higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N4

(8190194)

12 August 2021 (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 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. Only use a black or blue pen.
6. Write neatly and legibly.

QUESTION 1

1.1 Name FIVE advantages of process layout. (5)

1.2

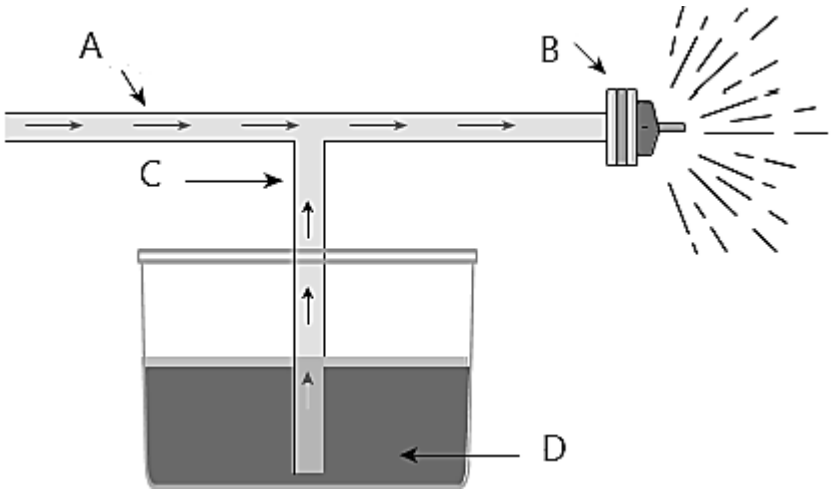

FIGURE 1

1.2.1 Name the painting process depicted in FIGURE 1 above. (1)

1.2.2 Name the labels (A–D) in the diagram in FIGURE 1. (4)

1.3 Name FIVE general methods of lubrication. (5)
[15]

QUESTION 2

FIGURE 2 below shows a workpiece with a V-groove which has a 60° included angle and is 50 mm in depth.

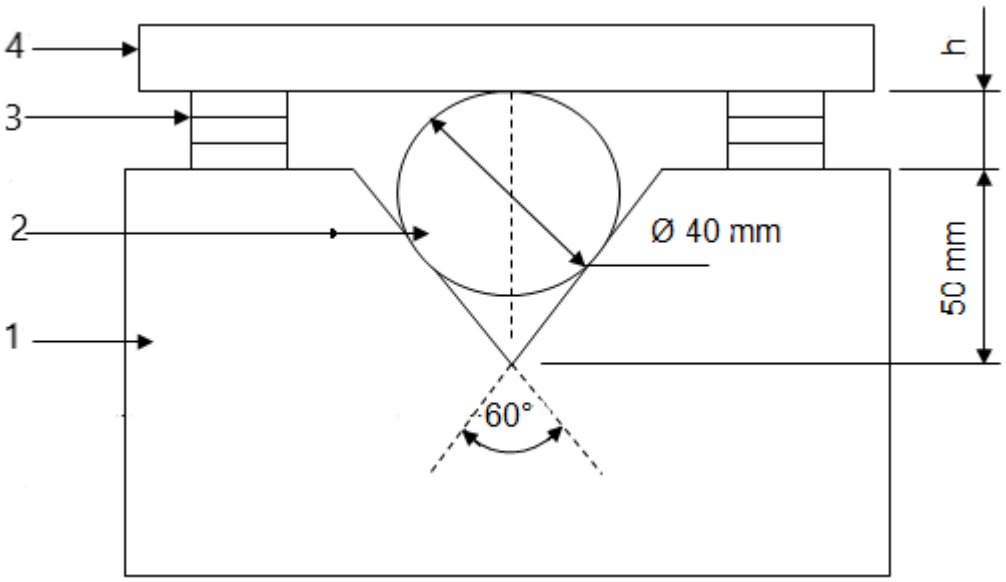

FIGURE 2

2.1 Refer to FIGURE 2 above and name the components labelled 1–4. (4)

2.2 Use the drawing in FIGURE 2 to calculate distance h. (6)

2.3 The drawing in FIGURE 3 below depicts how two rollers of 25 mm diameters are used for checking the accuracy of the two inclined faces.

