higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N5

(8090075)

30 March 2020 (X-paper)
09:00–13:00

OPEN-BOOK EXAMINATION

Calculators, mathematical tables, textbooks and personal notes may be used.

This question paper consists of 6 pages.

009Q1A2030

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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. Answer questions in any order, but keep subsections of questions together.
5. Approximate all answers to THREE decimal places.
6. Show all intermediate steps.
7. Write neatly and legibly.

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QUESTION 1: WELDING

1.1 A flat bar, 60 mm wide × 6 mm thick, is fixed at 90° to a base plate by means of two 6 mm side angle fillet welds. The allowable stress is 85 MPa. No return welds are used.

Calculate the safe load for this weld. (4)

1.2 The allowable tensile strength of a butt-welded joint is 138 MPa. Two flat bars, 150 mm wide × 8 mm thick, are butted together.

Calculate the safe tensile load for this joint. (6)

[10]

QUESTION 2: LAP AND BUTT JOINTS

Determine the number of rivets for a lozenge joint that connects two 178 mm × 10 mm tie plates.

The working stresses are:

Tension: 108×10^6 N/m^2
Shear: 62×10^6 N/m^2
Crushing: 170×10^6 N/m^2

Determine each of the following:

2.1 Rivet diameter (4)

2.2 Safe tensile load of the plate at the section with one rivet hole (2)

2.3 Safe shearing load of one rivet in double shear (2)

2.4 Safe crushing load of one rivet (2)

2.5 Number of rivets (2)

[12]

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QUESTION 3: BELT DRIVES

The following data applies to a belt drive:

Driving pulley diameter:	360 mm
Driving pulley rotational frequency:	281 r/min
Coefficient of friction between the belt and pulley:	0,4
Driven pulley diameter:	280 mm
Pulley centre distance:	1 200 mm
Belt thickness:	15 mm
Safe tensile load of the belt:	105 kN
Stress in the belt material (σ_t):	26 MPa

Calculate each of the following:

3.1 Contact angle on the driving pulley (4)

3.2 Width of the belt (3)

3.3 Length of the belt (4)

3.4 Tension in the slack side of the belt (4)

3.5 Velocity of the belt (2)

3.6 Power transmitted by the belt (3)
[20]

QUESTION 4: COTTER AND KNUCKLE JOINTS

The allowable tensile stress in a knuckle joint is 104,5 MPa and the diameter of the rods is 18 mm.

Calculate each of the following on the knuckle joint:

4.1 Tensile load on the knuckle joint (3)

4.2 Thickness of the eye required for tension (4)

4.3 Thickness of the fork ends (3)
[10]

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QUESTION 5: BEARINGS

A solid shaft transmitting 53 kW at 140 r/min has a load of 18 kN applied at the journal. The maximum allowable shear stress due to torque must not exceed 65 MPa and the maximum bearing load allowed on the journal projected area is 1 MPa. If the ratio of length of journal to journal diameter is 2 to 1, find the diameter and length of journal and answer the following questions:

5.1 Calculate the shearing torque. (3)

5.2 If $T_{mean} = T_{max}$, determine the journal dimensions. (3)

5.3 Consider the bearing pressure and determine the journal dimensions. (4)

[10]

QUESTION 6: COUPLINGS

Design a shaft and flange coupling to transmit 373 kW at 300 r/min.

Shear stress for the shaft:	69 MPa
Shear stress for the bolts:	55 MPa
Shear stress for the key:	83 MPa
Crushing stress for the bolts:	27,6 MPa
Crushing stress for the key:	207 MPa

Determine each of the following:

6.1 Shaft diameter (4)

6.2 Length of the key (6)

6.3 Bolt diameter (5)

6.4 Thickness of the flange (5)

[20]

QUESTION 7: STEAM COVERS

The steam pressure in a 320 mm diameter cylinder is 1 425 kPa. The wall thickness is 20 mm and 15 studs are needed to seal the cylinder. The safe allowable tensile stress of the studs is 25 MPa. The core area of the studs is 70% of the nominal area.

Calculate each of the following on the steam cover:

7.1 Force acting on the cover (3)

7.2 Diameter of each stud (3)

7.3 Pitch diameter (3)

7.4 Circular pitch of the studs (5)

[14]

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QUESTION 8: KEYS AND KEYWAYS

A splined connection in a vehicle transmission consists of 10 splines cut into a 60 mm diameter shaft. The height of each spline is 5 mm, the splines in the hub are 70 mm long and the allowable pressure on the splines is 6 MPa.

Calculate the power that can be transmitted at 2 750 r/min. **[4]**

TOTAL: 100

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