UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
JANUARY 2016 SEMESTER

COURSE CODE	:	LEB 40203
COURSE NAME	:	UNDERWATER ACOUSTICS SYSTEM
PROGRAMME NAME	:	BACHELOR OF MARINE ELECTRICAL AND ELECTRONIC
DATE	:	28 MAY 2016
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) Define and elaborate the principle of a sound wave or acoustic wave in the air and in the underwater medium as the followings:
   i. Sound wave or acoustic wave source.
   ii. Propagation medium.

[10 marks]

b) Based on Table 1 below, calculates the acoustic impedance of fresh water, salt water and air in temperature of 20 °C.

[6 marks]

Medium	C_p (m/s)
Air, 20°C	343
Fresh water, 20°C	1497
Salt water, 20°C, 33ppt, D-1m	1532

Density of air, 20°C – 1.3 kg/m^3

Density of fresh water, 20°C – 1000 kg/m^3

Density of salt water, 20°C, 33ppt, D-1m – 1035 kg/m^3

c) Compute the Sound Pressure Level (SPL) changes when the pressure level in projector or sonar is changed by a factor of 0.1.

[4 marks]

d) Explained 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 2

a) Combine the total of SPL when the pressure at 43 dB, 42 dB and 30 dB are combined.

[5 marks]

b) Define the intensity of the acoustic signal in the underwater medium. Based on the intensity level equation, defined the Sound Pressure Level (SPL) of the acoustic signal in the underwater medium as the followings:
   a. Underwater acoustic intensity definition.
   b. Underwater acoustic intensity equation.
   c. SPL equation.

[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 3

a) Explained in detail (including the figure) of the half-channel propagation theory for underwater acoustic propagation path.

[5 marks]

b) Thermal structure of the ocean governs the refractive conditions for given water mass. Explain 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 750 meters from the hydrophone. The noise came from the reciprocating engine part and radiated frequency at 3517 Hz. The wave is traveling with two times of underwater bounce. The bounce loss is 1.5 dB/bounce.

[5 marks]

d) Basic sonar equation relating signal to noise in parameters determined by the equipment, the environment and the target. Determined the parameters that are influenced by the equipment.

[5 marks]

Question 4

a) Hydrophone array determines the bearing of the signal and enhances the detection of the received signal by increased the signal to noise ratio. Both functions are performed by the beam-forming processor. Explained in detail the principle of the beam-forming processor.

[10 marks]

b) The direction of the signal is determined by the time delays that maximize the Active sonar system most closely resembles the operation of basic radar. Active sonar emits a short burst or pulse of sound energy called ping that is transmitted through the transducer into water. Draw a functional diagram of an active sonar system and explained the detail of each sub-components.

[15 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 3 with speed at 13 knots. Water depth is 1000 meters. Using the following information, 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).

Target parameters:	
Radiated noise source level	105 dB
Radiated noise frequency	2588 Hz
Target strength	8 dB
Target detection range	3030 meters
NL (shipping)	40 dB

Sonar parameters:		
	Active	**Passive**

Source level	160 dB	
Frequency	37.5 kHz	
Self-noise at 13 knots	50 dB	45 dB
Self-noise at 15 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) Explain the crystal and ceramics transducers operation for hydrophone and sonar application.

[10 marks]

END OF EXAMINATION PAPER