higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MACHINES AND PROPERTIES OF METALS N4

(8190054)

5 December 2023 (X-paper)
09:00–12:00

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages and a formula sheet of 2 pages.

251Q1G2305

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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. Round off all calculations to THREE decimal places.
5. Write neatly and legibly.

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QUESTION 1: POWER TRANSMISSION BELT DRIVES AND ROPE DRIVES

A V-belt is fitted to a machine with a pitch circle diameter of 300 mm. The V-belt revolves at 1 300 r/m and the power transmitted to the machine is 28 kW.
The V-groove angle is 36, the belt contact angle is 140°, and the coefficient of friction is 0,2. The mass of the belt is 0,6 kg/m in length and the maximum allowable tensile load per belt is 660 N.

Calculate the number of V-belts required. **[16]**

QUESTION 2: ROLLER CHAIN DRIVES

2.1 Give a brief explanation of how a roller chain drive operates. (3)

2.2 In roller chain drives, a lubricant serves several purposes. State THREE purposes of lubricating chain drives. (3)
[6]

QUESTION 3: POWER TRANSMISSION GEAR DRIVES

3.1 State TWO conditions for the use of gear drives. (2)

3.2 Explain the following terms regarding gear teeth and write down the equation.

3.2.1 Whole depth

3.2.2 Working depth

(2 × 2) (4)
[6]

QUESTION 4: POWER TRANSMISSION COUPLINGS AND CLUTCHES

4.1 Explain the difference between a clutch and a coupling. (4)

4.2 Glazed frictional surfaces are one of the causes of slip in a cone clutch. Explain how one could rectify this cause of slip. (2)

4.3 Couplings are grouped into THREE categories. One of them is fast or permanent couplings. Name the other two categories of couplings. (2)
[8]

QUESTION 5: FRICTION

5.1 State THREE disadvantages of friction. (3)

5.2 A body with a mass of 40 kg slides down an incline with an angle of 30˚ to the horizontal. The coefficient of friction between the body and the sliding surface is 0,3.

Calculate the following:

5.2.1 The weight component perpendicular to the sliding plane. (3)

5.2.2 The weight component parallel to the sliding plane. (2)

5.2.3 The frictional force. (2)

5.2.4 The external force required to pull the body up the inclined plane. (2)
[12]

QUESTION 6: SAFETY PRECAUTIONS/DEVICES

6.1 With reference to the Occupational Health and Safety Act 85 of 1993, as amended, list TWO regulations applicable to the earthing of machines. (2)

6.2 With reference to the Occupational Health and Safety Act 85 of 1993, give the regulations pertaining to repairing and oiling machinery. (4)

6.3 Explain TWO regulations concerning portable electric power tools. (2)

6.4 Explain TWO regulations regarding lifting gear. (2)

6.5 Write down any THREE safety precautions to be taken during welding. (3)

6.6 Explain TWO regulations applicable to lighting. (2)
[15]

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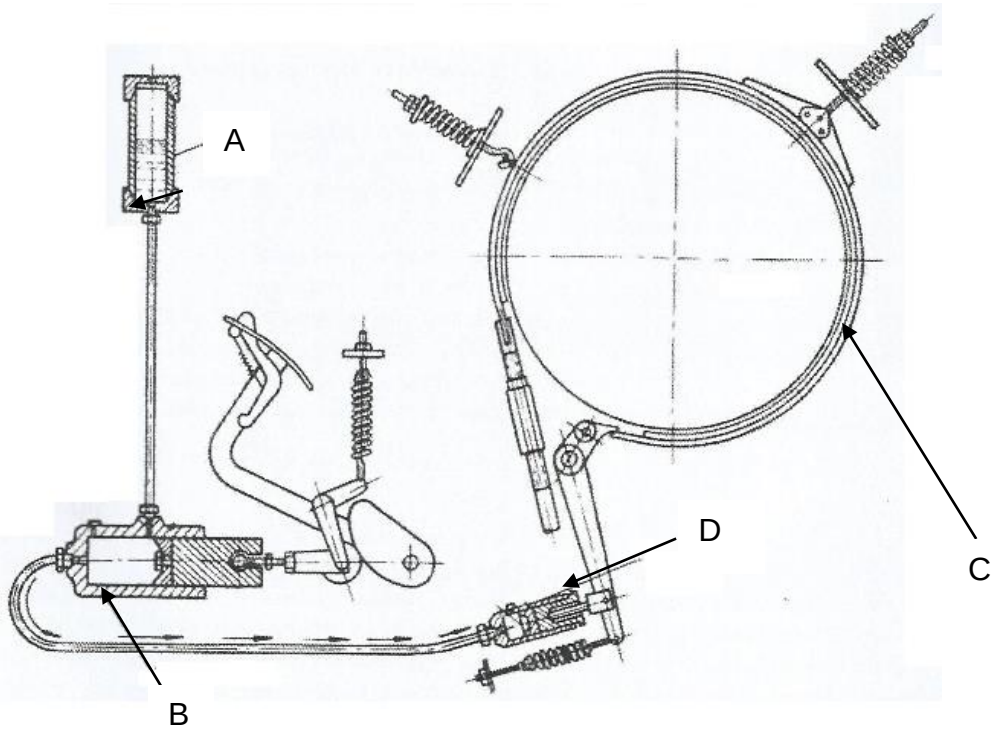
QUESTION 7: BRAKES