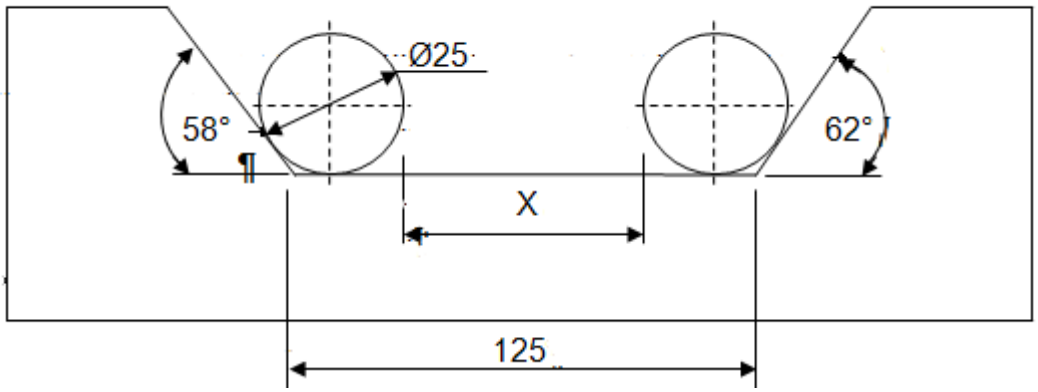

FIGURE 3

Use the given dimensions to calculate distance X. (5)
[15]

QUESTION 3

A set of spur gears has a velocity ratio of 5:3 and a module of 6 mm.

If the pinion has 30 teeth, calculate the following:

3.1 The pitch circle diameter of both gears (5)

3.2 The centre distance between the two shafts (2)

3.3 The outside diameter of both gears (4)

3.4 The total depth that the drilling cutter must be fed into the gear blank in order to cut the teeth (4)
[15]

QUESTION 4

The following specifications apply to an open flat belt drive between a motor and a machine.

Contact angle on the driving pulley:	160°
Revolutions of the driving pulley:	600 r/min
Diameter of the driving pulley:	600 mm
Coefficient of friction between belt and pulley:	0,2
Safe working stress in the belt:	4 MPa
Thickness of belt :	20 mm
Belt mass:	0,5 kg per meter length
Width of belt:	155 mm

Calculate the following:

4.1 The centrifugal force (T_c) exerted on the belt. (3)

4.2 The tension (T_1) in the tight side of the belt. (2)
[5]

QUESTION 5

5.1 Water is in steady motion in a pipe that is inclined downwards. The diameter at the upper end is 100 mm and the pressure is 55 kPa. The diameter at the lower end is 63 mm and the pressure there is 35 kPa. The difference in vertical height between the two points is 3 m.

Determine the rate of flow in litres/seconds (ℓ/s). Assume that there are no losses due to friction in the pipe. (14)

5.2 A tank has an orifice with a diameter of 45 mm in the side, 4 m below the surface of the water. Assume that the coefficient of delivery (C_d) is 0,64.

Calculate the rate at which water flows from the tank in litres per hour (ℓ/h). (6)
[20]

QUESTION 6

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

6.2 Draw and label the graphs named in QUESTION 6.1 above. (12)
[15]

QUESTION 7

7.1 A lathe is driven by a motor providing a maximum input of 3 kW at 1 500 r/min. At maximum power the machine efficiency is 80%. The maximum and minimum velocities of the lathe spindle are 3 600 r/min and 40 r/min respectively.

Find the torque of the maximum power

7.1.1 At the driving shaft of the motor (2)

7.1.2 At the driving spindle of the lathe at maximum velocity (4)

7.1.3 At the driving spindle of the lathe at minimum velocity (2)

7.2 Calculate the power in kW consumed by

7.2.1 A shaping machine operation in which the cuffing force is 1 200 N and the stroke length of 275 mm takes 13 *s* to complete (3)

7.2.2 A lathe operation during which the cutting force applied to the cutting tool is 1 000 N and the rotational speed of the work piece with a diameter of 350 mm is 350 r/min (4)

[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. $T\alpha = Ie \times \alpha A$

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. $Ti + To + Th = 0$

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. $T1 = \delta \times A$

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

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. $P = \omega \times T$

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

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

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

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

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

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

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

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

75. $Side\ thrust = Fc Cos\theta - mg\ Sin\theta$

76. $\mu = \frac{Fc Cos\theta - mg Sin\theta}{mg Cos\theta + Fc Sin\theta}$

77. $P_l = CmgL + mgh$