higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1080**(E)**(M26)T

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N5

(8090075)

26 March 2018 (X-Paper)
09:00–13:00

OPEN-BOOK EXAMINATION

This question paper consists of 5 pages.

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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. Where applicable, standard size items must be used.
7. ALL the answers must be approximated accurately to THREE decimal places.
8. Write neatly and legibly.

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QUESTION 1

Two rods of equal diameter are joined together by a knuckle joint. The joint is designed to carry a load of 120 kN in tension. All parts are made of steel with an allowable stress of 115 MPa in tension, 90 MPa in shear and 190 MPa in compression.

Calculate the following:

1.1 The diameter of the rods (3)

1.2 The diameter of the pin (3)

1.3 The thickness of the fork ends (3)

1.4 The thickness of the eye (2)

1.5 The diameter of the pin head and collar (2)

1.6 The thickness of the curved section of the fork (2)
[15]

QUESTION 2

2.1 A 60-mm diameter shaft is connected to a vehicle transmission by means of a splined connection. The number of splines cut into the shaft is 12 and the shaft is revolving at its maximum speed of 50 revolutions per second. Each spline is 5 mm high and 50 mm long and the allowable pressure on the splines is 5 MPa.

Calculate the following:

2.1.1 The power that can be transmitted (5)

2.1.2 The force required to slide the hub axially, under full load, if the coefficient of friction is 0,25 (3)

2.2 A hollow shaft with a diameter ratio of 1 : 0,5 transmits 4 500 kW at 300 revolutions per minute. The maximum torque is 12,5% greater than the mean torque and the maximum angle of twist is limited to 2,5° per metre length of the shaft.

Calculate the inside and outside diameters of the shaft.
Assume a modulus of rigidity of 85 GPa for the shaft material.

HINT: Use $\frac{T}{J} = \frac{\tau}{R} = \frac{G\theta}{L}$ (10)

2.3 Compare the strength of the *hollow shaft* in QUESTION 2.2 above with the strength of a *solid shaft* with the same mass and length and made of the same material. (7)
[25]

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QUESTION 3

Snap-head rivets are used to join two plates, each 15 mm thick, by means of a double-riveted lap joint. The rivets are arranged in a staggered formation and the distance between two consecutive rivets in each row is 60 mm. The tensile stress for the plates is 420 MPa and the shear stress for the rivet material is 300 MPa. The compressive stress between the rivets and the plate is 600 MPa.

Using a factor of safety of 4, determine the efficiency of the joint.

(HINT: Use $F_t = F_s$ to determine the rivet diameter.) **[18]**

QUESTION 4

A flat belt drive, 20 mm wide and 5 mm thick, with a total mass of 1,25 kg, is used in a crossed belt drive system to transmit power at 200 r/min. The belt can withstand a maximum tensile stress of 4,5 MPa. The diameters of the driving and the driven pulleys are 320 mm and 960 mm respectively, and the distance between their centres is 1 450 mm. The coefficient of friction between the belt and the pulleys is 0,25.

4.1 Calculate the power that the drive can transmit, taking both the thickness and the centrifugal effects of the belts into consideration. (16)

4.2 Determine the minimum dimensions of a rectangular key that can be used to couple the driven pulley with a 60-mm diameter shaft. (4)

[20]

QUESTION 5

The following data is given regarding an internal combustion engine for a motorcycle:

Piston diameter	150 mm
Engine stroke	200 mm
Length of the connecting rod	500 mm
Working pressure	1,675 MPa

Calculate the following when the crank is at right angles with the piston rod centre line:

5.1 The angle between the connecting rod and the piston rod centre line (3)

5.2 The angle between the crank arm and the connecting rod centre (1)

5.3 The magnitude of the force acting on the piston (2)

5.4 The magnitude of the reaction force below the crosshead (3)

5.5 The magnitude of the force in the crank arm (3)

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5.6 The outside and inside diameters of the crank pin if the compressive stress and the shear stress of the pin material are 100 MPa and 84 MPa respectively.

Consider double shear. (10)
[22]

TOTAL: 100

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