2506/205
AIRCRAFT MECHANICAL
TECHNOLOGY I
June/July 2023
Time: 3 hours

THE KENYA NATIONAL EXAMINATIONS COUNCIL

DIPLOMA IN AERONAUTICAL ENGINEERING (AIRFRAMES AND ENGINES OPTION)

MODULE II

AIRCRAFT MECHANICAL TECHNOLOGY I

3 hours

INSTRUCTIONS TO CANDIDATES

You should have the following for this examination:
Answer booklet;
Mathematical tables/Non-Programmable scientific calculator;
Drawing instruments;
Thermodynamic and transport properties of fluids tables, by G.F.C. Rogers and Y.R. Mayhew.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions in total taking at least **TWO** questions from each section.*
All questions carry equal marks.
Maximum marks for each part of a question are as indicated.
All dimensions are in mm unless stated otherwise.
Candidates should answer the questions in English.

This paper consists of 7 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) Define the following terms as applied to engineering materials:

(i) shear modulus;

(ii) Poisson's ratio.

(2 marks)

(b) A circular steel bar of diameter 25 mm and length 500 mm is subjected to a tensible load of 15 kN. The modulus of elasticity of steel is 200 GN/m^2 and the Poisson's ratio is 0.3.

Determine the:

(i) change in length of the bar;

(ii) change in the diameter;

(iii) stress exerted on the bar.

(9 marks)

(c) The coupling shown in figure 1 is constructed from steel of rectangular cross-section and is designed to transmit a tensile force of 50 kN. If the rivet is of 15 mm diameter, determine the:

(i) shear stress in the rivet;

(ii) direct stress in the plate;

(iii) direct stress in the forked end of the coupling.

(9 marks)

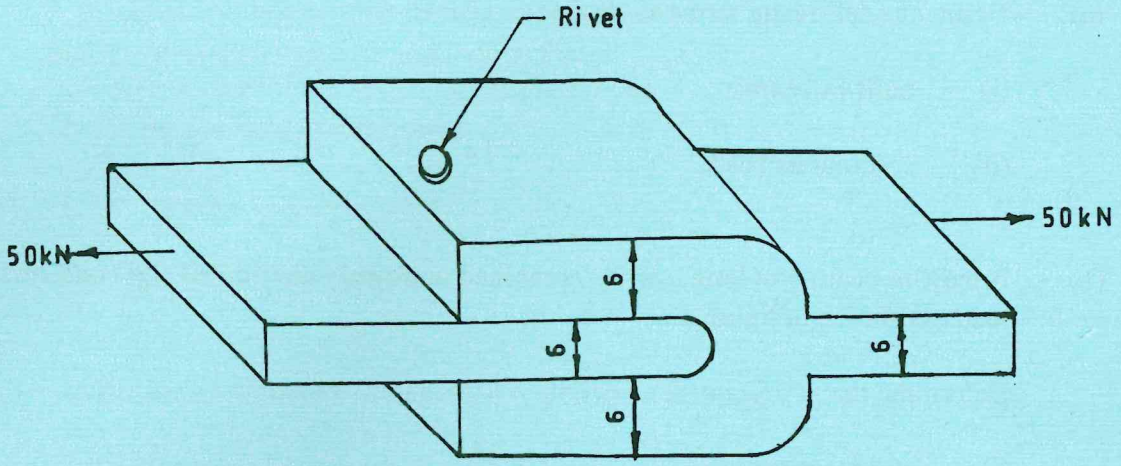

Fig.1

2. (a) Define the following terms as used in Engineering:

(i) shear force;

(ii) bending moment.

(4 marks)

(b) Figure 2 shows a beam AB of span 5 m simply supported at points C and B, carrying a concentrated load of 5 kN at point A and a uniformly distributed load of intensity 10 kN/m between points C and B.

Determine the:

(i) reactions at C and B;

(ii) shear force at a point 2 m from A;

(iii) maximum bending moment.

(16 marks)

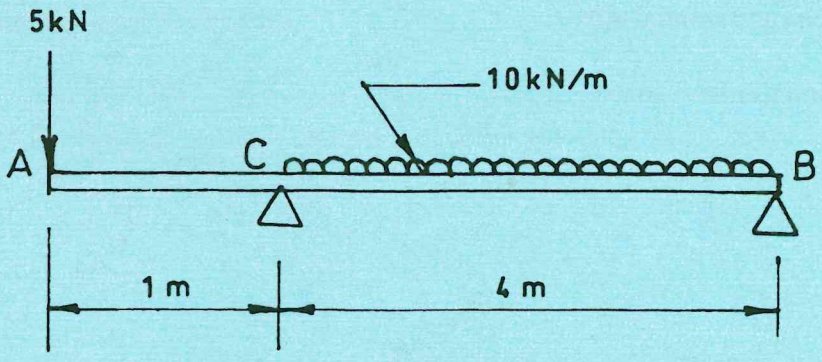

Fig.2

3. (a) Define the following terms as applied to beams:

(i) built-in beam;

(ii) continuous beam.

(2 marks)

(b) A built-in beam 4 m long, carries combined uniformly distributed and concentrated loads as shown in figure 3.

Determine the:

(i) end reactions;

(ii) fixing moments at the built-in supports.

