higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N5

(8090075)

27 March 2019 (X-Paper)
09:00–13:00

OPEN-BOOK EXAMINATION

This question paper consists of 6 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 steps to achieve as many marks as possible. An incorrect answer which must be carried forward will receive fair consideration.
5. Make sketches freehand and in good proportion in the ANSWER BOOK.
6. Use standard-sized items where applicable.
7. Accurately approximate ALL answers to THREE decimal places.
8. Write neatly and legibly.

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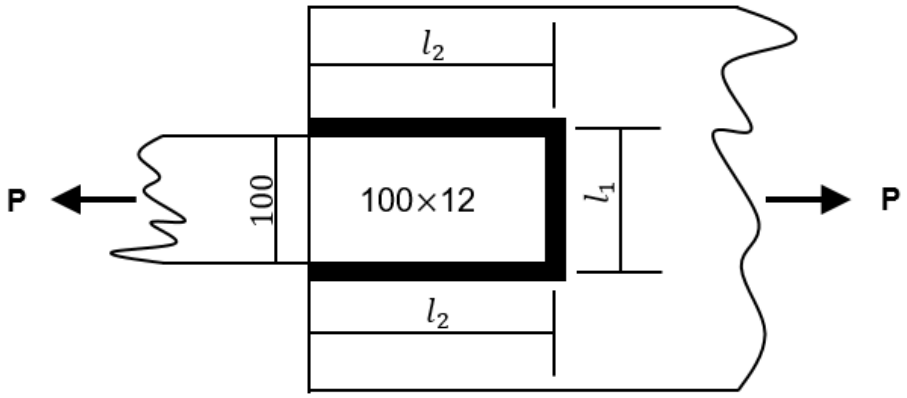
QUESTION 1

A plate, 100 mm wide and 12 mm thick, is joined with another plate by a single transverse fillet lap weld and a double parallel fillet weld as shown below. The maximum tensile and shear stresses of the weld material are 80 N/mm^2 and 60 N/mm^2 respectively.

Find the length l_2 of each parallel fillet if the joint is subjected to a total tensile load P of 100 kN.



[9]

QUESTION 2

A compound shaft consists of two steel shafts; one solid with a 50 mm diameter and another hollow with an inside diameter of 55 mm. The shafts fit inside one another and are rigidly fixed together.

Calculate:

2.1 The outside diameter of the sleeve assuming that the torque transmitted by the hollow shaft is 2,5 times that of the solid shaft – express the answer as a whole number (6)

2.2 The torque transmitted by the compound shaft if the shear stress for the steel is 80 MPa (5)

2.3 The power transmitted if the compound shaft rotates at 900 r/min and there is an overload of 12,5% (4)

[15]

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QUESTION 3

3.1 Two mild steel shafts are to be connected by a claw coupling with FOUR claws on each half of the coupling. The inside and the outside diameters of the claws are 60 mm and 150 mm respectively. The area of the splines resisting compression is $\frac{3}{5}$ times the area resisting shear.

Determine the following if the allowable shear strength of the splines is 5 MPa and the crushing strength is 12 MPa:

3.1.1 The minimum depth of the claws – express the answer as a whole number in millimetres (5)

3.1.2 The maximum power with 15% overload that the claws can safely transmit at 80π rad/s (10)

3.2 The operating mechanism used in the claw coupling in QUESTION 3.1 has a hand-operated lever keyed onto a 30 mm diameter shaft. The ultimate shear stress of the shaft and the key is 75 MPa.

Use a safety factor of 2,5 and determine:

3.2.1 The maximum length of the lever if a force of 250 N is applied at the end of the lever (4)

3.2.2 The mean diameter of a taper pin that can be used to secure the lever on the shaft (2)

[21]

QUESTION 4

A double-acting steam-engine cylinder has a bore and stroke of 450 mm and 360 mm respectively. The steam pressure when the crank arm is in the middle of the stroke is 1,45 MPa.

Calculate:

4.1 The force on the piston (2)

4.2 The magnitude of the force on the crank pin if the length of the connecting rod is 750 mm (5)

4.3 The pressure between the crank pin and the connecting rod if the length of the bearing is 150 mm and the diameter of the crank pin is 125 mm (3)

4.4 The length and the width of the crosshead shoes if the bearing pressure between the shoes and the slide bars is 7 500 kPa and the length of the shoes is 2,5 times the width of the shoes (7)

[17]

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QUESTION 5

A 40 kW motor drives a machine through a flat-belt drive. The driving pulley is coupled with the motor and the driven pulley is mounted directly below the driving pulley. The driven pulley is mounted on a shaft with a diameter of 50 mm and the shaft is running at 9 r/sec. Both the driving and the driven pulleys have an effective pitch-circle diameter of 250 millimetres. The distance from the motor shaft to the driven shaft is 900 mm. The thickness of the belt is 15 mm and the slack-side tension of the belt is 40% of the tight-side tension.

5.1 Determine the following if the belt is arranged in the crossed configuration:

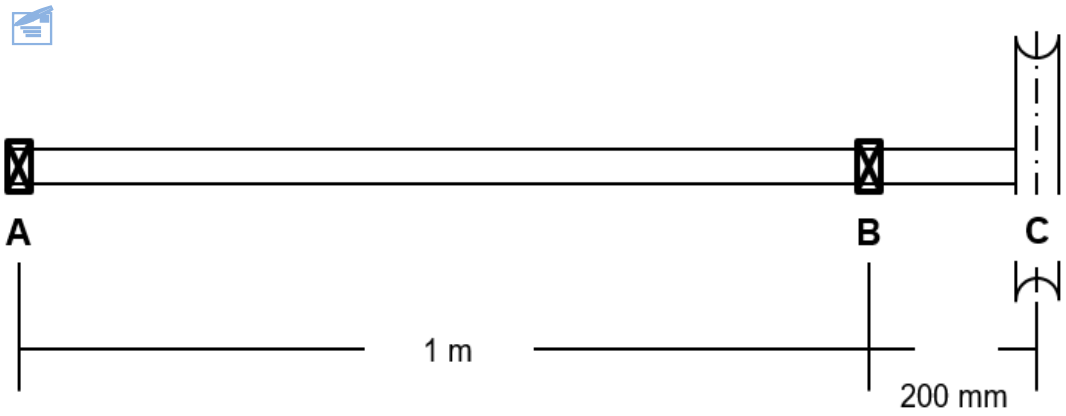
5.1.1 The total length of the belt (2)

5.1.2 The coefficient of friction between the belt and the pulleys (8)

5.1.3 The tight- and slack-side tensions of the belt assuming 0,1% power loss due to misalignment of the driving pulley (8)

5.1.4 The coefficient of friction between the driven shaft and the bearings if 10 W is lost due to friction (6)

5.2 The figure below shows the arrangement of the driven shaft and pulley. The driving pulley, which is directly above the driven pulley C, and the belt are NOT shown.



Determine the maximum bearing stress exerted on the bearings by the shaft if the bearings at A and B are each 75 mm wide. (5)

[29]

QUESTION 6

A thin cylindrical pipe with an inside diameter to thickness ratio of 62,5:1 is fitted with end covers. It is subjected to an internal pressure of 5 MPa.

6.1 Calculate the circumferential and the longitudinal stresses induced. (3)

6.2 Which axially applied compressive load would reduce the longitudinal stress to zero if the pipe is 4 mm thick? (6)

[9]

TOTAL: 100

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