2506/205
AIRCRAFT MECHANICAL TECHNOLOGY I
June/July 2019
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.
*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 5 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) modulus of elasticity;
(ii) Poisson's ratio.

(4 marks)

(b) A member of an airframe load stanchion is required to carry a tensile load of 50 kN. The member is 5 metres long, and is to be made of a material whose ultimate strength is 400 MN/m^2. The Poisson's ratio is 0.42 and Young's modulus of elasticity is 200 GN/m^2. A factor of safety of 8 is recommended. Determine the:

(i) required member diameter(s), if the section is:

(I) solid circular;
(II) hollow circular, with its inside diameter being two thirds of the outside diameter;

(ii) change in length and cross sectional diameter, if a solid circular section is used.

(16 marks)

2. (a) With the aid of sketches, distinguish between:

(i) close coiled and open coiled springs.
(ii) semi elliptic and quarter elliptic leaf springs.

(8 marks)

(b) A hollow circular aero shaft has inside and outside diameters of 40 mm and 80 mm respectively. The shaft has a length of 3500 mm, and transmits 240 kW of power at 800 rev/min.
Determine the:

(i) minimum and maximum shear stresses in the shaft;

(ii) angular twist in degrees.

Take: $G = 85$ GN/m^2.

(12 marks)

3. (a) State:

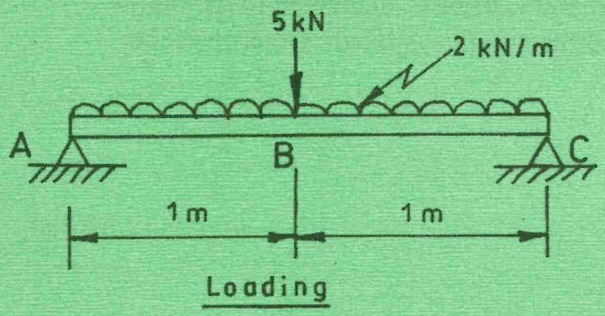
(i) **four** assumptions made in the theory of elastic bending;

(ii) the equation of pure bending and define each parameter in the equation.

(8 marks)

(b) Figure 1 shows the loading and cross section of a member of a submarine undercarriage. If the modulus of elasticity of the material is 240 GN/m², determine the maximum stress at midspan.

(12 marks)



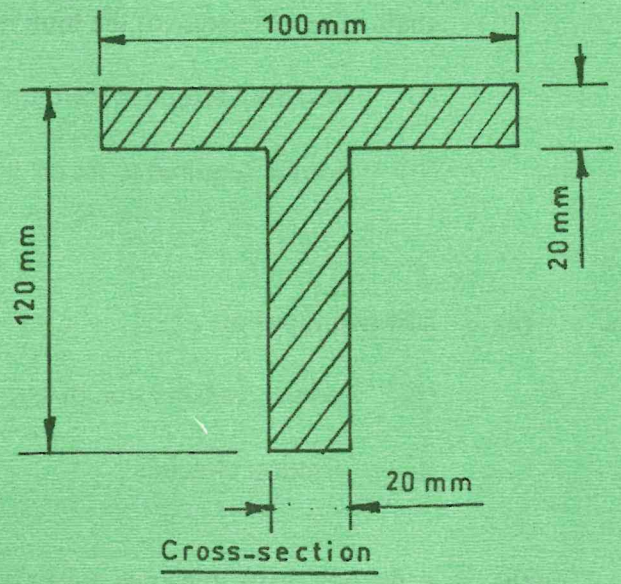


Fig.1

4. (a) Outline **three** factors which determine the maximum deflection of a beam.

(3 marks)

(b) Show that the maximum deflection δ of a cantilever beam of length L, carrying a uniformly distributed load of intensity W per unit length, is given by:

$$\delta = \frac{WL^4}{8\,EI}.$$

Where: EI = flexural rigidity of the beam.

(8 marks)

(c) A mono-rail load crane of an aircraft has a length of 10 metres, and is simply supported at its two ends. At a particular instant, the rail carries a load of 10 kN at a distance of 4 metres from its left hand support. The flexural rigidity of the rail is 135 kNm². Neglecting the mass of the rail, determine its maximum deflection.

(9 marks)

SECTION B: MECHANICS OF MACHINES

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

5. (a) With the aid of sketches, distinguish between:

(i) simple and compound spur gear trains;
(ii) sun wheel and planet wheels in epicyclic gear trains.

(8 marks)

(b) In an aircraft simple epicyclic gear train, the sun wheel has 60 teeth, and each of the three planet wheels has 30 teeth. The input shaft transmits 20 kW and carries the sun wheel which rotates at 1200 rev/min. The planet carrier is connected to the output shaft. The efficiency of the train is 92% and the annulus is fixed. Determine the:

(i) resisting torque at the output shaft;

(ii) torque required to fix the annulus.

(12 marks)

6. (a) List **two** types of:

(i) power transmission belts;

(ii) friction clutches.

(4 marks)

(b) A flat belt drive transmits power between two similar pulleys. From first principles, show that the belt tension ratio is given by

$$\frac{T_1}{T_2} = 23.14^{\mu}.$$

Where:

T_1 and T_2 = tensions on tight and slack sides of the belt;
μ = coefficient of friction.

(10 marks)

(c) A single flat belt drive with two similar pulleys transmits 20 kW of power. The co-efficient of friction between the belt and the pulley is 0.42, and the mean speed of the belt is 20 m/s. Neglecting the effect of centrifugal tension, determine the tensions in each side of the belt.

(6 marks)

7. (a) Outline **three** effects of unbalanced forces in rotating systems.

(3 marks)

(b) A 1.5 m long shaft is mounted on bearings P and Q at its two ends. The shaft carries four pulleys A, B, C and D of masses 50 kg, 80 kg, 100 kg and 50 kg respectively. The distances of A, B, C and D from bearing P are 0.3 m, 0.5 m, 0.8 m and 1.2 m respectively, and their eccentricities are 10 cm, 5 cm, 6 cm and 4 cm respectively. The angular dispositions of B, C and D from the line of A are 30°, 150° and 240° respectively. The shaft runs at 2400 rev/min. Determine the dynamic load in each bearing.

(17 marks)

8. (a) (i) Define the following terms:

(I) kinematics;
(II) momentum.

(ii) State the law of conservation of linear momentum.

(6 marks)

(b) An engine flywheel assembly has a mass of 40 kg and a radius of gyration of 400 mm. At an instant when the flywheel runs at 2400 rev/min, it suddenly meshes with a stationary friction clutch which is carried by an aircraft rotor of mass 50 kg and radius of gyration of 500 mm. Determine the:

(i) final rotational speed of the system;
(ii) energy lost during the coupling.

(14 marks)

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