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STRENGTH OF MATERIALS AND MECHANICS OF MACHINES
June/July 2021
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN MECHANICAL ENGINEERING (PRODUCTION OPTION)
DIPLOMA IN MECHANICAL ENGINEERING (PLANT OPTION)
DIPLOMA IN AUTOMOTIVE ENGINEERING
DIPLOMA IN WELDING AND FABRICATION
DIPLOMA IN CONSTRUCTION PLANT ENGINEERING

MODULE II

STRENGTH OF MATERIALS AND MECHANICS OF MACHINES

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Drawing instruments;
Scientific calculator.
*This paper consists of **EIGHT** questions in **TWO** sections; A and B.*
*Answer **FIVE** questions, taking at least **TWO** question from each section.*
All questions carry equal marks.
Maximum marks for each part of a questions are indicated.
Candidates should answer the questions in English.

This paper consists of 6 printed pages.

Candidates should check the question paper to ascertain that all the pages are printed as indicated and that no questions are missing.

SECTION A: STRENGTH OF MATERIALS

Answer at least TWO questions from this section.

1. (a) (i) Define Poisson's ratio of an engineering material and state its S.I units.

(ii) Distinguish between modulus of elasticity and modulus of rigidity of an engineering material.

(4 marks)

(b) A solid alloy bar has a length of 1400 mm and a diameter of 35 mm. When it is subjected to a compressive load of 50 kN, its length reduces by 0.0364 mm and its diameter increases by 0.003183 mm. When subjected to a pure torque of 150 NM, it undergoes an angular twist of 1.2°. Determine the following for the alloy:

(i) modulus of elasticity;
(ii) Poisson's ratio;
(iii) modulus of rigidity.

(11 marks)

(c) Figure 1 shows a simply supported beam. Determine the:

(i) reactions at the supports;
(ii) bending moment at the point of action of the 50 kN load;
(iii) shear force at midspan.

(5 marks)

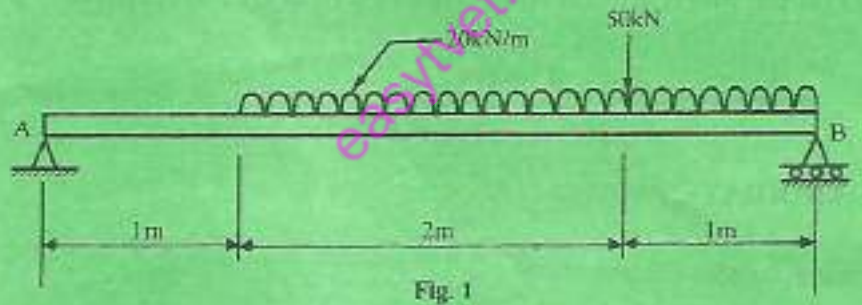

Fig. 1

2. (a) A cantilever beam of length L metres carries a concentrated load P Newtons at its free end and a uniformly distributed load of intensity W Newtons per meter over its full span. Using the principle of superposition, show that the maximum deflection of the beam, y_{max} is given by:

$$y_{max} = \frac{L^3}{EI}\left(\frac{WL}{8} + \frac{P}{3}\right)$$

where EI = flexural rigidity. (14 marks)

(c) A semi elliptic leaf spring has 8 plates each of breath 80 mm and thickness 5 mm. The length of the longest plate is 1 m and E = 200 GN/m^2. The stress in the spring is not to exceed 40 MN/m^2 and the maximum spring deflection is to be 10 mm. Determine the:

(i) maximum permissible load;
(ii) required radius of curvature.

(8 marks)

SECTION B: MECHANICS OF MACHINES

*Answer at least **TWO** questions from this section.*

5. (a) With the aid of sketches, explain the difference between flat belt and vee belt drives.

(4 marks)

(b) Show that the torque T transmitted by a pair of worn clutch is given by:

$$T = \mu W R$$

where μ = coefficient of friction between the surfaces;
W = axial forces pressing the surface together;
R = mean radius of the friction surfaces.

(10 marks)

(c) The following data refers to a cone clutch:

-	inside diameter of friction	=	200 mm
-	outside diameter of friction surface	=	400 mm
-	axial load pressing the surface together	=	2.5 kN
-	coefficient of friction between the surfaces	=	0.56
-	rotational speed	=	1500 rev/min
-	cone angle	=	45°

Neglecting clutch slip, determine the power transmitted by the clutch if the friction surfaces are worn. (6 marks)

6. (a) (i) Define radius of gyration of a body.
(ii) State the parallel axes theorem.

(4 marks)

(b) Show that for a rectangular section of breadth b and depth d, the moment of inertia Ixx about the centroidal axis X-X is given by:

$$Ixx = \frac{bd^3}{12}$$

(7 marks)

(c) The rotating parts of a mill have a mass of 200 kg and a radius of gyration of 600 mm. The mill is initially stationary. By means of a clutch, the mill is suddenly coupled to an electric motor running at 1200 rev/min. The rotor of the motor has a mass of 120 kg and a radius of gyration of 300 mm. Determine the:

(i) speed of the motor and mill immediately after coupling, in rad/s;
(ii) kinetic energy loss due to the coupling.

(9 marks)

7. (a) Show that for a body moving round a circular track of radius r at a velocity V, the centripetal acceleration a_c is given by:

$$a_c = \frac{V^2}{r}$$

(6 marks)

(b) Figure 3 shows a homogeneous disc of uniform thickness, with four holes P, Q, R and S. The disc rotates on a spindle about its axis. The diameters of the holes P, Q, R ad S are 25 mm, 30 mm, 20 mm and 15 mm respectively and the distances of their respective centres from the spindle are 200 mm, 100 mm, 150 mm and 200 mm. An additional hole T is to be drilled through the disc to restore balance. If the diameter of hole T is to be 26 mm, determine the:

(i) required eccentricity of hole T;
(ii) angular inclination of hole T from the line of P.

(14 marks)

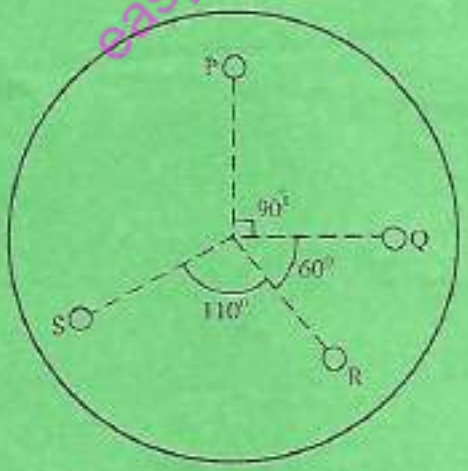

Fig. 3

8. (a) With the aid of a sketch, describe the compound spur gear train. (4 marks)

(b) The input shaft to a gear box transmits 80 kW at a speed of 1500 rev/min. A torque of 201 Nm acting in the direction of rotation of the input shaft is required to fix the gear housing. If the overall efficiency of the gear train is 90%, determine the:

(i) direction of rotation of the output shaft;
(ii) speed of the output shaft in rev/min.

(10 marks)

(c) A truck of mass 12 tonnes has road wheels of 760 mm diameter. The truck engine develops a power of 40 kW at the maximum engine speed of 3000 rev/min. The overall transmission efficiency is 88% and the overall resistance to motion is 300 N. Determine the shortest time take for the truck to accelerate from rest to a speed of 1.2 m/s on level track for driving gear ratio of 10/1 (6 marks)

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