2506/205
AIRCRAFT MECHANICAL TECHNOLOGY I
Oct./Nov. 2018
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:
Thermodynamic and Transport properties of fluid tables by Rogers and Mayhew;
Mathematical tables/Non-programmable scientific calculator;
Answer booklet.
*This paper consists of **EIGHT** questions in **TWO** sections; **A** and **B**.*
*Answer **FIVE** questions taking at least **TWO** questions from each section.*
Maximum marks for each part of a question are as shown.
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) Define the following terms:

(i) shearing force;
(ii) Bending moment.

(2 marks)

(b) A beam CADEBFG 4.8 m long is simply supported at two points A and B, 3.2 m apart. The beam is subjected to concentrated loads of 6 kN, 12 kN, 15 kN and 10 kN at C, D, E and F respectively.

CA = 0.5 m, AB = 1.1 m, DE = 1.2 m, EB = 0.9 m, BF = 0.6 m, and FG = 0.5 m

Draw the shearing force and bending moment diagrams indicating the principal values.

(18 marks)

2. (a) State **four** assumptions made in the theory of pure bending. (4 marks)

(b) Derive the simple bending equation.

$$\frac{M}{I}=\frac{\sigma}{y}=\frac{E}{R}$$

where: M = bending moment;
I = second moment of area;
σ = bending stress;
E = Youngs modulus of elasticity;
R = radius of curvature;
y = distance from the neutral axis.

(12 marks)

(c) Figure 1 shows the cross-section area of a beam. The beam is used as a cantilever which projects 2.5 m from a wall and carries a load of 5 kN at the free end. Determine the maximum bending stress in the beam. (4 marks)

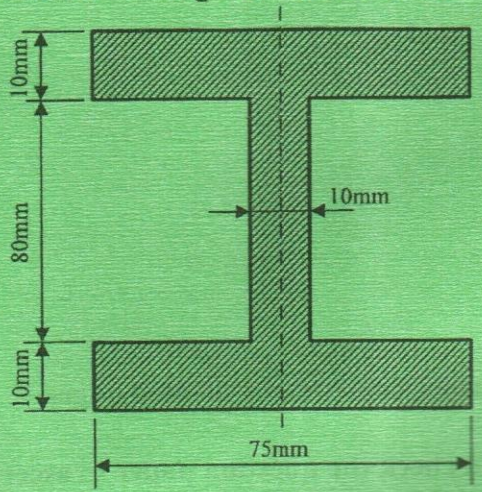


Fig. 1

3. (a) State the following:

(i) principle of superposition;

(ii) **two** disadvantages of fixed beams over simply supported beams.

(4 marks)

(b) A built in beam 5 m long is loaded as shown in figure 2.
Determine the:

(i) end reactions;

(ii) fixing moments at the built in support;

(iii) deflection under the 50 kN load.

Take : EI = 12 MNm^2.

(16 marks)

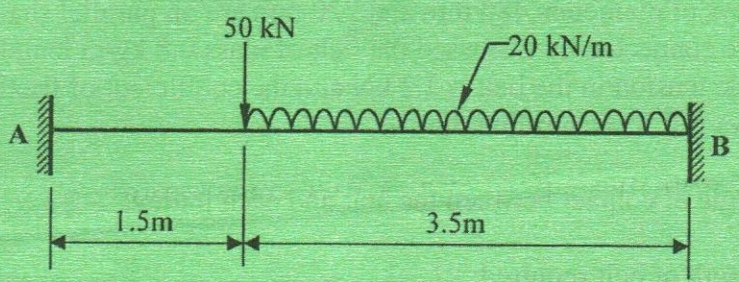


Fig. 2

4. (a) A semi elliptic leaf spring of length L has n plates each of breadth b and thickness t. If the spring carries a central concentrated load W, derive the expression for the:

(i) bending stress σ;

(ii) maximum deflection δ.

(13 marks)

(b) A semi elliptic carriage spring is required to support a central load of 3 kN. The length of the spring is 1.2 m and the breadth of each leaf is 100 mm. The maximum stress is limited to 250 MN/m^2 and the central deflection to 80 mm. Determine the:

(i) thickness of each leaf;

(ii) number of plates.

