higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MACHINES AND PROPERTIES OF METALS N4

(8190054)

20 April 2021 (X-paper)
09:00–12:00

Nonprogrammable calculators may be used.

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

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
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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 decimals.
5. Work neatly.

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QUESTION 1: POWER TRANSMISSION BELT DRIVES AND ROPE DRIVES

1.1 Give THREE disadvantages of V-belts compared to chain and gear drives. (3)

1.2 A single V-belt drive transmits 125 kW at a speed of 1000 m/min. The coefficient of friction is 0,2. The arc of belt contact with the pulley is 165° and the included angle of the V-groove is 40°.

Calculate each of the following:

1.2.1 Ratio of belt tensions

1.2.2 Effective tension in belt

1.2.3 Tensile force on journal bearings

(3 × 4) (12)
[15]

QUESTION 2: ROLLER CHAIN DRIVES

Explain, with the aid of a labeled sketch, the construction of a roller chain drive. **[6]**

QUESTION 3: POWER TRANSMISSION GEAR DRIVES

3.1 Give TWO reasons for using intermediate gears in conjunction with simple gear drives. (2)

3.2 Make neat drawings of each of the following gear drives to distinguish between them:

3.2.1 Simple gear drive

3.2.2 Compound gear drive

(2 × 2) (4)
[6]

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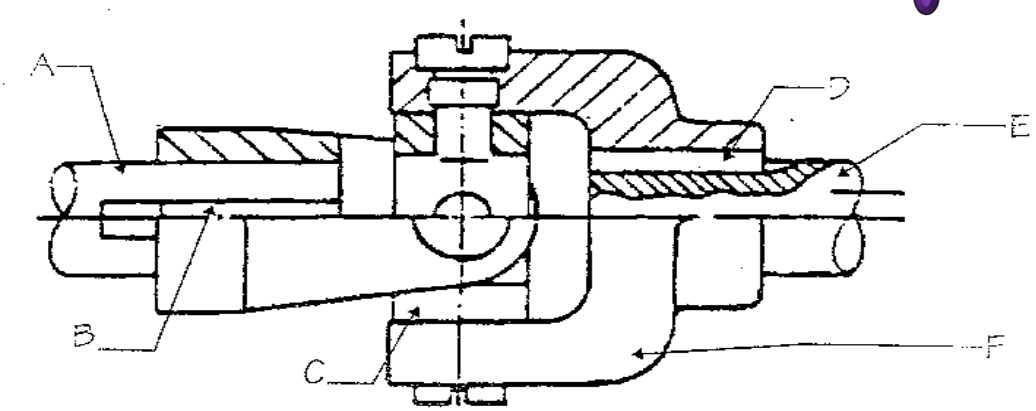
QUESTION 4: POWER TRANSMISSION COUPLINGS AND CLUTCHES

Identify the parts of the universal coupling in the half-sectional view below by writing the answers next to the letter (A–F) in the ANSWER BOOK.



[6]

HALF-SECTIONAL VIEW OF UNIVERSAL COUPLING

QUESTION 5: FRICTION

An object with a mass of 40 kg rests on an incline of 30° to the horizontal. The coefficient of friction is 0,6 for the surfaces.

Calculate each of the following:

5.1 Force required to pull object upwards against the slope if pulling force forms an angle of 20° with incline (6)

5.2 Force required to push object downwards along the slop if pushing force forms an angle of 25° with incline (6)

[12]

QUESTION 6: SAFETY PRECAUTIONS

6.1 Describe the regulations regarding each of the following as contained in the Occupational Health and Safety Act No 85 of 1993:

6.1.1 Selection of erection

6.1.2 Conditions of floors

6.1.3 Conditions of safety appliances and machinery

6.1.4 Revolving machinery

(4 × 3) (12)

6.2 State THREE regulations applicable to lighting. (3)
[15]

QUESTION 7: BRAKES

7.1 Write down FOUR advantages and THREE disadvantages of disc brakes compared to drum brakes. (7)

7.2 Explain why self-locking band brakes are used in cranes and hoists. (2)

7.3 How is the braking in QUESTION 7.2 accomplished? (2)
[11]

QUESTION 8: ALLOY METALS

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

8.1 Chromium

8.2 Nickel

8.3 Silicon

(3 × 2) **[6]**

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QUESTION 9: HEAT TREATMENT OF CARBON STEELS

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

9.2 Explain the following terms with respect to the heat treatment of carbon steels:

9.2.1 Decalescence point

9.2.2 Recalescence point

9.2.3 Lower critical point

(3 × 1) (3)

9.3 Give THREE qualities achieved by heat treatment of carbon steels. (3)
[8]

QUESTION 10: ENGINEERING MATERIALS: MANUFACTURING PROCESSES

10.1 Give FIVE advantages of the basic oxygen processes in the manufacturing of steel. (5)

10.2 Name THREE types of cast iron. (3)
[8]

QUESTION 11: FLUID DRIVES

11.1 State FOUR ways in which a pump may operate to affect the transport fluid. (4)

11.2 Give THREE reasons why slip, which is the leakage of water in a pump, happens. (3)
[7]

TOTAL: 100

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MACHINES AND PROPERTIES OF METALS N4

FORMULA SHEET

Any other applicable formula may also be used.

FRICTION FORMULAE

$W = mg$

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

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

$Tan\emptyset = \mu$

$F_\mu = \mu \times mg$

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)

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

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

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

BELT AND ROPE DRIVE FORMULAE

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

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

$\text{Effective tension} = (T_1 - T_2)$

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

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

Negleting centrifugal tension (T_c)

Flat belt

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

Rope and $V-$ belt

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

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Considering centrifugal tension (T_c)

Flat belt

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

Rope and V − belt

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

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

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

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

OPEN BELT

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

Angle of lap (θ)

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

CROSSED BELT

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

Angle of lap (θ)

$$\cos\frac{\emptyset}{2} = \frac{R - r}{C} \quad \emptyset = 360° - \emptyset$$

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

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

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