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, $g = 9.81 m/s^2$ where applicable.
6. **Do not write on the question paper**

QUESTION ONE

(a) Briefly explain the following terms:-

i) Modulus of elasticity

ii) Modulus of rigidity

(4 Marks)

(b) A mild steel rod 12mm diameter was tested for tensile strength with a gauge length of 50mm and the following observations were recorded: Final length = 80mm; final diameter = 7mm; yield load = 3.4KN and ultimate load = 6.1KN. Calculate:

i) Yield stress

ii) Ultimate tensile stress

iii) Percentage reduction in area

iv) Percentage elongation

(8 Marks)

(c) A rectangular timber tie, 0.18m by 0.08m, is reinforced by a bar of aluminium of 25mm diameter. Calculate the stresses in the timber and reinforcement when the tie caries an axial load of 300KN. Take modulus of elasticity for timber as $15GN/m^2$ and that for aluminium as $90GN/m^2$. (8 Marks)

QUESTION TWO

(a) The working condition to be satisfied by a shaft transmitting power is that, the shaft must not twist more than 1 degree on a length equal to 15 diameters. If the Modulus of rigidity of the shaft material is $80x10^3N/mm^2$, determine the stress induced in the shaft and also the appropriate diameter of the shaft to satisfy the given condition and to transmit 1MW of power at 240rev/min. (7 Marks)

(b) A composite shaft is used to transmit 380KW at a speed of 750rev/min. The composite shaft is made by passing a solid cylindrical shaft of 65mm diameter and 1.8m long through the centre of a hollow cylindrical shaft of 1.8m long, 65mm and 75mm internal and external diameter respectively. They are then rigidly joined together at their ends. The solid shaft is made of steel and the hollow shaft is made of brass. Determine:

(i) The angle of twist.

(ii) The maximum stresses in the two shafts.

Take G for bras as $35GN/m^2$ and G for steel as $78GN/m^{2.}$

(13 Marks)

QUESTION THREE

a) A solid shaft runs at 240rev/min. Its diameter is 150mm and the permissible shear stress in the shaft material is 55N/mm^2. The shaft has a coupling on it having six bolts on a 260mm pitch circle. Determine:

i) The maximum allowable power that can be transmitted by the shaft

ii) The diameter of the bolts if the maximum shear stress in the bolts must not exceed 100N/mm^2.

(8 Marks)

b) Two solid shafts are rigidly connected at their ends to form one single shaft. One of the shafts is 5m long, 0.6m in diameter and has a Modulus of rigidity of 41GN/m^2. The second shaft is 3m long, 1m in diameter and has a Modulus of rigidity of 82GN/m^2. The connected shaft is subjected to a toque of 1200NM. Determine:

(i) The maximom shear stress induced in each part of the shaft.

(ii) The resulting angle of twist.

(iii)Shear strain of the shaft.

(12 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. (12 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

(8 Marks)

QUESTION FIVE

a)

(i) Show that the hoop stress induced in a cylindrical shell subjected to internal pressure is twice the resulting longitudinal stress.

(ii) The radial stress in a pressurized cylindrical shell can be ignored in relation to the resulting hoop and longitudinal stresses. Show this justification by making a reasonable comparison of the stresses.

(9 Marksks)

b) A cylindrical shell, 2.4m in diameter, capable of holding a gas at a pressure of $2MN/m^2$ is to be made from steel plate whose tensile strength is $600N/mm^2$. Assuming a factor of safety of 4 and a joint efficiency of 70%, determine the minimum thickness of the plate required.

(5 Marks)

c) A spherical shell, thickness 20mm, diameter 1m is subjected to an internal pressure of $5MN/m^2$. Calculate the stress in the material and the change in diameter. Take the value of Young's Modulus as $200KN/mm^2$.

(6Marks)