Take: E = 200 GN/m^2

(7 marks)

SECTION B: MECHANICS OF MACHINES

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

5. (a) Neglecting the mass of the belt, show that for a flat belt drive, the ratio of belt tensions is given by the equation:

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

where:

T_1 = tension on the tight side;
T_2 = tension on the slack side;
θ = angle of lap;
μ = coefficient of friction.

(8 marks)

(b) Two pulleys of diameters 480 mm and 220 mm are on parallel shafts 2 m apart. The pulleys are connected by a crossed flat belt of mass 0.8 kg/m length. The maximum permissible tension in the belt is 1.2 kN and the coefficient of friction between the belt and pulleys is 0.3. Determine the:

(i) angle of contact between the belt and each pulley;

(ii) length of belt required;

(iii) power transmitted when the larger pulley rotates at 250 rev/min.

(12 marks)

6. In an aircraft hoisting gear, an electric motor drives a winding drum of mean diameter 1.6 m, radius of gyration 620 mm and mass 80 kg. A cable runs round the drum carrying a load of 6 tonne on one end and a balancing mass of 3.8 tonne on the other end.
The frictional resistance to the movement of the load is 90 N and that to the movement of the balance mass is 70 N. The frictional torque on the drum shaft if 60 Nm. If the transmission efficiency is 82% at an instant when the upward velocity and acceleration of the load is 3 m/s and 1.5 m/s^2 respectively. Determine the:

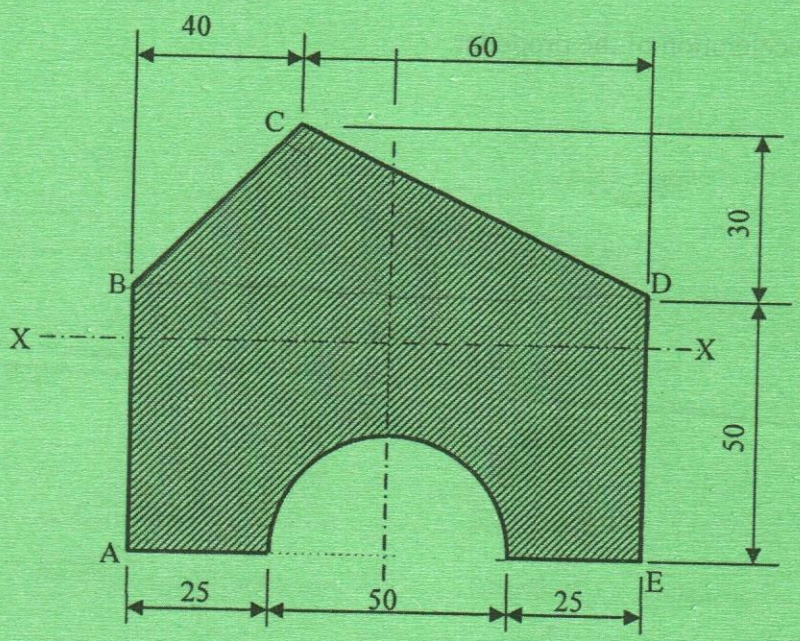
(a) motor power required to drive the drum.

(17 marks)

(b) total kinetic energy of the system. (3 marks)

7. (a) With the aid of a diagram, state the parallel axes theorem. (5 marks)

(b) Determine the second moment of area of the shaded portion shown in figure 3, about the centroidal axis x-x. (15 marks)



Dimensions in mm

Fig. 3

8. (a) (i) State the principle of conservation of angular momentum.

(ii) Distinguish between elastic and inelastic collisions. (5 marks)

(b) A model aeroplane of mass 4 kg is rotated by a string at a constant speed V in a vertical circle of radius 1 m. If the minimum tension of the string is 30 N. Determine the:

(i) constant speed V;

(ii) maximum tension;

(iii) tension when the string is just horizontal.

(6 marks)

(c) A rocket travelling in a horizontal straight line at 5000 m/s explodes and breaks up into two parts of mass 900 kg and 300 kg. Both parts travel in the same direction as the rocket. The lighter part moves at 500 m/s faster than the heavier part. Determine the velocity of each part. (3 marks)

(d) An aircraft propeller of diameter 1.8 m makes 80 revolutions while accelerating uniformly to a final angular speed of 950 rev/min in 9 seconds.
Determine the:

(i) initial angular speed of the propeller in rev/min;

(ii) linear acceleration of the propeller.

(6 marks)

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