UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION

MARCH 2025 SEMESTER SESSION

SUBJECT CODE	:	**LEB41403**
SUBJECT TITLE	:	**WIRELESS COMMUNICATIONS**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**BACHELOR OF ELECTRICAL AND ELECTRONICS ENGINEERING TECHNOLOGY (MARINE) WITH HONOURS**
TIME / DURATION	:	**09.00 AM - 12.00 PM (3 HOURS)**
DATE	:	**30 JUNE 2025**

INSTRUCTIONS TO CANDIDATES

1. Please read **CAREFULLY** the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of **ONE (1) section**.
4. Answer **FOUR (4) questions ONLY**.
5. Please write your answers on the answer booklet provided.
6. Answer **ALL** questions in English language **ONLY**.

THERE ARE 5 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

(Total: 100 marks)

INSTRUCTION: Answer FOUR (4) questions ONLY

Please use the answer booklet provided.

Question 1 (CLO 1) with respect to fundamentals of space time coding for multiuser(s).

(a) The concept of wireless communication is transferring data or signals through space. Determine the technical challenges for multi-user wireless communication.

(4 marks)

(b) During wireless transmission, an ***'additional frequency'*** involves in the channel during the process. Explain the term ***'additional frequency'*** that interferes widely in the receiver system. Thus, specify the steps to minimize the ***'additional frequency'*** in the system.

(4 marks)

(c) Orthogonal Frequency Division Multiplexing (OFDM) is a specific type of multi-carrier modulation. Explain the benefits and the characteristics of OFDM in general.

(5 marks)

(d) Multiple user environment is more practical with frequency division multiplexing (FDM) technique. Calculate the total bandwidth in Hertz (Hz) available in 4 channels that have a limit of 100 kHz per channel. Consider the guard band involved is 10Hz to avoid channel interference.

(12 marks)

Question 2 (CLO 2) With respect to operations of MIMO OFDM signals.

(a) Determine the advantages of digital modulation techniques that are used to improve the MIMO system.

(4 marks)

(b) Describe with a block diagram of Quadrature phase shift keying (QPSK) modulation technique deploy in transmitter and receiver system.

(5 marks)

(c) Transmitting radio signals involve space time codes (STC). Compare the TWO (2) types of STC techniques that improve the quality of communication.

(5 marks)

(d) Achieving high channel capacity includes the following terms. Determine the function of the following in order to improve the data rate.

i. Decoding in Space-Time codes

(3 marks)

ii. Alamouti Scheme space-time code

(3 marks)

(e) Space-time block codes (STBC) is a technique that improves wireless communication by encoding data across multiple antennas configurations. Write the general form of an STBC for two transmit antennas.

(5 marks)

Question 3 (CLO 2) with respect to channel capacity and theorem.

(a) In the context of channel capacity theorem, determine the relationship between channel bandwidth and capacity of channel in wireless communication.

(3 marks)

(b) Compute the channel capacity of a 2x2 MIMO system using space-time coding with a 20 dB SNR and 10 MHz bandwidth.

(4 marks)

(c) If a transmitter produces 50 W of power that applied to a unity gain antenna with a 900 MHz carrier frequency, calculate the received power in dBM at a free space distance of 100 m from the antenna. Assume unity gain for the receiver antenna.

(6 marks)

(d) A wireless channel has a bandwidth of 5 MHz and operates at a Signal-to-Noise Ratio (SNR) of 20 dB. By using the Shannon-Hartley theorem, calculate the maximum channel capacity (C) in Mbps.

(6 marks)

(e) A wireless system operates with a bandwidth of 6 MHz and uses 16-QAM (16-level Quadrature Amplitude Modulation). Calculate the maximum achievable data rate using the Nyquist formula.

(6 marks)

Question 4 (CLO 2) with respect to wireless location and positioning.

(a) Wireless stations have transmission ranges, and not all stations are within radio range of each other. Thus, it occurs hidden terminal problem. Determine solution for Hidden Terminal Problem in order to avoid collisions.

(5 marks)

(b) Data traffic is giving tough competition to voice traffic. The service provider offers good Quality of Service (QoS) to the user as an agreement. Discuss the advantages of having QoS and Class of Service (CoS) to the data traffic.

(5 marks)

(c) Determine the main difference between the range-free and range-based methods used to identify the virtual coordinates of the node.

(5 marks)

(d) In positioning wireless network, the node for its physical coordinate or symbolic location can be determined by using Multihop Scheme Estimation and Trilateration. Discuss the comparison between both methods.

(5 marks)

(e) Distance Vector Routing (DVR) Protocol is a method used to find the best path for data achieving the destination in a network. By using DV hops, calculate the best path for Node A to Node C in Figure 1.

(5 marks)

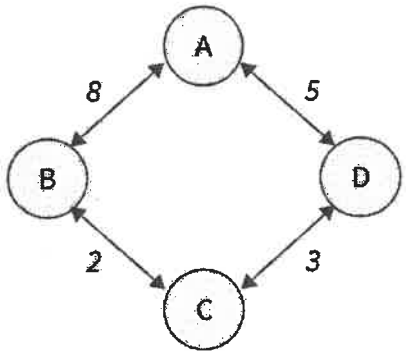

Figure 1

Question 5 (CLO 2) with respect to ultra-wide band radio.

(a) Explain THREE (3) major applications of Ultra-Wideband (UWB) technology in wireless communication.

(3 marks)

(b) The nature of the short-duration pulses used in Ultra-Wide Band (UWB) technology offers several advantages over narrowband communications systems. Determine FOUR (4) advantages of UWB that operates in the wireless system.

(4 marks)

(c) A UWB system operates between a certain bandwidth. Figure 2 shows the bandwidth of a signal with lower and upper frequencies as $\mathbf{f_l}$ and $\mathbf{f_u}$ respectively. Thus, calculate the bandwidth of the system.

(6 marks)

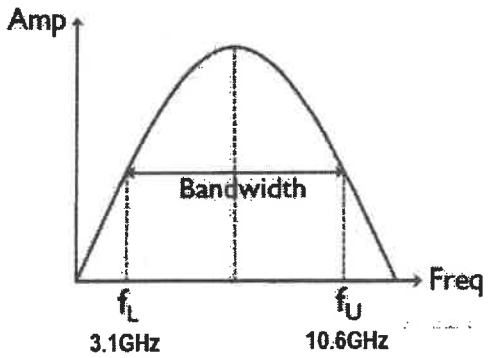

Figure 2

(d) The free space equation is a fundamental in wireless communication that relates to the transmitted power, antenna gains, path loss, and received power. With the parameters shown in Table 1, calculate the received power (Pr) for the system.

(6 marks)

Table 1.

Parameter	Value (unit)
Transmit power	0 dBm
Transmitted gain	0 dBm
Received gain	0 dBi
Distance,	10m
frequency	4GHz

e) With a situation of a transmitter operating at 2.4 GHz with a power of 20 dBm, and both antennas have a gain of 2 dBi. Thus, determine the received power at 10 meters.

(6 marks)

END OF EXAMINATION PAPER