TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL & AUTOMOTIVE ENGINEERING

DIPLOMA IN MARINE ENGINEERING

EMR 2219: APPLIED MECHANICS II

END OF SEMESTER II YEAR II EXAMINATION

SERIES:APRIL2016

TIME:2HOURS

DATE: Pick DateSelect MonthPick Year

TIME: 2 HOURS

INSTRUCTIONS TO CANDIDATES

1. You are required to have the following for this examination:
    - Examination Booklet, Examination pass and student ID.
    - Drawing instruments
    - Scientific calculator
2. This paper consists of **FIVE** Questions.
3. Answer **ANY THREE** Questions.
4. Maximum marks for each part of a question are shown.
5. Take gravitational acceleration, g = 9.81m/s^2 where applicable.
6. **Do not write on the question paper**

QUESTION ONE

(a) State any **THREE** assumptions made in the theory of pure torsion of shafts. (3 Marks)

(b) A solid circular is required to transmit a torque of 40KN. The shaft material has a modulus of rigidity of 80GN/m^2. If the shear stress is not to exceed 80MN/m^2, determine:

i) The diameter of the shaft

ii) The angle of twist in a length of 1m of the shaft

(7 Marks)

(a) A hollow shaft of 400mm external diameter transmits 9MW at 120rev/min. If the angle of twist measured over a length of 2m is 0.45^o and Modulus of rigidity of the material is 80GN/m^2, determine:

(i) The internal diameter of the shaft.

(ii) The maximum shearing stress.

(iii) The diameter of a solid to replace the hollow shaft and to have the same maximum shearing stress.

(iv) The number of times the solid shaft will be heavier than the hollow shaft provided that both shafts are made of the same material.

(10 Marks)

QUESTION TWO

(a) From the first principles, show that the torque (T) applied to a hollow shaft of external diameter d_o and internal diameter d_i respectively is given by :

$$T = \frac{\prod G\theta}{32L}\left(d_o^4 - d_i^4\right)$$

Where:

G – Modulus of rigidity

θ – Angle of twist in radians

L – Shaft length

(10 Marks)

(b) A solid aluminium alloy rod fits inside a hollow steel shaft of internal diameter 60mm and external diameter 70mm. The two are rigidily connected so that they twist together. If a torque of 1KNm is applied to the composite shaft, determine:

i) The torque in each material

ii) The angle of twist per metre length of the composite shaft

Take modulus of rigidity of aluminium as 30GN/m^2 and that of steel as 80GN/m^2.

(10 Marks)

QUESTION THREE

(a) Show that the total elongation e, of an initially stright bar of length L, cross-sectional are A and modulus of elasticity E is given by: $e = \frac{FL}{AE}$; where F is the bar tensile load.

(3 Marks)

(b) A steel strut, 40mm diameter, is turned to 20mm diameter for one-half length. Calculate the ratio of extensions in the two parts due to axial loading. (6 Marks)

(c) A solid cylindrical bar 20mm diameter and 180mm long, is welded to a hollow tube 20mm internal diameter, 120mm long, to make a bar of total length 300mm. Determine the external diameter of the tube if when loaded axially by 40KN load, the stress in the solid bar and that in the tube are the same.

(5 Marks)

(d) A column of steel tube, 70mm inside diameter, is filled with concrete. If the maximum stress in the concrete is not to exceed 25N/mm^2 and the column is to carry a compressive load of 200KN, calculate the minimum outside diameter of the tube. Take modulus of elasticity for concrete as 20KN/mm^2 and that for steel as 200KN/mm^2.

(6 Marks)

QUESTION FOUR

a) A hollow shaft having the external diameter twice the internal diameter is subjected to pure torque and attains a maximum shear stress τ . Show that the strain energy per unit volume of the shaft is $\frac{5\tau^2}{16G}$, where G is Modulus of rigidity of the shaft material.

(9 Marks)

b) Such a shaft in (a) above is required to transmit 4.6MW at 120rev/min with a uniform torque and the maximum shear stress is not to exceed 70MN/m^2. Calculate:

(i) Shaft diameter

(ii) Actual energy stored per unit volume when transmitting this power

(11 Marks)

QUESTION FIVE

a) (i) State Castigliano's first theorem of deflection.

(ii) Using the Castigliano's first theorem of deflection, derive the deflection at the free end of an end loaded cantilever.

(8 Marks)

(b) A steel bar of constant section, second moment of area *I* is bend and is fixed at one end as shown below with a force P acting horizontally. Show that:

(i) Vertical deflection = Pal^2

(ii) Horizontal deflection = $\frac{Pa^2}{EI}\left[\frac{a}{3}+L\right]$

(12 Marks)