UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
JANUARY 2016

SUBJECT CODE	:	LNB 30503
SUBJECT TITLE	:	SHIP STRUCTURES
LEVEL	:	BACHELOR
TIME / DURATION	:	9.00 pm – 12.00 am (3 HOURS)
DATE	:	18 MAY 2016

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper CAREFULLY.
2. This question paper is printed on both sides of the paper.
3. Please write your answers on the answer booklet provided.
4. Answer should be written in blue or black ink except for sketching, graphic and illustration.
5. Answer FIVE (5) questions only.
6. Answer all questions in English.

THERE ARE 8 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 40 marks)

INSTRUCTION: Answer ALL questions.

Question 1

a) List 2 types of typical loadings that may be subjected to a structure or beam.

(2 marks)

b) A ship structural beam is supported and loaded as shown in Figure 1. Calculate the reactive forces R_1 and R_2.

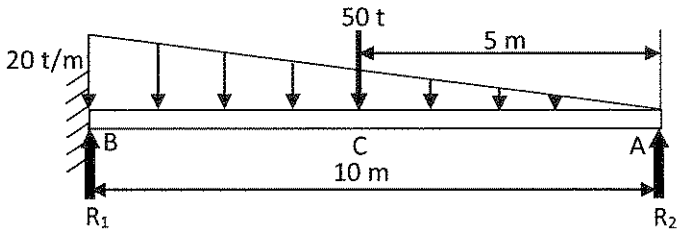

Figure 1

(10 marks)

c) In case b) above, evaluate the bending moment (BM) distribution along the length of the beam, determine the maximum BM and draw the BM diagram.

(8 marks)

Question 2

Answer the following questions:

a) Calculate the position of the horizontal neutral axis (NA), the second moment of area (I) and the section modulus (Z) of the section above the neutral axis of a ship structure which is a combination of a deck plating and a T-section beam with the cross section as shown in Figure 2.

(6 marks)

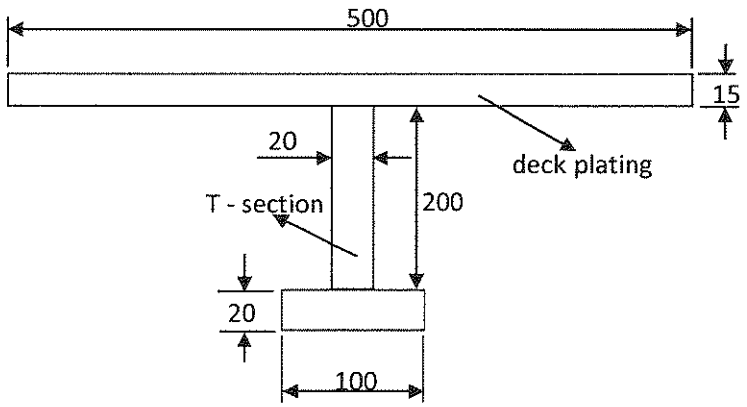

Figure 2

Note: All dimensions in mm

b) Answer the following questions related to shear stress on a structural beam:

i) Prove that the total unbalanced shear force F subjected to incremental beding moment δM across a beam section is given as F = (δM/I)Aȳ (where A - beam sectional area above the neutral axis, I - second moment of area, ȳ - the distance from the centroid of the element to the neutral axis and y - the distance of the bottom end of the element above the neutral axis).

(4 marks)

ii) Further to i) above show that the shear stress subjected to the section of the beam of width b is given as q = FAȳ/Ib. A beam of cross-sectional area 150 cm^2, depth 15 cm is subjected to a shear force of 2 kN. Calculate the shear stress on the beam.

(5 marks)

iii) On the same beam in ii) above prove that the shear force distribution on the section of depth d is also given as q = (F/2I).((d^2/4) – y). A beam of width 10 cm, depth 20 cm subjected to a shear stress 20 x 10^3 t/m^2. Calculate the shear force subjected to the section.

(5 marks)

SECTION B (Total: 60 marks)
INSTRUCTION: Answer only THREE (3) questions

Question 3

a) By considering a small element of a beam subjected to bending forming an arc length ds (i.e. pq) as shown in Figure 3, the radius of curvature is R with dx and dy are the horizontal and the vertical lengths respectively and made an angle of $d\Psi$ at centre point O. Derive the relationship of the bending moment (BM) in terms of the flexural rigidity (EI) and the radius of curvature. Subsequently explain how the slope and the deflection could be calculated.

