

The Open University of Sri Lanka Faculty of Engineering Technology Department of Mechanical Engineering



Study Programme

: Bachelor of Technology Honours in Engineering

Name of the Examination

: Final Examination

Course Code and Title

: MEX5232/DMX5532 Strength of Materials II

Academic Year

:2017/18

Date

: 16 January 2019

Time

: 0930 h-1230 h

Duration

: 3 hours

General Instructions

1. Read all instructions carefully before answering the questions.

2. This question paper consists of Seven (7) questions in four (4) pages.

3. Answer any Five (5) questions only. All questions carry equal marks.

4. This is a Closed Book Test (CBT).

5. Answers should be in clear hand writing.

6. Do not use Red colour pen

Q1 A simply supported beam AB carries a uniformly distributed load and a concentrated load as shown in Figure Q 1.

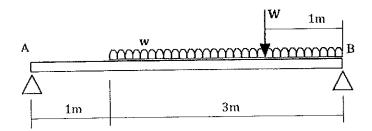


Figure Q1

(a)	Find out the reactions at the supports A and B in terms of w and W.	
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(2 marks)

(b) Write down the differential equation of the elastic curve, using Macaulay's Method, indicating the used sign convention.

(6 marks)

(c) Determine the deflection at the mid span with the following data:

(8 marks)

 $W = 8 \text{ kN}, \quad w = 0.5 \text{ kN/m},$

Flexural rigidity of the beam is 800 kNm²

(d) Sketch the bending moment diagram

(4 marks)

(4 marks)

Q2 (a) Figure Q2 (a) shows a beam carrying two point loads. The ends of the beam are fixed. The flexural rigidity (EI) of the beam is 150 kNm².

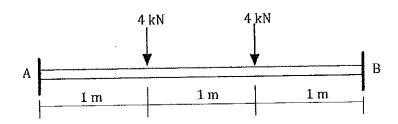


Figure Q2(a)

(i) Sketch the bending moment diagrams considering each load acting on the beam separately. Neglect the self weight of the beam.

(Hint: Consider the beam as a cantilever, by introducing an internal moment and a force at one end)

- (ii) Determine the value of fixing moments at A and B using **Moment** (4marks) **Area Method.**
- (iii) Find the deflection at mid-span. (6 marks)
- (b) The beam shown in Figure Q2 (b) is fixed at A, and is simply supported at D. B is a hinge.

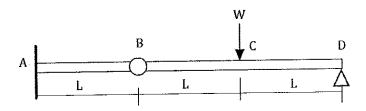


Figure Q2(b)

- (i) Sketch the Bending Moment Diagram of the beam AD. (2 marks)
- (ii) Find the slope at point B in terms of W, L and flexural rigidity (EI) (4 marks)
- Q3 (a) Write down the Lame Equations for stresses in thick Cylinders (4 marks)
 - (b) The inner radius of a thick cylinder 100 mm. The permissible stress of the cylinder material is 100 MPa (tensile).
 - (i) Find the outer radius of the cylinder, if the cylinder is to be subjected to an internal pressure of 60 MPa. (8 marks)
 - (ii) Find the value of external pressure in addition to the internal pressure which makes the hoop stress at the outer surface zero. (8 marks)

Q4 (a) The radial and circumferential stresses induced in a solid rotating cylinder are given by the following two equations.

$$\sigma_r = A - \frac{B}{r^2} - (3 + \nu) \frac{\rho r^2 \omega^2}{8}$$

$$\sigma_{H} = A + \frac{B}{r^2} - (1 + 3\nu) \frac{\rho r^2 \omega^2}{8}$$

Deduce an equation for the radial stress in a rotating solid disc.

(8 marks)

(b) A steel ring has been fitted to a steel solid shaft of diameter 150 mm. The outer diameter of the ring is 250 mm. When the shaft runs at the speed of 100 rad/s, the radial pressure at the interface is 10 MN/m². Find the hoop stress at inner surface of the ring.

For steel use the following:

Density = $7,500 \text{ kg/m}^3$, Poisson's ratio = 0.3

Q5 (a) Show that the maximum shear stress (τ_{max}) and the angle of twist (ϕ) of a solid circular shaft of diameter d and length L, subjected to a torque of T are given by the following two equations.

$$\tau_{max} = \frac{16T}{\pi d^3} \qquad \qquad \phi = \frac{TL}{GJ}$$

Where G = Modulus of Rigidity of the shaft material

J= Second Polar Moment of Area

(b) A solid steel shaft AD rotates freely in a bearing at D, and is loaded at B and C by torques in the same direction as shown in Figure Q5. The shaft is connected in a gear box at A. G = 75 GPa

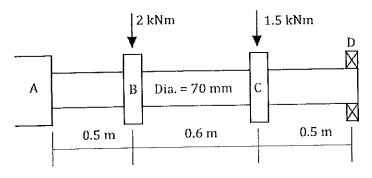


Figure Q5

Determine the following; in a situation, the gear box is locked.

(i) Maximum shear stress in each part of the shaft.

(9 marks)

(ii) Angle of twist at D.

(5 marks)

06 (a) Define the following referring to bending of beams.

(6 marks)

- (i)Section Modulus
- (ii)Plastic Modulus
- (iii)Shape Factor
- (b) Show that the Shape Factor for a rectangular section is 1.5.

(4 marks)

(c) A cantilever beam of length 1.2 m is subjected to a uniformly distributed load, w. The beam section is 60 mm x 40 mm with 60 mm side vertical. The yield stress of the beam material is 300 MPa.

Find the following.

(i) Value of w that initiates yielding of the beam.

(2 marks)

(ii) Minimum value of w that causes a fully plastic condition in the beam.

(4 marks)

(iii) Distance from the free end to the point where 50 % of the section has become fully plastic, with the value of **w** found in (ii).

(4 marks)

Note:

Partially Plastic Bending moment for a rectangular section is given by the following formula:

$$M_{PP} = \frac{B\sigma_{y}}{12}(3D^{2} - d^{2})$$

D=depth, B=width, d=depth to which plastic deformation has taken place.

Q7 (a) Explain how the Neutral Axis is established for a beam section.

(2 marks)

(b) Explain briefly the following failure theories.

(8 marks)

Maximum Principal Stress Theory

Maximum Shear Stress Theory

- (c) A shaft is subjected to an axial load of 5 kN and a torque of 1 kNm. The elastic limit in tension of the shaft material is 270 MN/m².
 - (i) Obtain an expression for maximum principal stress in terms of (6 marks) diameter "d".
 - (ii) If d = 40 mm, is the shaft in safe operating condition according to maximum shear stress theory with a factor of safety 2?