



**higher education
& training**

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N4

(8190194)

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

Drawing instruments and nonprogrammable calculators may be used.

This question paper consists of 6 pages and 3-page formula sheet.

072Q1E2217

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA
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MECHANOTECHNICS 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 section on a new page.
 5. Use a blue or black pen.
 6. Use $g = 9,81 \text{ m/s}$.
 7. Write neatly and legibly.
-

QUESTION 1

1.1 Three production methods that are generally used in the manufacturing industry are mass production, batch production, and individual production.



1.1.1 Briefly discuss what is meant by *individual production*.

(2)

1.1.2 Give ONE example where the individual production method could possibly be applied.

(1)



1.1.3 Give SEVEN characteristics of batch production.

(7)

1.2 During the spray-painting processes, four faults can happen.

Give these FOUR possible faults, and explain ONE cause of each fault. (4 × 2)

(8)

1.3 Give TWO advantages of electrostatic spray painting.

(2)

1.4 Make a labelled sketch of a *needle lubricator*.

(5)

1.5 The materials from which bearings are made should have certain properties. Give FIVE of these properties.

(5)

[30]**QUESTION 2**

The following particulars apply to an inclined belt conveyor:

Angle of incline of belt conveyor = 14° to the horizontal

Inclined length of the belt = 115 m

Speed at which belt moves = 2,2 m/s

Contact angle on driving pulley = 210°

Force needed to overcome belt friction = 4 100 N

Coefficient of friction between belt and pulley = 0,2

If the belt conveys 420 tonnes of rocks per hour, calculate the following:

2.1 Output power needed from electric motor to drive the system

(7)

2.2 Belt tensions T_1 and T_2 .

(7)

[14]

QUESTION 3

- 3.1 A drill with a diameter of 20 mm is used to drill a hole in a workpiece at 1 500 r/min. Take the motor power as 700 W and the efficiency of drive as 70%.

Find the force exerted on each of the TWO cutting edges of the drill.

☆
(7)

- 3.2 The moving table of a horizontal milling machine has a mass of 500 kg. The workpiece mounted on the table has a mass of 13 kg, while the clamping screws and clamps have a mass of 4 kg. The feed of the table is 250 mm/min, and the coefficient of friction between the table and the slides is 0,06.

Find the power lost as a result of the friction between the table and the slides.

(7)
[14]

QUESTION 4

- 4.1 Study FIGURE 1 below, which shows the dimensions of an internal dovetail. Use these dimensions to calculate the diameter of the roller used in this test. (Construction of triangles must be shown on the ANSWER SHEET.)

NOTE: Dimensions are in mm and angle in degrees.

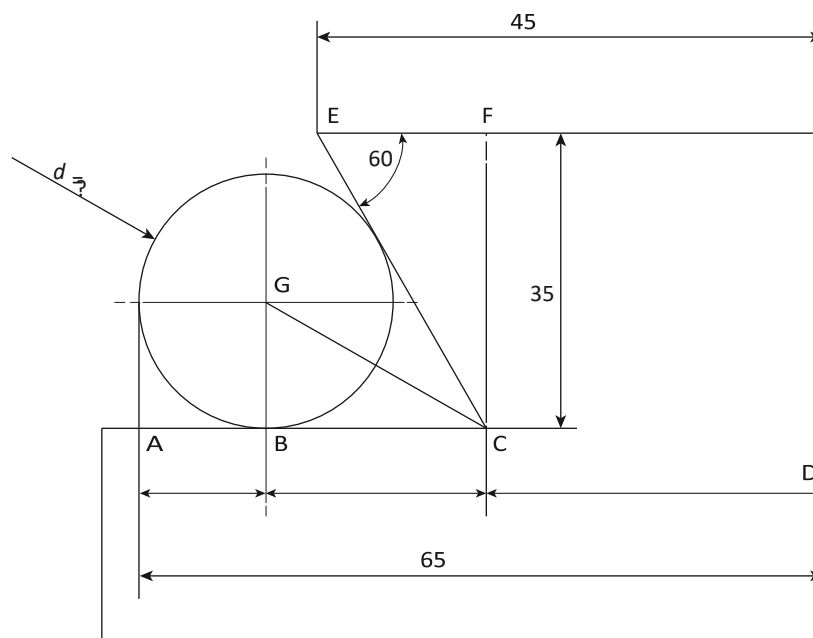


FIGURE 1

- 4.2 FIGURE 2 below shows an internal dovetail to be tested with TWO 15 mm-diameter precision rollers.

Use the measurements on the diagram, and calculate Distance X across the outside of the rollers.

