UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
JANUARY 2017 SEMESTER

COURSE CODE	: LGB10503
COURSE NAME	: ENGINEERING SCIENCE
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	: BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN NAVAL ARCHITECTURE & SHIPBUILDING
DATE	: 03/07/2017 MON
TIME	: 2.00 PM - 05.00 PM
DURATION	: 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read CAREFULLY the instructions given in the question paper.
2. This question paper has information printed on both sides.
3. This question paper consists of FIVE (5) questions. Answer FOUR (4) questions only.
4. Please write yours answers on the answer booklet provided.
5. Write your answers only in BLACK or BLUE ink.
6. Answer all questions in English.

THERE ARE 8 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

INSTRUCTION: Answer only FOUR (4) questions.
Please use the answer booklet provided.

Question 1

An electric vehicle starts from rest and accelerates at a rate of 2 m/s^2 in a straight line until it reaches a velocity of 20 m/s. This velocity is maintained for 1 minute. The vehicle then slows at a constant rate of 1 m/s^2 until it stops.

(a) Calculate the time taken for the vehicle to reach the speed of 20 m/s from the starting point.

(2 marks)

(b) Sketch the velocity – time graph for the entire motion.
*(**Show all the calculation involved)*

(7 marks)

(c) Sketch the displacement – time graph of the electric vehicle from starting point until it stops.
*(**Show all the calculation involved)*

(10 marks)

(d) Determine the distance moved by the vehicle when the velocity is constant.

(2 marks)

(e) Calculate the average velocity of the motion.

(4 marks)

Question 2

(a) Explain Newton's First Law of Motion.

(3 marks)

(b) Many automobile passengers have suffered from injuries when the front end of the vehicle crash into something that cause an abrupt stop. Using the concept of inertia, describe how seatbelt can prevent injury during the crash.

(5 marks)

(c) Figure 1 shows a force of magnitude 12 N that is applied to a FedEx box of mass m_2 = 1 kg. The force is directed up a smooth plane tilted by θ = 37°. The box is connected by a cord to a UPS box of mass m_1 = 3 kg on the floor. The floor, plane and pulley are frictionless and the masses of the pulley and cord are negligible.

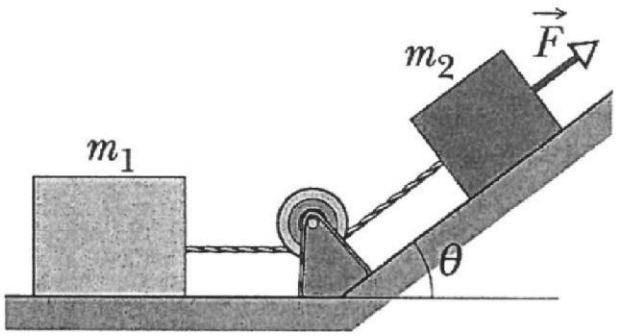

Figure 1 : A pulley system

i. Sketch the free body diagram to show all the forces acting to both boxes.

(4 marks)

ii. Determine the acceleration of the system.

(8 marks)

iii. Calculate the tension in a cord.

(2 marks)

iv. If m_1 is travelling by a distance of 1.75 m from rest, determine the time taken for m_1 to reach that distance.

(3 marks)

Question 3

(a) i. Differentiate between tangential acceleration and centripetal acceleration.

(4 marks)

ii. Explain the term centripetal force.

(3 marks)

(b) The flywheel of the steam engine runs with a constant angular velocity of 150 rev/min. When the steam engine is shut off, the friction of the bearings and of the air stops the flywheel in 2.2 hours.

i. Calculate the constant angular acceleration, in radians per second-squared, of the wheel during the slowdown.

(5 marks)

ii. Compute the number of revolutions the wheel makes before stopping.

(3 marks)

iii. At the instant the flywheel is turning at 75 rev/min, what is the tangential component of the linear velocity of a flywheel particle that is 50 cm from the axis of rotation.

(3 marks)

iv. Determine the magnitude of the net linear acceleration of the particle in Question 3b (iii).

(7 marks)

Question 4

(a) Define the following :

i. Amplitude

ii. Period

iii. Frequency

(6 marks)

(b) A simple harmonic oscillator consists of a 0.5 kg block attached to a spring. The block slides back and forth along a straight line on a frictionless surface with equilibrium point $x = 0$. At $t = 0$ the block is at $x = 0$ and moving in the positive x direction. A graph of the magnitude of the net force on the block as a function of its position is shown in Figure 2. The vertical scale is set by $F_{max} = 75$ N. Determine :

i. the angular frequency

(4 marks)

ii. the period of the motion

(2 marks)

iii. the magnitude of the maximum acceleration

(2 marks)

iv. the maximum kinetic energy

(3 marks)

v. the potential energy of the motion at x = 0.15 m

(3 marks)

vi. the total energy when x = 0.15 m

(5 marks)

