higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MACHINES AND PROPERTIES OF METALS N4

(8190054)

28 November 2022 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 5 pages and formula sheet of 3 pages

251Q1E2228

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
MACHINES AND PROPERTIES OF METALS N4
TIME: 3 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. Start each question on a new page.
5. Use only a black or a blue pen.
6. Write neatly and legibly.

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QUESTION 1: POWER TRANSMISSION: BELT DRIVES AND ROPE DRIVES

1.1 The table below shows the manufacturer's data regarding belt drives.

Driving pulley speed	900 r/min
Driving pulley diameter	235 mm
Tight side tension of belt	400 N
Ratio between tight and slack sides	3

Refer to the table above and calculate the power transmitted by the belt drive. (5)

1.2 Name TWO basic flat belt drives. (2)

1.3 With the aid of a simple sketch, explain the use of a crowned-rim pulley. (3)

1.4 Name TWO types of ropes that can be used for power transmission. (2)

1.5 Tabulate TWO advantages and TWO disadvantages of rope drives. (4)
[16]

QUESTION 2: ROLLER CHAIN DRIVES

2.1 Give TWO reasons why adequate lubrication on chain drives is necessary. (2)

2.2 Explain the operation of a drip-feed lubricator with the aid of a neat sketch. (4)
[6]

QUESTION 3: POWER TRANSMISSION: GEAR DRIVES

3.1 Why are spiral gears used in engineering? (2)

3.2 Explain the use of rack-and-pinion gears. (2)

3.3 Explain the term, *whole depth*, with regard to a gear tooth and give the equation. (2)
[6]

QUESTION 4: POWER TRANSMISSION: COUPLINGS AND CLUTCHES

4.1 State TWO causes of slip in a cone clutch. (2)

4.2 List the THREE main parts of a centrifugal clutch. (3)

4.3 Give THREE reasons for the use of shaft couplings in the industry. (3)
[8]

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QUESTION 5: FRICTION

5.1 List TWO places where friction can be used to an advantage in an engineering workshop. (2)

5.2 A piece of steel with a mass of 5 kg lies on the horizontal steel bed surface of a milling machine. A horizontal force of 7 N is required to move the steel block.

Calculate the coefficient of static friction. (2)

5.3 A block of steel with a mass of 4 kg experiences a frictional force of 20 N if pulled along a gradient of 20°.

Calculate the force required to move the block:

5.3.1 Up the incline

5.3.2 Down the incline

(2 × 4) (8)
[12]

QUESTION 6: SAFETY PRECAUTIONS/DEVICES

6.1 With reference to the amended Factories, Machinery and Building Work Act of 1941, in your own words, describe the regulations with regard to the following:

6.1.1 Loose outer clothing

6.1.2 Clear space

(2 × 3) (6)

6.2 State FOUR safety precautions to be taken during the welding process. (4)

6.3 With reference to the Occupational Health and Safety Act 85 of 1993, give the regulations relating to revolving machinery. (3)

6.4 Explain TWO regulations with regard to lighting. (2)
[15]

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QUESTION 7: BRAKES

7.1 State FOUR advantages and THREE disadvantages of *disc brakes* compared to *drum brakes*. (4 + 3) (7)

7.2 Briefly describe the function of the following valves regarding a compressed-air braking system:

7.2.1 Drain valve

7.2.1 Quick-release valve

(2 × 2) (4)
[11]

QUESTION 8: ALLOY METALS

8.1 The alloy, white metal, is commonly used for the lining of bearings.

8.1.1 List TWO elements used to produce white metal. (2)

8.1.2 Give TWO characteristics of white metal. (2)

8.2 State TWO reasons for adding alloy elements to steel. (2)
[6]

QUESTION 9: HEAT TREATMENT OF CARBON STEEL

9.1 Explain the difference between *ferrous* and *non-ferrous metals*. (2 × 2) (4)

9.2 State FOUR properties of high-carbon steel. (4)
[8]

QUESTION 10: ENGINEERING MATERIALS: MANUFACTURING PROCESSES

Name THREE main groups of cast iron and give one practical use of each group.
(3 × 2) **[6]**

QUESTION 11: FLUID DRIVES

11.1 Name the THREE main parts of a hydraulic torque converter. (3)

11.2 State THREE reasons for the use of hydraulic accumulators. (3)
[6]

TOTAL: 100

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MACHINES AND PROPERTIES OF METALS N4

FORMULA SHEET

Any other applicable formula may be used.