(6)

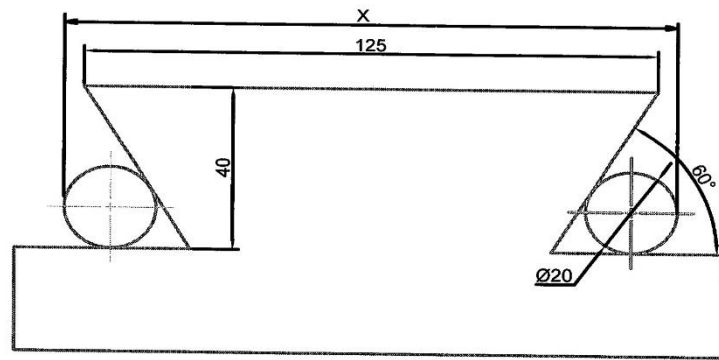


FIGURE 2

[14]

QUESTION 5

- 5.1 Study FIGURE 3 below, which shows a simple epicyclic gear drive. It comprises Gear Wheel B with 100 teeth, Pinion A with 30 teeth, and Arm C.

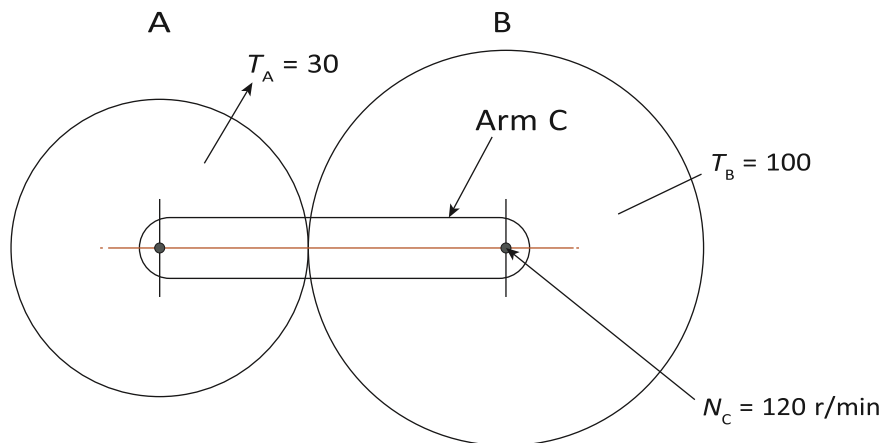


FIGURE 3

Assuming that Gear Wheel B is fixed, construct a table and find the speed and direction of rotation of Pinion A. Pinion A is mounted on Arm C rotating clockwise at 100 r/min about the centre of Gear B.

(6)

- 5.2 A set of spur gears meshing with each other has a velocity ratio of 2,5:1 and a module of 6 mm. If the pinion has 35 teeth, calculate:

5.2.1 The pitch-circle diameter of both gears

5.2.2 The outside diameters of both gears

(2 × 4)

(8)

[14]

QUESTION 6

- 6.1 FIGURE 4 below shows two reservoirs, A and B. The pipe is 3,2 km long. The difference between the two reservoirs is 35 m. Assume that the flow rate of the water in the pipe is $0,65 \text{ m}^3/\text{s}$ and the coefficient of friction is 0,004.

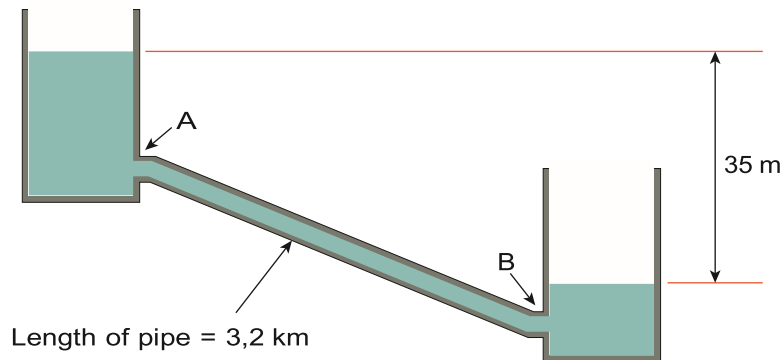


FIGURE 4

Calculate:

6.1.1 The diameter of the pipeline

6.1.2 The hydraulic gradient (i)

(2 × 2)

(4)

- 6.2 A venturi meter with a throat diameter of 140 mm is in a pipe with a diameter of 230 mm. The discharge rate of the pipe is 120 l/s . Use a coefficient of delivery of 0,96 and assume that the venturi meter has a mercury manometer.



Calculate the *mercury head* in manometer.

(10)

[14]

TOTAL:

