MACHAKOS UNIVERSITY

University Examinations 2019/2020 Academic Year

SCHOOL OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF MECHANICAL AND MANUFACTURING ENGINEERING

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

DIPLOMA IN MECHANICAL ENGINEERING (AUTOMOTIVE AND PLANT)

MEDPR 315: STRENGTH OF MATERIALS III

DATE: 21/10/2020 **TIME: 8.30-10.30 AM**

INSTRUCTIONS:

-Section A is compulsory

-Attempt any TWO other questions from section B

SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

a) Derive an expression for the simple theory of torsion. (10 marks)

b) A uniform metal bar has a cross-sectional area of $0.0007m^2$ and a length of 1.5m with an elastic limit of $156.96MN/m^2$.Take $E=196.2GN/m^2$ and determine the;

i. Proof resilience

ii. Maximum value of an applied tensile load, which may be suddenly applied without exceeding the elastic limit.

iii. Value of the gradually applied load which will produce the same extension as that produced by the suddenly applied load. (10 marks)

c) A close-coiled helical spring is to have a stiffness of 1KN/m compression, a maximum load of 50N and a maximum shearing stress of $120MN/m^2$. The solid length of the spring i.e. when the coils are touching is to be 45mm.Find the diameter of the wire, the mean radius of the coils and the number of coils required. Take $G=82GN/m^2$. (10 marks)

SECTION B: (ATTEMPT ANY TWO QUESTIONS IN THIS SECTION)

QUESTION TWO (20 MARKS)

a) State four assumptions made in the simple torsion theory. (4 marks)

b) A hollow shaft with a diameter ratio of 3:4 is to transmit 60KW at 200 rev/min. The maximum shear stress in the shaft is limited to $70MN/m^2$ and the angle of twist to 3.8^0 in a length of 4m, take $G=80GN/m^2$ and determine the dimensions of the shaft.
(16 marks)

QUESTION THREE (20 MARKS)

a) A 25mm diameter bar,2.6m long is suspended vertically, if a mass of 10kg falls through a height of 300mm onto a collar which is rigidly attached to the bottom end of the bar. Taking $E=200GN/m^2$and $g=10m/s^2$, determine the instantaneous stress and elongation of the bar. (10 marks)

b) When used horizontally as a simply supported beam, a concentrated force of 1KN applied at the centre of the support span produces a static deflection of 5mm. The same load will produce a maximum bending stress of $158MN/m^2$. When a mass of 10kg is allowed to fall through a height of 12mm on to the beam at mid-span, determine the;

i. Magnitude of the instantaneous stress produced.

ii. Instantaneous deflection. (10 marks)

QUESTION FOUR (20 MARKS)

a) An open coiled helical spring of 10 coils and mean diameter 76mm, with a helix angle of 20^o is made from wire of 6mm diameter. Take $E=210GN/m^2$ and $G=70GN/m^2$.
Determine the;

i. Load required to produce an extension of 8mm.

ii. Bending and shear stress on the surface of the wire. (11 marks)

b) When the spring is subjected to an axial torque of 1.5Nm, determine the;

i. Angular twist at the free end of the spring.

ii. Bending and shear stresses set up. (9 marks)

QUESTION FIVE (20 MARKS)

Determine using Castigliano's first theorem, for the bend cantilever shown below which is constructed from 50mm diameter bar throughout, with E=200GN/m^2; The vertical deflection of point A when loaded at A with a vertical load of 600N.