FRICTION FORMULAE

$W = mg$

FOR EQUILIBRUIM
forces perpendicular to plane → $R = W$
forces parallel to plane → $F = F_\mu$

$F_\mu = \mu R$

$\mu_s = \frac{F_s}{R}$

$\mu_k = \frac{F_k}{R}$

$Tan\emptyset = \frac{F_\mu}{R}$

$$\text{Coefficient of static friction } (\mu) = \frac{\text{friction force}}{\text{Perpendicular force between surfaces}}$$

$$\text{Coefficient of kinetic friction } (\mu) = \frac{\text{friction force}}{\text{Normal reaction force between surfaces}}$$

$Tan\emptyset = \mu$

$F_\mu = \mu \times mg$

Movement downwards against an incline plane (Slope)

$F_\mu = \mu \times WCos\theta$

$F = \mu \times WCos\theta - WSin\theta$

$F_{down} = F_\mu - WSin\theta$

Movement upwards against an incline plane (Slope)

$F_\mu = \mu \times WCos\theta$

$F = \mu \times WCos\theta + WSin\theta$

$F_{up} = F_\mu + WSin\theta$

$Power = Force \times Velocity$

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BELT AND ROPE DRIVE FORMULAE

$$V = \frac{\pi \times D \times N}{60}$$

$$V = \frac{\pi \times (D + t) \times N}{60}$$

Effective tension $= (T_1 - T_2)$

$$\text{Power} = (T_1 - T_2) \times \frac{\pi \times D \times N}{60}$$

$1\text{Pa} = 1\text{N per m}^2$

Negleting Centrifugal tension (T_c)

Flat Belt

$$\frac{T_1}{T_2} = e^{\mu\theta}$$

Rope and V − belt

$$\frac{T_1}{T_2} = e^{\frac{\mu\theta}{Sin\frac{\emptyset}{2}}}$$

Considering Centrifugal tension (T_c)

Flat Belt

$$\frac{T_1 - T_c}{T_2 - T_c} = e^{\mu\theta}$$

Rope and V − belt

$$\frac{T_1 - T_c}{T_2 - T_c} = e^{\frac{\mu\theta}{\text{Sin}\frac{\emptyset}{2}}}$$

$T_c = \text{Mass} \times V^2$

$$\text{Mass} = \text{Density}\left(\frac{\text{kg}}{\text{m}^2}\right) \times \frac{\text{Volume}}{\text{m}}\left(\frac{m^3}{\text{m}}\right)$$

$$\text{Initial tension in belt} = \frac{T_1 + T_2}{2}$$

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OPEN BELT

$$\text{Length} = \frac{\pi}{2}(D + d) + \frac{(D - d)^2}{4C} + 2C$$

Angle of lap (θ)

$$\text{Cos}\ \frac{\emptyset}{2} = \frac{R - r}{C}$$

CROSSED BELT

$$\text{Length} = \frac{\pi}{2}(D + d) + \frac{(D + d)^2}{4C} + 2C$$

Angle of lap (θ)

$$\text{Cos}\ \frac{\emptyset}{2} = \frac{R - r}{C}\ \emptyset = 360° - \emptyset$$

$$\text{Belt pull on bearing} = (T_1 - T_2)$$

$$\text{Safe Stress} = \frac{T_1}{\text{Width} \times \text{Thickness}}$$

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