100



FORMULA SHEET

1. $m = \frac{PCD}{T}$
2. $DO = m \times (T + 2)$
3. $C = \frac{m}{2} \times (TA + TB)$
4. $Ke = \frac{1}{2}mv^2$
5. $VR = \frac{TA}{TB}$
6. $VR = \frac{PCD \text{ of gear}}{PCD \text{ of pinion}}$
7. $VR = \frac{NB}{NA}$
8. $NA \times TA = NB \times TB$
9. $F_t = \frac{2 \times T}{PCD}$
10. $F_r = F_t \times \tan \phi$
11. $F_n = F_t \times \sec \phi$
12. $I_e = IA + (VR)^2 IB + (VR)^2 IC + (VR)^2 ID$
13. $T\alpha = I_e \times \alpha A$
14. $T\alpha = TA + \frac{(NB)}{(NA)} \frac{TBC}{\eta_1} + \frac{(ND)}{(NA)} \frac{TD}{\eta_1 \eta_2}$
15. $\frac{NB}{NA} = \frac{\omega_B}{\omega_A} = \frac{\alpha_B}{\alpha_A} = \frac{IA}{IB}$
16. $T_{OUTPUT} = T_{INPUT} \times GR \times \eta$
17. $P = \frac{\pi \times PCD}{n}$
18. $T_i + T_o + T_h = 0$
19. $TA = TS + 2TP$
20. $\frac{\text{Input speed}}{\text{Output speed}} = \frac{\text{Teeth on driven gears}}{\text{Teeth on driving gears}}$
21. $v = \pi \times (d + t) \times N$
22. $P = T_e \times v$
23. $\frac{T_1}{T_2} = e^{\mu \theta}$
24. $T_1 = \delta \times A$
25. $T_c = m \times v^2$
26. $\frac{T_1 - T_C}{T_2 - T_C} = e^{\mu \theta \csc \alpha}$
27. $L = \frac{\pi}{2} \times (D + d) + \frac{(D \pm d)^2}{4 \times C} + 2C$
28. $T_g = m \times g \times \sin \phi$
29. $v = T \times r$

$$30. v = \sqrt{\mu \times g \times r}$$

$$32. v = \sqrt{gr \left[\frac{\mu + \tan \theta}{1 - \mu \tan \theta} \right]}$$

$$34. \frac{T1}{T2} = \left[\frac{1 + \mu \tan \theta}{1 - \mu \tan \theta} \right]^n$$

$$36. \cos \frac{\phi}{2} = \frac{R + r}{C}$$

$$38. T1 = w \times n \times ft$$

$$40. t = \frac{I \times \omega}{T}$$

$$42. T = F \times r$$

$$44. do = de + 0,65P$$

$$46. h = m \left[1 - \frac{\pi}{4} (\sin \theta \cos \theta) \right]$$

$$47. \frac{p1}{\rho} + \frac{(v1)^2}{2} + gh1 = \frac{p2}{\rho} + \frac{(v2)^2}{2} + gh2$$

$$48. V_w(V_a) = \sqrt{\frac{gx^2}{2y}}$$

$$50. hf = \frac{4 \times f \times \ell \times v^2}{2 \times g \times d}$$

$$52. Q = \frac{Cd \times A \times a \times \sqrt{(2gh)}}{\sqrt{(A^2 - a^2)}}$$

$$54. V = \sqrt{(g \times R \times \cos \theta)}$$

$$56. L = 2C + \pi D$$

$$58. \text{One load} = \frac{m2 \times g \times S}{4 \times h}$$

$$31. v = \sqrt{\frac{g \times b \times r}{2 \times h}}$$

$$33. v = \sqrt{gr \left[\frac{h \tan \theta + b/2}{h - b/2 \tan \theta} \right]}$$

$$35. \cos \frac{\theta}{2} = \frac{R - r}{C}$$

$$37. m = w \times t \times L \times \rho$$

$$39. P = Pg + P\mu$$

$$41. P = \frac{2 \times \pi \times N \times T}{60}$$

$$43. w = do + 3d - 1,5155P$$

$$45. w = \frac{\pi \times m}{2} (\cos^2 \theta)$$

$$49. v = C\sqrt{mi}$$

$$51. hf = \frac{f \times \ell \times O^2}{3,026 \times d^5}$$

$$53. Q = Cd \times A \times \frac{\sqrt{(2gh)}}{\sqrt{(m^2 - 1)}}$$

$$55. \text{Vol. bucket} = \frac{m \times s}{\rho \times v}$$

$$57. \text{Self-weight} = \frac{m1 \times g \times S^2}{8 \times h}$$

$$59. T(\text{acc load}) = (T1 - T2)R$$

$$60. T(\text{acc drum}) = I \times \alpha = mk^2 \times \frac{a}{R}$$

$$61. P = \omega \times T$$

$$63. Ke = \frac{1}{2} I \times \omega^2$$

$$65. P = Ke \times \text{operations/sec}$$

$$67. \mu = \tan \theta$$

$$69. T = \mu \times F \times Re \times n$$

$$71. T = \mu \times n \times (Fc - S)R$$

$$73. Fc = \frac{mv^2}{\gamma}$$

$$74. \text{Tractive effort} = \text{mass on driving wheels} \times \mu \times g$$

$$75. \text{Side thrust} = Fc \cos \theta - mg \sin \theta$$

$$76. \mu = \frac{Fc \cos \theta - mg \sin \theta}{mg \cos \theta + Fc \sin \theta}$$

$$77. P_l = CmgL + mgh$$

$$62. \omega = 2\pi \times N$$

$$64. Ke = \frac{\text{work done}}{\text{efficiency}}$$

$$66. (I_1 + I_2)\omega_3 = I_1\omega_1 + I_2\omega_2$$

$$68. \eta = \frac{\tan \theta}{\tan(\theta + \phi)}$$

$$70. T = \frac{\mu \times F \times Re}{\sin \theta}$$

$$72. Fc = m \times \omega^2 \times \gamma$$