higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N4

(8190194)

7 April 2021 (X-paper)
09:00–12:00

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

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
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 question on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.

QUESTION 1

1.1 State FIVE principles of a good workshop layout. (5)

1.2 Name FIVE metal-protection processes. (5)

1.5 Make a neat labelled diagram of siphon-wick lubricator. (5)

[15]

QUESTION 2

2.1 FIGURE 1 below shows two rollers of 25 mm diameters, which are being used to check the accuracy of two inclined faces. Calculate the distance X across the inside faces of the rollers if the angles have been correctly machined.

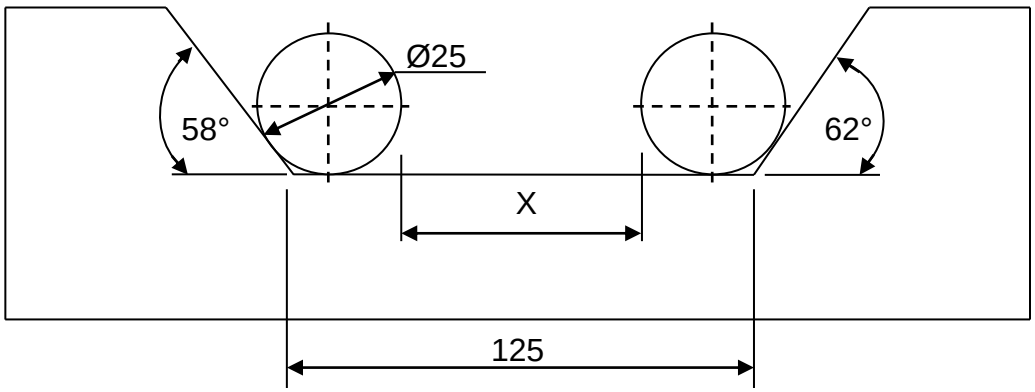
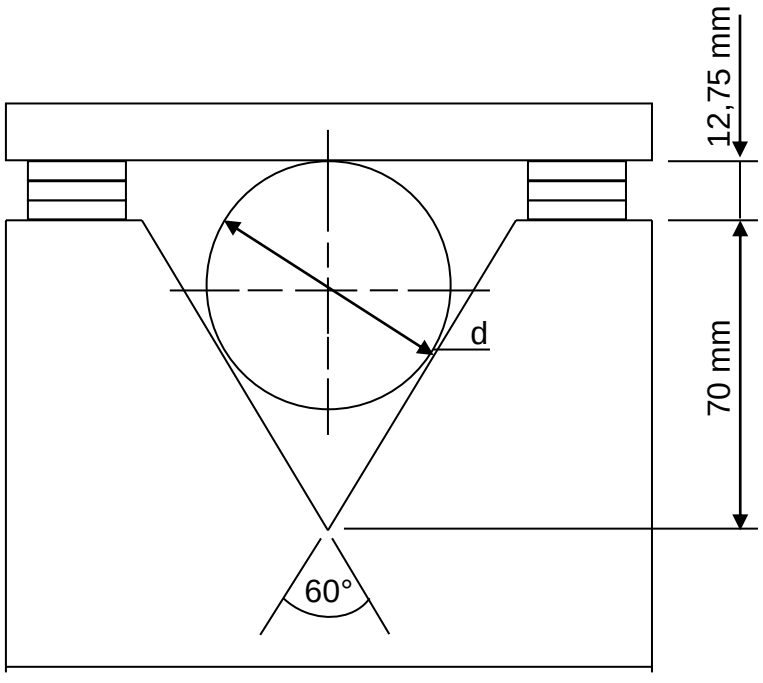


FIGURE 1 (8)

2.2 FIGURE 2 below shows a roller with two sets of gauge blocks of 12,75 mm each. The distance from the bottom of the groove to the top face is 70 mm and the included angle of the groove is 60°.

Use the given dimensions to calculate the diameter of the roller.



(7)

[15]

FIGURE 2

QUESTION 3

The epicyclic gear train shown in FIGURE 3 below consists of an annulus, a sun gear with 60 teeth and three planetary gears each having 20 teeth. The output shaft is connected to the arm carrying the planetary gears, while the input shaft is connected to the sun gear which is rotating at 450 r/min in a clockwise direction.

