UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION

OCTOBER 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	:	**28 JANUARY 2026**

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 **ONLY**.
4. Answer **FOUR (4)** questions **ONLY**.
5. Please write your answers on the answer booklet provided and arrange them properly for submission.
6. Answer **ALL** questions in English language **ONLY**.

THERE ARE 5 PAGES OF QUESTIONS, EXCLUDING THIS PAGE.

(Total: 100 marks)

INSTRUCTION: Answer FOUR (4) questions ONLY

Please use the answer booklet provided.

Question 1

(a) A new Very High Frequency (VHF) Data Exchange System (VDES) is being proposed for ship-to-ship and ship-to-shore communication. Unlike traditional VHF, it aims to support higher data rates for e-navigation and safety information.

i. Explain TWO specific challenges in the marine wireless channel that could degrade the performance of this high-data-rate VDES.

(2 marks)

ii. Justify the increasing of transmitted power is not an efficient or sustainable solution to overcome these challenges.

(3 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.

(5 marks)

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

(5 marks)

(d) A multi-user environment utilizes the Frequency Division Multiplexing (FDM) technique to combine several low-bandwidth data streams onto a single high-capacity link.

i. Compare the Frequency Division Multiplexing (FDM) with Time Division Multiplexing (TDM). Provide one advantage of each.

(4 marks)

ii. Calculate the total bandwidth (in Hertz) required for the link if there are 6 channels where each channel requires a dedicated bandwidth 50kHz. The necessary guard band between adjacent channels to avoid interference must be 200Hz.

(6 marks)

Question 2

(a) Determine the critical role of the Cyclic Prefix (CP) in a MIMO-OFDM system.

(4 marks)

(b) Consider a 4-state, QPSK STTC for 2 transmit antennas. The encoder has a memory order of $v = 2$, meaning the state is defined by the two previous input bits. The generator sequences for the two antennas are given as:

Antenna 1: $g_1 = [2,0], g_2 = [1,0]$ (in octal)

Antenna 2: $g_1 = [0,2], g_2 = [0,1]$ (in octal)

i. Explain the number of states in their binary labels.

(4 marks)

ii. Illustrate the complete state transition diagram for STTC, showing all states, transitions, and the corresponding output symbols (Ant1, Ant2).

(6 marks)

(c) If a transmitter produces 50W of power that applied to a unity gain antenna with a 900MHz 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.

(11 marks)

Question 3

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

(4 marks)

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

(5 marks)

(c) A satellite link has a bandwidth of 10 MHz and a linear Signal-to-Noise Ratio (SNR) of 255. Calculate the maximum channel capacity in Mbps.

(5 marks)

(d) A system engineer needs to achieve a data rate of at least 54 Mbps over a channel with 20 MHz of bandwidth. Thus, determine the minimum SNR (in dB) required to support this capacity.

(5 marks)

(e) A Wi-Fi router operates on a 40 MHz channel with an SNR of 100.

i. Calculate the initial channel capacity for the wireless system.

(3 marks)

ii. The user changes location, which improves the SNR to 400. However, to avoid interference, the channel bandwidth is reduced to 20 MHz, Thus, calculate the new channel capacity to improve the overall performance of the system.

(3 marks)

Question 4

(a) Wireless stations have transmission ranges, and not all stations are within radio range of each other. Describe the Hidden Terminal Problem that leads to collisions in a wireless network.

(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) 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)

(d) Compare the hardware requirements for implementing range-based versus range-free localization.

(10 marks)

Question 5

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

(3 marks)

(b) Two vessels need to establish a reliable communication link. Vessel A's VHF radio transmits at 156 MHz with a power of 25 Watts. Both vessels use standard VHF antennas with a gain of 3 dBi. If the receiver on Vessel B has a sensitivity of -110 dBm, calculate the maximum range in kilometers for which communication can be established. Assume free-space propagation over water.

(5 marks)

(c) An Inmarsat satellite provides data services to ships. The satellite transmits at 1.5 GHz with an Effective Isotropic Radiated Power (EIRP) of 48 dBW. The ship's antenna has a gain of 20 dBi. The satellite is in geostationary orbit at 36,000 km.

i. Calculate the received power at the ship's antenna in dBm.

(4 marks)

ii. If the system noise temperature on the ship is 300 Kelvin, and the channel bandwidth is 1 MHz, calculate the Signal-to-Noise Ratio (SNR) in dB.

(4 marks)

(d) A network of UWB acoustic sensors is deployed on the seabed for pipeline monitoring. Unlike RF UWB in air, this system uses acoustic waves in water with a bandwidth of 20 kHz centered at 40 kHz. The system uses time-hopping pulse position modulation.

i. Calculate the channel capacity for this acoustic UWB link if the measured SNR is 15 dB.

(4 marks)

ii. Compare the data robustness of this UWB acoustic system to a conventional narrowband acoustic modem in the presence of frequency-selective fading caused by multipath in the underwater channel.

(5 marks)

END OF EXAMINATION PAPER