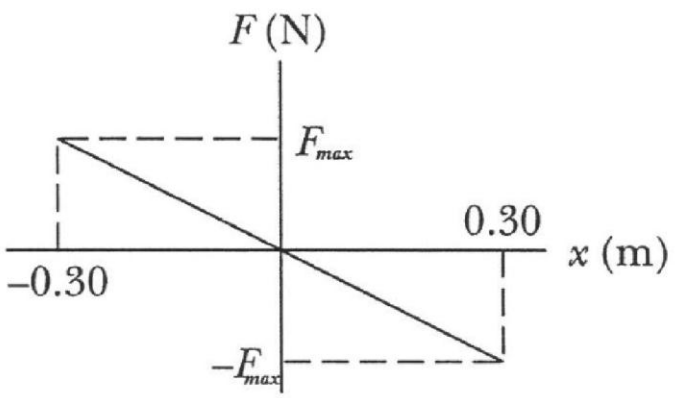

Figure 2 : Graph of net force as a function of position

Question 5

a) As shown in Figure 3, the ship (made of steel) and the steel block have the same weight. Using the concept of Archimedes' Principle, explain why the ship floats while the steel block sinks in seawater.

(7 marks)

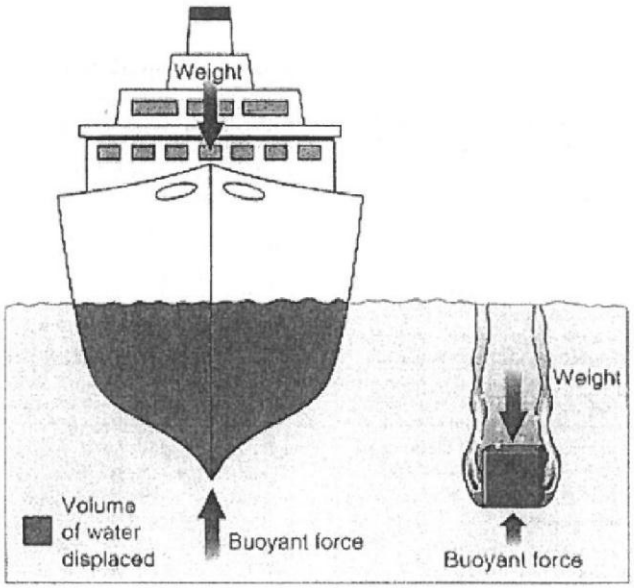

Figure 3 : Ship and steel block in seawater

b) An underwater research chamber is spherical in shape with an external diameter of 6.5 m. It has a mass of 85,000 kg when occupied. The chamber is anchored to the sea bottom by a cable.

(Density of seawater, $\rho_{sea\ water} = 1025\ kg/m^3$ and density of water, $\rho_{water} = 1000\ kg/m^3$)

i. Compute the buoyant force on the chamber.

(7 marks)

ii. Determine the tension in the cable.

(5 marks)

iii. Calculate the specific gravity (SG) of the chamber.

(6 marks)

Question 6

a) A gas that is undergoing a certain thermodynamic process and has expanded under constant pressure.

i. Sketch the pressure – volume graph of the process.

(3 marks)

ii. Show how to calculate the work done in expanding the gas.

(2 marks)

iii. Explain what happens to its final temperature during the expansion.

(2 marks)

b) Suppose a system of monatomic ideal gas at 2×10^5 Pa and an initial temperature of 293 K slowly expands at constant pressure from a volume of 1 L to 2.5 L.

i. Determine the work done by the system.

(4 marks)

ii. Calculate the change in internal energy of the gas.

(9 marks)

iii. Compute the thermal energy absorbed by the gas during the process.

(2 marks)

iv. Use the molar heat capacity at constant pressure to determine the thermal energy absorbed.

($Heat\ capacity\ at\ constant\ pressure, C_p = \frac{5}{2}R$)

(3 marks)

END OF EXAMINATION PAPER

APPENDIX

1. TABLE OF FORMULAE

$v = u + at$	$s = ut + \frac{1}{2}at^2$	$v^2 = u^2 + 2as$
$F = ma$	$F_f = \mu F_N$	$W = mg$
$\omega = \omega_0 + \alpha t$	$\omega^2 = \omega_0^{\ 2} + 2\alpha\theta$	$\theta = \omega_0 t + \frac{1}{2}\alpha t^2$
$s = r\theta$	$v = r\omega$	$a = r\alpha$
$a_c = \frac{v^2}{r}$	$f = \frac{1}{T}$	$\omega = 2\pi f$
$\omega = \sqrt{\frac{k}{m}}$	$F = -kx$	$K = \frac{1}{2}m\omega^2(x_o^2 - x^2)$
$U = \frac{1}{2}m\omega^2 x^2$	$v = \omega\sqrt{x_o^2 - x^2}$	$a = \omega^2 x$
$\rho = \frac{m}{V}$	$F_B = \rho_f V_f g$	$\Delta U = Q - W$
$W = P\Delta V$	$W = nRT\ln(\frac{V_f}{V_i})$	$\Delta U = \frac{3}{2}nR(T_f - T_i)$
$PV = nRT$	$Q = nC_P\Delta T$	$Q = mc\Delta T$

2. CONSTANT VALUES:

Gravitational acceleration, g = 9.81 m/s^2

Universal gas constant, R = 8.314 J/mol.K

Standard Temperature Pressure, STP conditions: P = 1 atm = 1.013 x 10^5 Pa

T = 273 K