbol interference.

a) Explain how a data rate of 10 Mbps can cause severe intersymbol interference. (Typical delay spread of wireless channel is given as $1 - 3\ \mu s$) **5 (CO3, PO2)**

b) Assume, $x(t)$ has a symbol rate R, and after modulation, $x(t)$ occupies a bandwidth of B. Describe multicarrier modulation process for transmitting this signal $x(t)$ with necessary diagrams. **10 (CO3, PO2)**

c) With neat diagrams, explain how multicarrier modulation will minimize the effect of intersymbol interference for the signal $x(t)$. **10 (CO3, PO2)**