(18 marks)

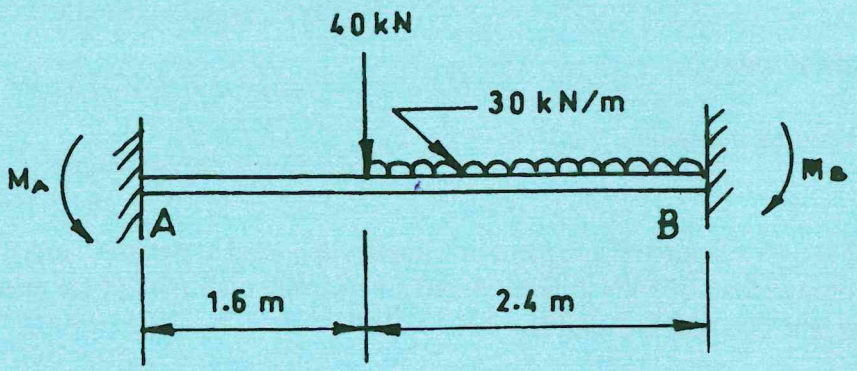

Fig.3

4. (a) A thin-walled cylindrical vessel is subjected to an internal fluid pressure of 2.1 MN/m^2. The internal diameter of the cylinder is 1 m while its length is 3 m. The wall thickness is 33 mm.

Determine the:

(i) circumferential stress;

(ii) longitudinal stress.

(4 marks)

(b) A solid circular steel rod of 60 mm diameter and 1.2 m long transmits 120 kW of power at a speed of 1500 rev/min. Determine the:

(i) maximum stress induced;

(ii) angular twist in degrees.

(Take G = 80 GN/m^2).

(8 marks)

(c) The following data refers to an open coiled helical spring:

rod diameter	=	6 mm;
coil diameter	=	60 mm;
pitch	=	80 mm;
number of coils	=	10;
axial load	=	100 N;
Young's modulus	=	200 GN/m^2;
modulus of rigidity	=	80 GN/m^2.

Determine the:

(i) helix angle;

(ii) length of the spring coil rod;

(iii) maximum bending stress at the surface of the wire.

(8 marks)

SECTION B: MECHANICS OF MACHINES

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

5. (a) Define the term kinematics. (2 marks)

(b) From first principles, show that the centripetal acceleration "a" of a body moving round a circular track of radius r, with a tangential velocity, "V" is given by:

$$a = \frac{V^2}{r}.$$

(8 marks)

(c) The propeller of an aircraft has a diameter of 2 m, a mass of 40 kg and a radius of gyration of 105 m. It makes 100 revolutions while accelerating uniformly from an initial angular velocity of 3 rad/s for 4 seconds. Determine the:

(i) final angular speed in rev/min;

(ii) linear acceleration at the tip of the propeller;

(iii) accelerating torque.

(10 marks)

6. (a) State the following theorems as applied to mass moment of inertia:

(i) perpendicular axes theorem;

(ii) parallel axes theorem.

(4 marks)

(b) Show that the mass moment of inertia, I of a thin uniform rod of length L and mass m rotating about one end is given by:

$$I = \frac{mL^2}{3}.$$

(5 marks)

(c) Figure 4 shows a T-section.

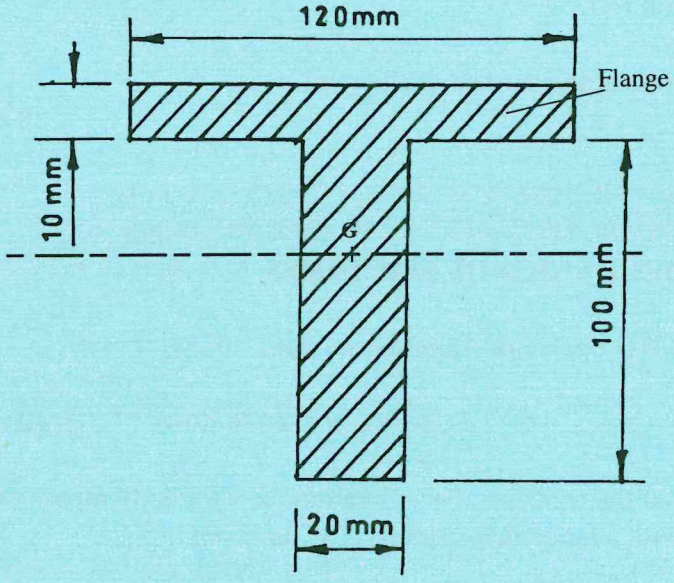

Fig. 4

Determine the:

(i) moment of inertia about an axis passing through the centroid G and parallel to the top of the flange;

(ii) radius of gyration.

(11 marks)

7. (a) Assuming uniform wear, show that the torque T, transmitted by a plate clutch is given by:

$$T = \mu WR \ .$$

Where: μ = coefficient of friction;
W = axial spring force;
R = mean radius of the friction surfaces.

(13 marks)

(b) A multiple disc clutch has four pairs of active friction surfaces. The intensity of pressure is not to exceed 127 kN/m^2. The outer and inner radii of friction surfaces are 125 mm and 75 mm respectively. The rotational speed is 500 rev/min. Assuming uniform wear and a coefficient of friction of 0.3, determine the power transmitted. (7 marks)

8. In an aircraft hoisting system, the electric motor drives a winding drum of mean diameter 600 mm, radius of gyration 200 mm and mass of 150 kg. A light cable wound around the drum carries a load of 100 kg. This is accelerated from an initial speed of 1. 5 m/s to a final speed of 3 m/s while travelling upwards through a distance of 5 m. The frictional resistance to the linear motion of the load is 150 N and the friction torque in the bearings of the drum is 5 Nm.

Determine the:

(a) work done; (16 marks)

(b) input torque applied; (2 marks)

(c) maximum input power delivered by the driving motor. (2 marks)

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