UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF MARINE ENGINEERING TECHNOLOGY

FINAL EXAMINATION
JANUARY 2017 SEMESTER

COURSE CODE	:	LNB31203
COURSE NAME	:	SEAKEEPING & MANEUVERING
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	BACHELOR OF ENGINEERING TECHNOLOGY (HONS) IN NAVAL ARCHITECTURE & SHIPBUILDING
DATE	:	03/07/2017 MON
TIME	:	9.00 AM - 12.00 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 TWO (2) sections; Section A and Section B. Answer ALL questions in Section A and THREE (3) questions from Section B.
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 7 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.
Please use the answer booklet provided.

Question 1

(a) State briefly the following terms when applied to a study of water waves;

i) Velocity potential

(4 marks)

ii) Standing wave

(4 marks)

(b) A wave is 300 m long and 12 m high, and the depth of water is 45 m. Estimate the velocity of the wave and compare the speed of the wave with that of a deep sea wave of the same dimensions.

(7 marks)

(c) A deep water wave having a length of 30.5 m and of height of 1.5 m travels toward shore.

i) Calculate the length and celerity at the position where the water is 0.5 m in depth.

(3 marks)

ii) Calculate the total wave energy and the energy flux (per unit width) of the wave in deep water. (Assume ρ_{sw} = 1025 kg/m^3)

(2 marks)

Question 2

(a) The directional stability derivatives of a 150 m long vessel are:

$$Y_v' = -0.0116 \qquad N_r' = -0.00166$$

$$N_v' = 0.00264 \qquad m' = 0.00798$$

$$Y_r' = -0.00298$$

When a skeg was included, Y_v' and N_v', with given -0.0050 and 0 respectively.

i) Assuming other derivatives remaining constant, discuss on the directional stability of the vessel with and without skeg.

(4 marks)

ii) Determine the corresponding positions of neutral points and the effective distance of the skeg aft of the c.g.

(5 marks)

(b) The following data were obtained by performing experiments of a seagoing vessel at a model scale 1/100 in fresh water:

V (m/s)	-0.4	-0.3	-0.2	-0.1	0.1	0.2	0.3	0.4
Y (KN)	102	76	51	25	-25	-50	-77	-101
N (KNm)	31	23	16	7.5	-7.5	-15.5	-22	-32

Where Y and N are the sway force and yaw moment respectively and v is the sway velocity. Calculate the magnitude of the linear derivatives $\frac{\partial Y}{\partial v}$ and $\frac{\partial N}{\partial v}$ full scale at the same Froude number.

(11 marks)

SECTION B (Total: 60 marks)

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

Question 3

(a) In the study of hydrostatics, stability, and resistance, the sea surface has been idealized to its simplest form namely, calm water but in fact the sea surface is covered with waves and its severity can vary enormously as climate changed. Determine the effects of waves on vessels.

(4 marks)

(b) As predicted by linear theory, wave breaks at $d = a$, where $u = c = \sqrt{gd}$, in shallow water. Show that when waves breaks that horizontal velocity component, $u = \sqrt{gd}$, given that in shallow water, the horizontal component of the water particles as;

$$u = \frac{gak}{\omega}\sin(kx - \omega t)$$

(6 marks)

(c) Derive the formula for the kinetic energy of per unit area of the water surface which is equal to ¼ $\rho g a^2$, where for a fluid element of mass, $\rho.dx.dz$:

$$\text{K.E. of element} = \frac{1}{2}(\rho.dx.dz)\left(\underline{u}^2 + \underline{w}^2\right)$$

u and *w* are the horizontal and vertical velocity components. For deep water, the velocity potential is given as;

$$\phi_\infty = -\frac{ga}{\omega}.e^{kz}\cos(kx - \omega t)$$

(10 marks)

Question 4

A model of MV Semarak Padi has the following particulars:

Length of model, L = Wave length = 5.852 m
Max. beam, B = 0.790 m
Draught, T = 0.349 m
LCG = 0.1463 m forward of φ
LCB = 0.1463 m forward of φ
Model speed, u = 1.459 m/s
Displacement, Δ = 1287.20 kg
Direction of ship travel, μ = 180° (i.e. head sea)
Water density, ρ = 1000 kg/m

Stn	Bn (m)	Tn (m)	Sn (m^2)
0	0	0.349	0
5	0.790	0.349	0.2735
10	0.790	0.349	0.2735
15	0.790	0.349	0.2735
20	0	0.349	0

i) Calculate the added mass for heaving in terms of the model mass.

(10 marks)

ii) If the heading angle, μ is 120° and wave amplitude, ζ_a = 0.06 m, determine non-dimensionless amplitude for pitching moment, f_o and exciting moment for the pitching motion, M_o.

(10 marks)

Question 5

(a) Explain how a wave spectrum typically changes shape as a wind of constant strength starts blowing over a previously calm ocean. Assume unlimited fetch and deep water. Use diagrams to support your question.

(4 marks)

(b) The encounter frequency in regular waves can be calculated using:

$$\omega_e = \omega_w - \frac{V\omega_w^2}{g}\cos\mu$$

Derive that the relationship between a wave spectrum and encounter spectrum as shown below:

$$S_\zeta(\omega_e) = S_\zeta(\omega_w)\frac{1}{1-(2\omega_w V/g)\cos\mu}$$

(6 marks)

(c) A seaway is defined by the spectral density ordinates provided in the table below. Note, the wave spectrum is based in wave amplitude.

ω_w (rad/s)	0.11	0.22	0.33	0.44	0.55	0.66	0.77	0.88	0.99	1.10	1.21
$S_\zeta(\omega_w)$ ($m^2.s$)	0.00	1.28	5.22	4.23	2.62	0.86	0.99	0.66	0.46	0.33	0.24

Analyse the significant wave height for the seaway. Include the correction factor in your calculation to account for the broadness of the spectrum. Hint: Use Simpson's Rule for numerical integration.

(10 marks)

Question 6

(a) Determine the use of Planar Motion Mechanism to determine the hydrodynamic derivation Y_v and N_v, which is necessary to evaluate the directional stability indices of a ship.

(4 marks)

(b) In a model experiment using a planar motion mechanism, the values of sway force (Y) and yaw moment (N) with respect to the yaw rate (r) are found as follow:

$$Y = -53.7r$$
$$N = -98.8r$$

If the model length is 3.0 m and the forward speed is 1.35 m/s, and the full scale vessel is 100 m in length:

i) Plot the graph for sway force (Y) and the yaw moment (N) with respect to the yaw rate (r).

(6 marks)

ii) Determine the non-dimensional values for sway force (Y) and the yaw moment (N)

(4 marks)

iii) Calculate the derivatives for the full scale vessel of 100 m long.

(6 marks)

Assume both are running at corresponding speed. All values are in metric.

END OF EXAMINATION PAPER