(10 marks)

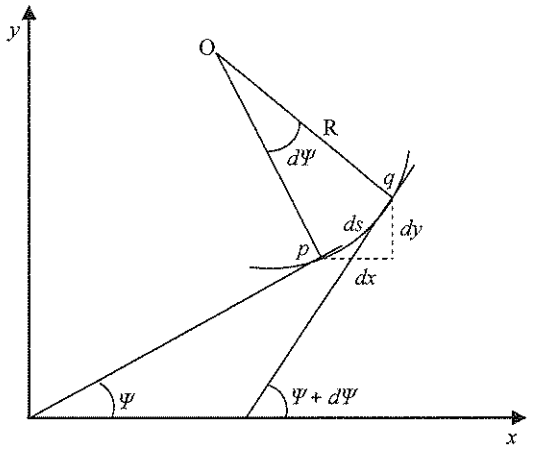

Figure 3

b) The bending moment distribution on the ship hull of a cargo ship of length L = 200 m floating in calm water is given in Table 1. The Young's Modulus (E) of the steel material of the main structure is 0.4 MN/m^2 and the second moment of area of the cross-section (I) at station 6 is 600 m^4. Evaluate the deflection of the ship at amidships.

(8 marks)

Table 1

Station	1	2	3	4	5	6	7	8	9	10	11
BM (MNm)	0	273	1320	3301	5713	14567	6538	4365	1987	480	0

c) Further to b) above the cargo ship hull is in sagging condition. If the section modulus (Z) at amidships of the vessel on the compressive section is 50 m^3, calculate the compressive bending stress on the main deck.

(2 marks)

Question 4

a) With reference to Figure 4, consider a part length of a beam $d\ell$ before subjected to a bending moment (BM). y is the distance of an element EF to the neutral axis GH. As it is subjected to bending it takes up a shape of an arc with the center O, and substends an angle θ and R being the radius of curvature as shown in Figure 5. Prove (i.e. derive) that б/y = E/R, where б - bending stress and E - elasticity or Young's Modulus of the material.

(10 marks)

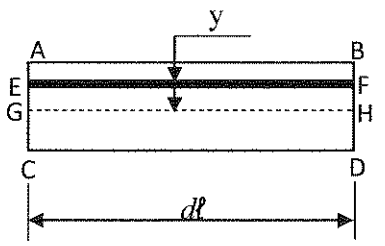

Figure 4

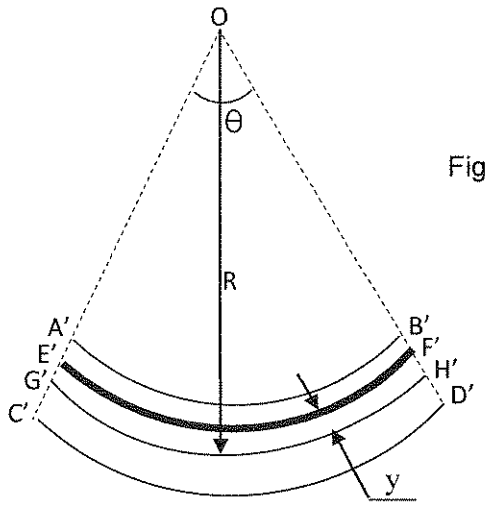

Figure 5

b) A typical high tensile strength (HTS) steel ship structure is subjected to a bending stress б = 230 N/mm^2, distance of the neutral axis of the cross-section of the structure on the compressive section y = 200 mm and the elasticity or the Young's

Modulus of the HTS steel E = 360 N/mm^2, calculate the radius of curvature R of the beam when subjected to bending.

(5 marks)

c) If the second moment of area of the cross-section of the structure in b) above is I = 2 x 10^{-6} m^4, calculate the probable BM subjected to the structure.

(5 marks)

Question 5

a) State the concept of Castigliano's Theorem on deflection due to strain energy (U) of an elastic body.

(3 marks)

b) Prove that the strain energy (U) stored in a structural member of Length L, cross-sectional area A, Young's Modulue E subjected to an axial force P is given as:

$$U = P^2L / (2AE)$$

(4 marks)

c) A structural member of length L = 5 m, cross-sectional area A = 0.05 m^2, Young's Modulus E = 270 N/mm2 is subjected to an axial force of 10 t. Calculate the strain energy stored in the structure and the axial deflection due to the applied force.

(3 marks)

d) Prove that the strain energy stored due to bending moment of a simply supported beam of length L subjected to a point load 2P at L/3 from one end and flexural rigidity EI is given as:

$$U = 24P^2L^3 / (729EI)$$

(5 marks)

e) A simply supported beam is subjected to a point load of 2 t at 2 m from one end, length of beam is 6 m and the flexural rigidity is 200 tm^2, calculate the strain energy in the beam.

