SET 1

CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
SEPTEMBER 2016 SEMESTER

COURSE CODE	: LEB 40203
COURSE NAME	: UNDERWATER ACOUSTICS SYSTEM
PROGRAMME NAME	: BACHELOR OF MARINE ELECTRICAL AND ELECTRONIC
DATE	: 24 JANUARY 2017
TIME	: 9.00 AM
DURATION	: 3 HOURS

INSTRUCTIONS TO CANDIDATES

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

THERE ARE 5 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

INSTRUCTION: Answer only FOUR questions.
Please use the answer booklet provided.

Question 1

a) Combine the total of Sound Pressure Level (SPL) when the pressure at 70 dB, 71 dB and 79 dB are combined. These pressures are coming from the ocean traffic and the reverberation effect.

[5 marks]

b) Knowledge of sound velocity profile is important to the oceanography and underwater navigation applications. Explained in detail including figure the expendable bathythermograph operation that being used as to estimate the sound velocity profile.

[10 marks]

c) Shallow water regions are particularly complicated and challenging acoustic environments due to the ocean structure, traffics and oceanographic conditions. Discuss the following reasons.

[10 marks]

Question 2

a) A propagating sound wave carries mechanical energy in the form of kinetic energy of the particles in motion and potential energy of stresses set up in the elastic medium. Formulate the expression of acoustic intensity in the underwater acoustic medium.

[5 marks]

b) From the acoustic intensity in a) above, formulate the sound pressure level in the underwater medium.

[5 marks]

c) Compute the acoustic impedance of salt water at depth of 50m from the surface based on Table 1 below:

[5 marks]

Table 1: Characteristics of the underwater environment

Medium	**C_p (m/s)**
Saltwater; Depth - 1m	1500
Saltwater; Depth - 50m	1525

Density of salt water, 33ppt, Depth - 1m – 1024 kg/m^3
Density of salt water, 33ppt, Depth - 50m – 1028 kg/m^3

d) Compute the Sound Pressure Level (SPL) changes when the pressure level in projector or sonar is changed by a factor of 0.5.

[5 marks]

e) Determined the factors that affecting the speed of sound in the ocean environment and the graphical relationship of sound speed to pressure, salinity and temperature.

[5 marks]

Question 3

a) Analysed in detail (including the figure) of the direct-path propagation theory for underwater acoustic propagation path.

[5 marks]

b) Thermal structure of the ocean governs the refractive conditions for given water mass. Determined in detail temperature structure in iso-velocity/iso-thermal, negative temperature gradient and positive temperature gradient.

[10 marks]

c) Calculates the total loss (TL) propagation in a passive mode involving underwater target located 1450 meters from the hydrophone. The noise came from the propulsion system and radiated frequency at 935 Hz. The wave is travelling with three times of underwater bounce. The bounce loss is 1.1 dB/bounce.

[5 marks]

d) Spreading loss in the underwater acoustic medium in the cylindrical spreading model is, TL = 20 log *r*. By providing the acoustic intensity of energy at the surface of a sphere of radius *r* is, $I_r = \frac{P_t}{4\pi r^2}$. Proof the TL = 20 log *r* equation.

[5 marks]

Question 4

a) Directivity pattern can be modified for the reduction of side-lobe by shading a transducer. Determined how this shading process can be accomplished.

[5 marks]

b) The transducer is a device that can convert one form of energy to another. Explained the crystal and ceramics transducers on its operation and material selection for SONAR application.

[10 marks]

c) Hydrophone array determines the bearing of the signal and enhance the detection of the received signal by increased the signal to noise ratio. Explain the principle of the beam-forming processor in passive sonar system (including figures).

[10 marks]

Question 5

a) Your sonar is capable of either passive or active operation. You are operating in the shipping lanes with a sea state of 2 with speed at 5 knots. Water depth is 2015 meters. Using the following information in Table 2 and 3 below, you must decide which mode to use. Based on the analysis provides some recommendation in order to get your sonar greater than 50% probability detection of the target. The target is a submarine (all dB are reference 1μPa).

Table 2: Target Parameters

Target parameters:	
Radiated noise source level	105 dB
Radiated noise frequency	1515 Hz
Target strength	9 dB
Target detection range	4015 meters
NL (shipping)	40 dB

Table 3: Sonar Parameters

Sonar parameters:		
	Active	**Passive**
Source level	160 dB	
Frequency	34.5 kHz	
Self-noise at 5 knots	50 dB	45 dB
Self-noise at 10 knots	52 dB	46 dB
Noise Level (sea state)	56 dB	58 dB
Noise Level (shipping)	33 dB	53 dB
Directivity index	11 dB	10 dB
Detection threshold	2 dB	2 dB

[15 marks]

b) In the process of underwater target detection, it is desirable to obtain information includes the target motion due to Doppler Effect. Explained in detail (including figures) about the Doppler Effect phenomena.

[10 marks]

END OF EXAMINATION PAPER