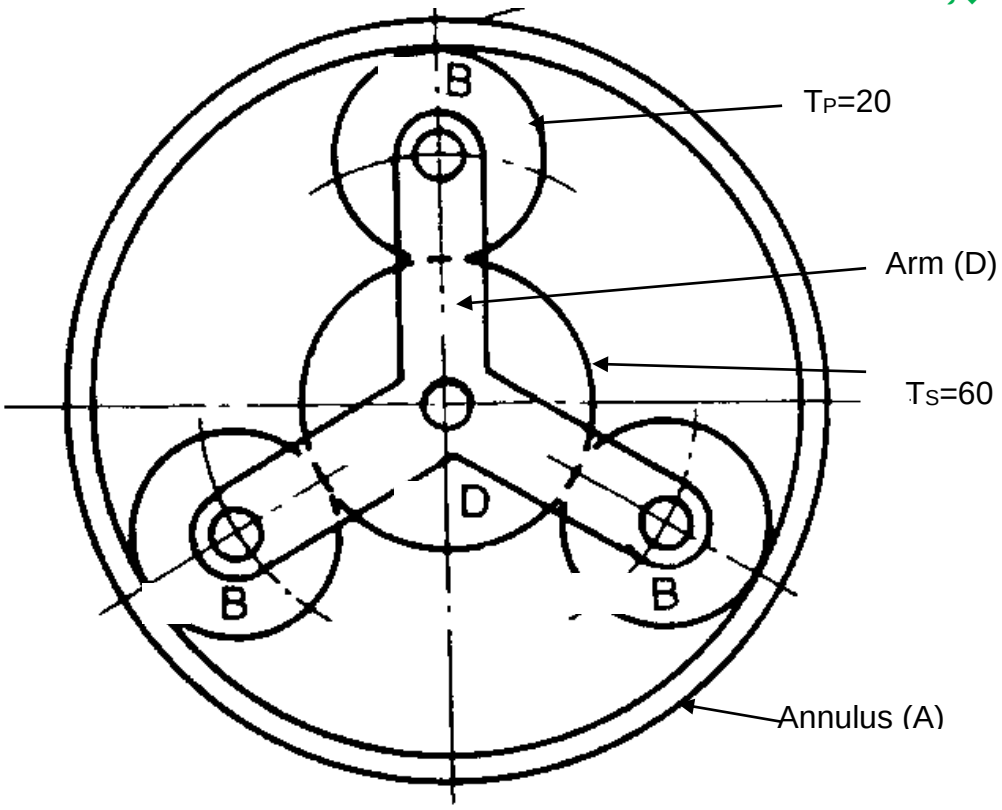


FIGURE 3

Calculate the following:

3.1 The speed and direction of rotation of the output shaft if the annulus is fixed. (11)

3.2 The speed and direction of rotation of the annulus if the output shaft rotates at 15 r/min in the opposite direction than the sun gear which is rotating clockwise at 450 r/min. (4)

[15]

QUESTION 4

A large pulley with a diameter of 1 200 mm rotates at 240 r/m. Determine the belt velocity if the belt is 12 mm thick. **[5]**

QUESTION 5

5.1 A horizontal pipeline with a diameter of 90 mm conveys water at 30 ℓ/s with a pressure drop of 60 kPa per 20 meter of pipeline.

5.1.1 Calculate the value of the coefficient of friction 'f' using the Darcy formula. (5)

5.1.2 Use the Chezy formula to calculate the hydraulic mean depth 'm'. (2)

5.1.3 Use the Chezy formula to calculate the hydraulic gradient 'I'. (2)

5.1.4 Calculate the Chezy coefficient 'c'. (5)

5.2 Find the flow rate of water, flowing through a 180 mm diameter pipe, which has a venturi meter throat diameter of 110 mm. The coefficient of delivery is 0,97. The mercury manometer shows a reading of 860 mm. (6)

[20]

QUESTION 6

6.1 Name THREE mean load graphs in bearings. (3)

6.2 Draw FOUR mean load graphs in bearings. (4 × 3) (12)

[15]

QUESTION 7

7.1 A shaft with a diameter of 300 mm revolves in a bearing and exerts a force of 80 kN on the bearing. The coefficient of friction between the shaft and the bearings is 0,02 and the shaft rotates at 350 r/min.

Calculate the power lost due to friction. (6)

7.2 A lathe is driven by a motor providing a maximum input of 3,5 kW at 1 750r/min. At the maximum power the machine efficiency is 80%. The maximum and minimum velocities of the lathe spindle are 3 500 r/min and 25 r/min respectively.

Calculate the torque of the maximum power:

7.2.1 At the driving shaft of the motor

7.2.2 At the driving spindle of the lathe at maximum speed

7.2.3 At the driving spindle of the lathe at minimum speed

(3 × 3) (9)

[15]

TOTAL: 100

MECHANOTECHNICS N4

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. $VR = \frac{PCD\ of\ gear}{PCD\ of\ pinion}$

7. $VR = \frac{NB}{NA}$

8. $NA \times TA = NB \times TB$

9. $Ft = \frac{2 \times T}{PCD}$

10. $Fr = Ft \times Tan\phi$

11. $Fn = Ft \times Sec\phi$

12. $Ie = IA + (VR)^2\ IB + (VR)^2\ IC + (VR)^2\ ID$

13. $T\forall = Ie \times \forall A$

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. $Ti + To + Th = 0$

19. $TA = TS + 2TP$

20. $\frac{Input\ speed}{Output\ speed} = \frac{Teeth\ on\ driven\ gears}{Teeth\ on\ driving\ gears}$

21. $v = \pi \times (d + t) \times N$

22. $P = Te \times v$

23. $\frac{T1}{T2} = e^{\mu\theta}$

24. $T1 = * \times A$

25. $Tc = m \times v^2$

26. $\frac{T1 - TC}{T2 - TC} = e^{\mu\theta cosec\,\alpha}$

27. $L = \frac{\pi}{2} \times (D + d) + \frac{(D \pm d)^2}{4 \times C} + 2C$

28. $Tg = m \times g \times sin\phi$

29. $v = T \times r$

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

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

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

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

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

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

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

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

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

39. $P = Pg + P\mu$

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

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

42. $T = F \times r$

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

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

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

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

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

48. $Vw\,(Va) = \sqrt{\frac{gx^2}{2y}}$

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

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

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

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

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

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

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

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

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

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

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

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

61. $P = T \times T$

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

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

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

65. $P = Ke \times operations/sec$

66. $(I_1 + I_2) T_3 = I_1 T_1 + I_2 T_2$

67. $\mu = Tan\ \theta$

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

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

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

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

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

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

74. *Tractive effort = mass on driving wheels* $\times \mu \times g$

75. $Side\ thrust = FcCos\theta - mg\ Sin\theta$

76. $\mu = \frac{FcCos\theta - mgSin\theta}{mgCos\theta + FcSin\theta}$

77. $P_l = CmgL + mgh$