(5 marks)

Question 6

a) State the main components of the total bending moment in considering longitudinal strength of vessels of unrestricted service adopted by Ship Classification Societies?

(4 marks)

b) What are the tanks filling conditions normally adopted for compliance with Ship Classification Rule for "all filling levels" requirement in longitudinal strength calculation?

(6 marks)

c) The Distribution Factor M envelope curve of wave bending moment extracted from Part 3, Chapter 2, Section1, Paragraph 3.5.2, Steel Vessels 2015 of ABS Rules Book is shown in Figure 6. Calculate the sagging wave bending moment of a ship amidships (between 0.4L to 0.65L from aft end) in accordance with the ABS Rules Book and determine the wave bending moments at 0.3L and 0.7L from aft end.

$M_{ws} = -k_1 C_1 L^2 B(C_b + 0.7) \times 10^{-3}$ Sagging Moment (kNm)

Ship dimensions and coefficients:

L = 330 m, B = 65 m, C_b = 0.52

C_1 = 10.75, k_1 = 110

(8 marks)

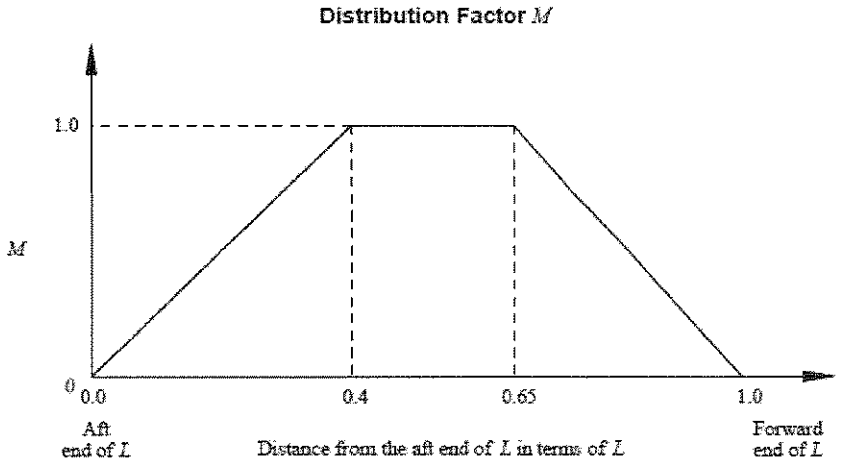

Figure 6

d) The positive shear force F_{wp} based on Part 3, Chapter 2, Section1, Paragraph 3.5.3, Steel Vessels 2015 of ABS Rules Book is given below and the envelopes of the maximum shearing forces Distribution Factor F_1 is given in Figure 7.

$F_{wp} = +kF_1C_1LB\ (C_b + 0.7) \times 10^{-2}$ kN

Calculate the positive F_{wp} at 0.2L, given that k = 30, C_1 = 10.75, for the ship with principal particulars give in c) above.

(2 marks)

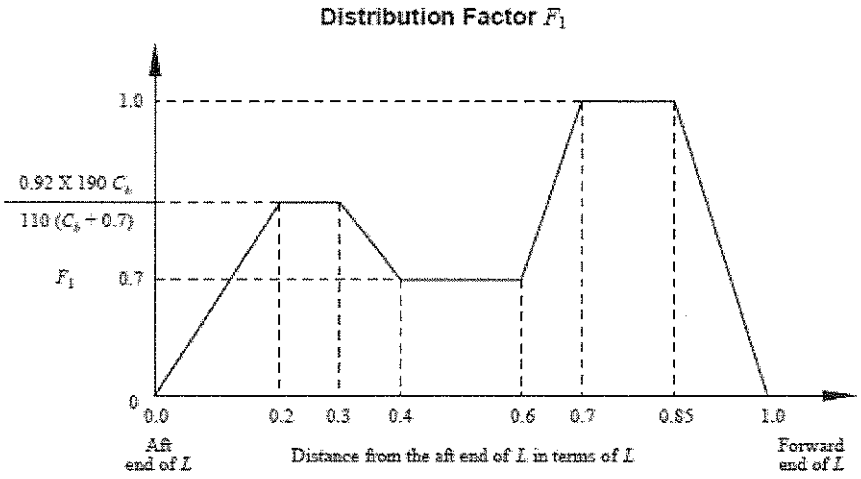

Figure 7