B.Sc. in EEE, 8th Semester

May 08, 2023
10:00 AM – 01:00 PM

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

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

Summer Semester, A. Y. 2021-2022
Time: 3 Hours
Full Marks: 150

There are **6 (six)** questions. Answer all **6 (six)** 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) Define delay spread. Consider two paths illustrated in Fig. 1(a), where the direct and scatter distances are given as $d_0 = 2\ km$, $d_1 = 3\ km$ respectively. Determine the value of delay spread for the scenario given in Fig. 1(a). **12 (CO2, PO2)**

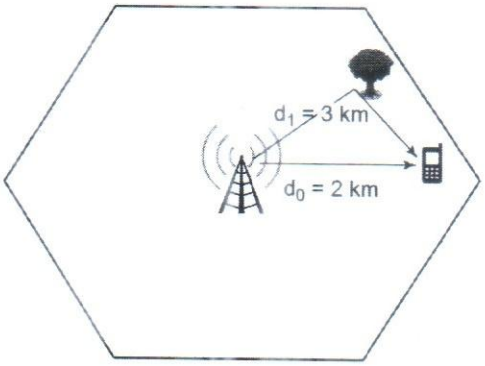

Fig. 1(a)

b) Define coherence bandwidth. Explain how variation in delay spread can affect the frequency response of the channel using suitable graphical examples. **13 (CO2, PO2)**

2. 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)**

3. a) Define Frequency Hopping Spread Spectrum (FHSS). With proper diagrams, explain the transmission process in FHSS. **17 (CO3, PO2)**

b) A signal occupies a bandwidth of 100 Hz when transmitted without any spreading technique. An FHSS system with a bandwidth of 400 MHz is employed for transmitting this signal. For the k-bit PN pattern generated in each frequency hop, find the minimum value of k in this FHSS system. **8 (CO3, PO2)**

4. a) Fig. 4(a) depicts a simplified scheme for CDMA encoding and decoding. There are seven users, all using CDMA with a spreading code of 7 bits. If all seven users transmit a data bit, in the form of a 7-bit sequence, the signals from all users combine at the receiver so that two positive or two negative values reinforce and a positive and negative value cancel. To decode a given user data, the receiver multiplies the incoming composite signal by the spreading code of that user, sums the result, and assigns binary 1 for a positive value and binary 0 for a negative value. **17 (CO3, PO2)**

i) Find the spreading codes for the seven users.
ii) Find the receiver output for user 3 and the bit value assigned.
iii) Determine the cross-correlation between spreading code of user 0 and each of the other 6 users' codes.

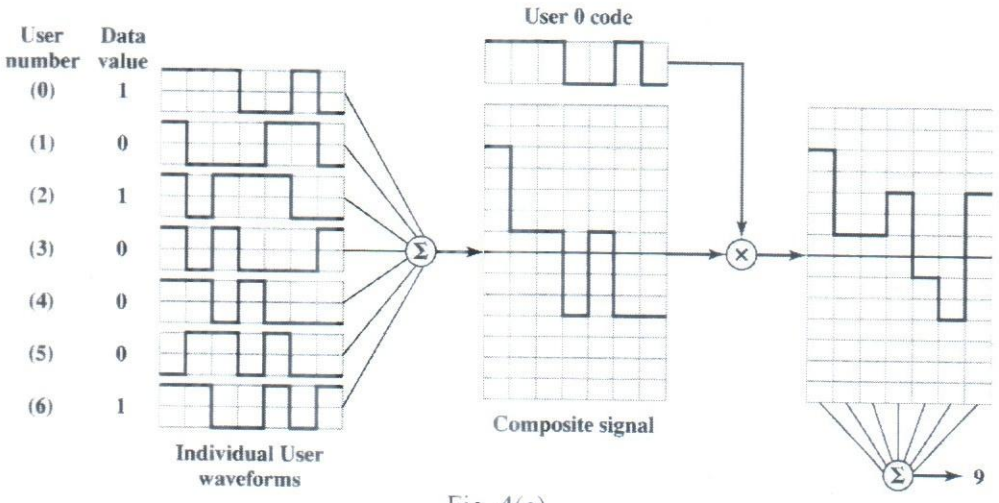

Fig. 4(a)

b) Define orthogonal codes. Explain how Walsh matrices are generated. **8 (CO3, PO2)**

5. a) For the 4-bit Linear Feedback Shift Register (LFSR) shown in Fig. 5(a), the initial state is taken as 1100. Find the PN sequence generated from this circuit, then justify whether the generated sequence is a maximal length sequence or not. **10 (CO3, PO2)**

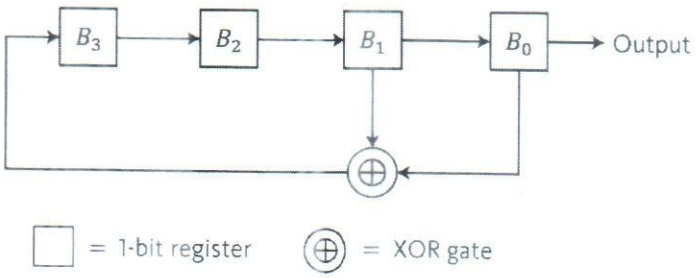

Fig. 5(a)

	b)	Define pseudonoise sequence. Explain how spread spectrum can minimize the effect of interference using suitable graphical example.	**15 (CO3, PO2)**
6.	a)	Describe balance and run property of randomness, and test these two properties on the sequence, 000100110101111.	**10 (CO3, PO2)**
	b)	With proper diagrams, explain how multipath fading effect can be minimized using spread spectrum.	**15 (CO3, PO2)**