7.1 The sketch below shows a hydraulic band brake. Write the letters (A-D) in your answer books and write the names of the various parts labelled (A-D).



(4)

7.2 State the TWO advantages and TWO disadvantages of disc brakes. (4)

7.3 Brake linings must meet certain requirements. Write down any THREE requirements. (3)

[11]

QUESTION 8: ALLOY METALS

8.1 Duralumin is non-ferrous aluminium. Name any TWO materials found in duralumin. (2)

8.2 What effects does the addition of the following elements have on plain carbon steel?

8.2.1 Chromium

8.2.2 Nickel

(2 × 2) (4)

[6]

QUESTION 9: HEAT TREATMENT OF CARBON STEELS

9.1 Why is heat treatment performed on carbon steels? (2)

9.2 Describe the effects of the following errors during the hardening of steel.

9.2.1 Steel that is over-heated (3)

9.2.2 Steel that is heated too quickly (3)
[8]

QUESTION 10: ENGINEERING MATERIALS: MANUFACTURING PROCESSES

10.1 Name the furnace in which oxygen is used to manufacture steel. (1)

10.2 The choice of the correct material for a particular job demands a theoretical knowledge of the properties of materials.

Explain the following properties:

10.2.1 Tenacity

10.2.2 Compressibility

(2 × 1) (2)

10.3 Write down any THREE advantages of the basic oxygen processes in the manufacturing of steel. (3)
[6]

QUESTION 11: FLUID DRIVES

11.1 Write down FOUR reasons for the use of hydraulic accumulators. (4)

11.2 All pumps are machines transporting fluids. The transport of fluid may be affected in different ways. State any TWO ways in which fluid is transported. (2)
[6]

TOTAL: 100

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FORMULA SHEET

Any other applicable formula may be used.

FRICTION

$W = mg$

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

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

$\text{Tan } \phi = \mu$

$F_{\mu} = \mu \times mg$

Movement downwards against an incline plane (Slope)

$F_{\mu} = \mu \times W\text{Cos}\theta$

$F = \mu \times W\text{Cos}\theta - W\text{sin}\theta$

$F_{down} = F_{\mu} - W\text{sin}\theta$

Movement upwards against an incline plane (Slope)

$F_{\mu} = \mu \times W\text{Cos}\theta$

$F = \mu \times W\text{Cos}\theta + W\text{sin}\theta$

$F_{up} = F_{\mu} + W\text{sin}\theta$

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BELT AND ROPE DRIVES

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

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

Effective tension $=(T_1-T_2)$

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

1 Pa = 1N per m^2

Neglecting Centrifugal tension (T_c)

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

Rope and V-belt $\frac{T_1}{T_2}=e^{\frac{\mu\theta}{\sin\frac{\phi}{2}}}$

Considering Centrifugal tension (T_c)

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

Rope and V-belt $\frac{T_1-T_c}{T_2-T_c}=e^{\frac{\mu\theta}{\sin\frac{\phi}{2}}}$

T_c = Mass $\times V^2$

Mass = Density $(kg/m^3)\times$ Volume/m (m^3/m)

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

OPEN BELT

Lenght = $\frac{\pi}{2}(D+d)+\frac{(D-d)^2}{4c}+2c$

Angle of lap (θ)

$\cos\frac{\phi}{2}=\frac{R-r}{C}$

CROSSED BELT

Lenght = $\frac{\pi}{2}(D+d)+\frac{(D+d)^2}{4c}+2c$

Angle of lap (θ)

$\cos\frac{\phi}{2}=\frac{R-r}{C}$ and $\phi=360°-\phi$

Belt pull on bearing = (T_1+T_2)

Safe stress = $\frac{T_1}{\text{Width}\times\text{thickness}}$

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