higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N5

(8090075)

18 November 2024 (X-paper)
09:00–13:00

OPEN-BOOK EXAMINATION

This question paper consists of 6 pages.

009Q1E2418

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
MECHANICAL DRAWING AND DESIGN N5
TIME: 4 HOURS
MARKS: 100

INSTRUCTIONS AND INFORMATION

1. Answer all the questions.
2. Read all the questions carefully.
3. Number the answers according to the numbering system used in this question paper.
4. A correct answer is worth only ONE mark. Show all the steps to achieve as many marks as possible. (An incorrect answer which must be carried forward will receive fair consideration.)
5. Sketches must be done freehand and in good proportion in the ANSWER BOOK.
6 Candidates may use personal notes and are not allowed to share their personal notes.
7. All work you do not want to be marked must be clearly crossed out.
8. Write neatly and legibly.

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QUESTION 1: DESIGN OF SHAFT FOR POWER TRANSMISSION

A solid shaft of 1,55 m is used as a tractor propeller shaft. The shaft twists through 1,8° while rotating at 900 r/min. The diameter of the shaft is 60 mm, and the modulus of rigidity is 85 GPa.

Calculate:

1.1 The maximum shear stress in the shaft (5)

1.2 The power transmitted by the shaft (2)
[7]

QUESTION 2: RIVETED JOINTS

A lozenge joint with 6 rivets on either side of the joint, has two tie bars 240 mm wide and 20 mm thick and are joined by two cover straps which are 15 mm thick and 240 mm wide. The rivets are 30 mm in diameter. The full stresses may not exceed the following: tensile stress = 73 MPa; shear stress = 58 MPa; crushing stress = 118 MPa.

Calculate:

2.1 The maximum load carried by the tie bar (7)

2.2 The maximum axial tensile stress (3)

2.3 The maximum axial shear stress (3)

2.4 The maximum axial crushing stress (3)
[16]

QUESTION 3: KEYS AND SPLINES

A shaft is 45 mm in diameter and transmits a torque of 700 Nm. The allowable stress in tension and compression for the key is 110 MPa and the allowable shear stress in the key is 60 MPa.

3.1 Determine the width and thickness of the key using any applicable table. (2)

3.2 Determine the required length of the key. (5)
[7]

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QUESTION 4: COTTERED JOINT

FIGURE 1 shows a two-view coupling of two circular mild steel rods subjected to compressive and tensile loads, connected by means of a cotter joint. The rectangular shape cotter has a mean width of 55 mm and a thickness of 18 mm. The allowable stresses for the steel used are: $\sigma_t = 50\ MPa$; $\tau = 48\ MPa$; $\sigma_c = 86\ MPa$

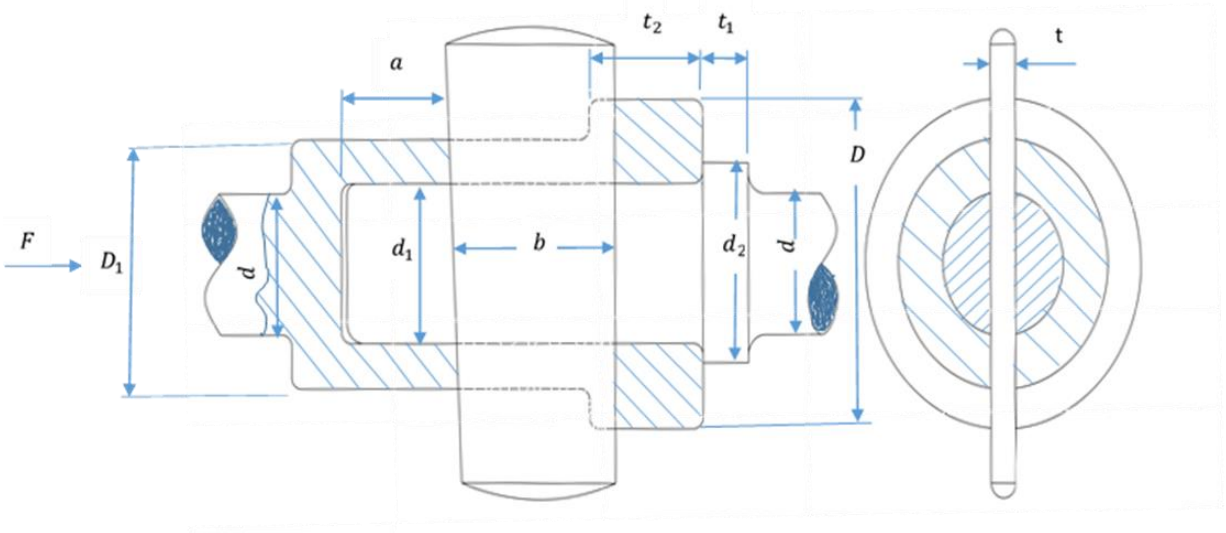

FIGURE 1

Calculate:

4.1 The safe load (2)

4.2 The diameter of the rods (4)

4.3 The diameter of the pierced rod (9)

[15]

QUESTION 5: FLANGE COUPLING

The following information is given for the flange coupling that is used between an internal combustion engine and hydraulic pump. The diameter of the shaft used is 95 mm and will produce a maximum torque of 12,6 k N.m.

PCD : 3D
Shear stress for key : 95 MPa
Compressive stress for key : 230 MPa

Calculate:

5.1 The length of the key (8)

5.2 The pitch circle diameter (1)

5.3 The flange thickness (1)

[10]

QUESTION 6: STEAM ENGINE

A steam cylinder has a diameter of 820 mm and a maximum allowable steam pressure of 880 kPa. The crank arm is perpendicular to the piston rod centre line and the piston rod is in compression. The stroke length is 1,2 m and the connecting rod length is 2 m. There are 20 bolts used to bolt down the cylinder cover, the allowable stress in the bolts is 45 MPa and the allowable shear stress on the crank pin is 35 MPa.

Calculate:

6.1 The force acting on the piston rod (2)

6.2 The force acting on the connecting rod (5)

6.3 The force acting on the crank pin (2)

6.4 The force acting on the cross-head guide (2)

6.5 The diameter of the crank pin (4)

6.6 The diameter of each bolt, when the core area of the bolt is equal to 0,75 nominal area (5)

[20]

QUESTION 7: BELT DRIVES

A belt pulley, 508 mm in diameter is located midway between two bearings on a line shaft which transmits 15 kW. The thickness of the belt is 6 mm and the velocity of the belt is 36 m/s. The coefficient of friction between the belt and the pulley is 0,2 and the angle of contact is 265°. The maximum torque exceeds the mean torque by 12,5%. The allowable safe shear stress in the shaft is 41 MPa.

Calculate:

7.1 The speed of the shaft in revolutions per minute, taking the thickness of the belt into account (2)

7.2 The mean torque transmitted by the shaft (3)

7.3 The maximum torque transmitted by the shaft (2)

7.4 The diameter of the shaft (3)

7.5 Both tensions of the belt drive, taking the thickness of the belt into account (5)

[15]

QUESTION 8: ULTIMATE AND WORKING STRESS FOR VARIOUS TYPE OF MATERIALS

If the ultimate stress of a material used is 300 MPa and the safety factor is 2…

8.1 Explain what one must do to find the allowable stress (2)

8.2 Calculate the allowable stress (2)
[4]

QUESTION 9: WELDED JOINTS

A single V-groove butt welded joint between two plates of the same thickness equal to 6 mm and the same width of 60 mm is subjected to a tensile force of 36 kN.

Calculate the average normal stress induced in the joint **[6]**

TOTAL: 100

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