higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N5

(8090075)

20 November 2023 (X-paper)
09:00–13:00

OPEN-BOOK EXAMINATION

REQUIREMENTS: Candidates may use textbooks and personal notes.

This question paper consists of 5 pages.

009Q1E2320

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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 made FREEHAND and in good proportion in the ANSWER BOOK.
6. Write neatly and legibly.

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QUESTION 1: POWER TRANSMISSION

A solid shaft is 30 mm in diameter and 400 mm long. A torsional deflection of 2° is noted when operating under load at 2 000 r/min. Given that the modulus of rigidity (G) is 80 × 10^9 Pa

Determine:

1.1 The power transmitted (5)

1.2 The maximum shear stress in the shaft (3)

1.3 The power transmitted with an overload of 12% (5)

[13]

QUESTION 2: STEAM ENGINE

2.1 A steam engine cylinder has a diameter of 620 mm. 20 bolts are used to bolt down the cylinder cover and the safe allowable stress for the bolt and cylinder material is 35 MPa. The maximum pressure in the steam cylinder is 1,18 MPa.

Calculate:

2.1.1 The diameter of the bolt if the core area = 0,75 crest area (4)

2.1.2 The wall thickness of the cylinder if no liner is used (2)

2.1.3 The circumference pitch. Check whether the cover is steam tight. (7)

2.2 A rectangular steam chest opening 520 mm x 420 mm, must be closed by a flat steel cover. The steam pressure is 1,2 MPa. Assume that the packing material extends to the stud and is subjected to the same steam pressure. The centre line of the stud is 40 mm from the inside edge of the opening. M18 studs are used with a safe tensile stress of 78 MPa.

Calculate:

2.2.1 The effective area of the packing material (3)

2.2.2 The number of studs required if the core area = 0,85 nominal area (4)

[20]

QUESTION 3: BELT DRIVES

The following data refer to a flat belt drive:

Belt width	:	130 mm
Thickness	:	9 mm
Maximum allowable belt stress	:	3 MPa
Density of belt material	:	1 200 kg/m³
Motor speed	:	1 440 r/min
Coefficient of friction	:	0,32
Angle of contact	:	160°
Centrifugal tension	:	864 N

Determine:

3.1 The belt speed (5)

3.2 The maximum transmissible power (9)

3.3 The diameter of the motor pulley (2)

[16]

QUESTION 4: RIVETTED JOINT

Two steel plates are joined by a double-riveted lap joint, using snap head rivets of diameter $d = 6\sqrt{t}$, using the nearest standard-size rivet. Design a suitable joint by equating tensile and shear strengths.

Thickness of each plate	:	14 mm
Tensile stress of plates	:	450 MPa
Shear stress of rivets	:	400 MPa
Crushing stress of rivets and plates	:	600 MPa
Factor of safety	:	5

Calculate:

4.1 The safe loads per pitch width of the joint for tension, shear and crushing. (15)

4.2 The efficiency of the joint. (2)

[17]

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QUESTION 5: FLANGE COUPLING

The following information is given for a flange coupling that is used between an internal combustion engine and a hydraulic pump. The flange is designed to transmit 450 kW at 340 r/min.

PCD	:	3D
Shear stress for shaft	:	75 MPa
Compressive stress for bolts	:	35 MPa
Shear stress for bolts	:	55 MPa
Shear stress for key	:	90 MPa
Compressive stress for key	:	225 MPa
Number of bolts	:	6 bolts
Key (W and L)	:	Use standard sizes

Determine:

5.1 The diameter of the shaft (6)

5.2 The length of the key (8)

5.3 The diameter of the bolt (9)

[23]

QUESTION 6: KNUCKLE JOINT

The following applies to a knuckle joint that was used as joint mechanism:

The ultimate tensile stress	:	438,56 MPa
The ultimate shear stress	:	219,28 MPa
The ultimate compressive stress	:	469,7 MPa
Safety factor	:	6
Subjected to a load	:	112 kN

Calculate:

6.1 The rod diameter for tearing (4)

6.2 The pin diameter for shearing (4)

6.3 Thickness of the fork for crushing (3)

[11]

TOTAL: 100

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