higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N4

(8190194)

21 November 2024 (X-paper)
09:00–12:00

Drawing instruments and non-programmable calculators may be used.

This question paper consists of 8 pages and formula sheets of 3 pages.

064Q1E2421

Copyright reserved

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. Use only a black or blue pen.
5. Round off your final answer to 3 decimal places.
6. Write neatly and legibly.

Copyright reserved

QUESTION 1

1.1 When choosing the most suitable type of production for a workshop, you have to take several factors into consideration.

Name any FIVE of these factors. (5)

1.2 Name any FIVE advantages of airless spray painting. (5)

1.3 Draw a neatly labelled sketch of a NEEDLE lubricator. (5)

[15]

QUESTION 2

2.1 A tapered hole with an included angle of 30° is tested by means of a precision steel ball of 15 mm diameter as shown in FIGURE 1. Find the distance X from the top face of the workpiece to the top of the ball. (7)

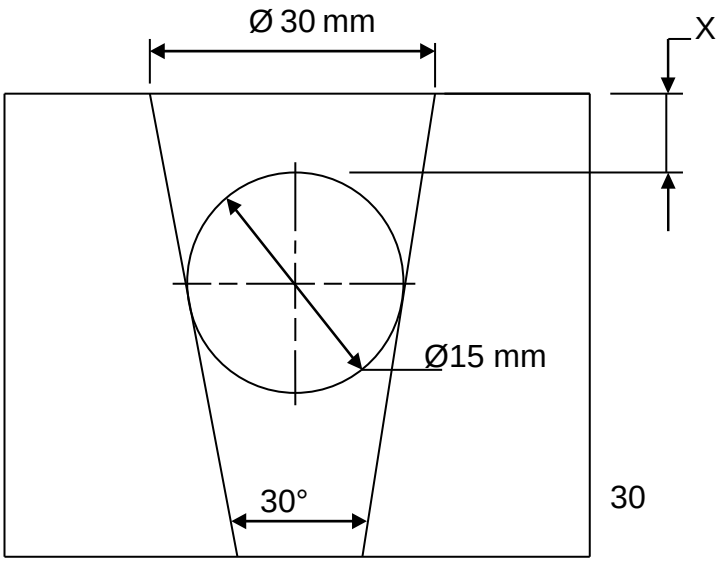


FIGURE 1

2.2 FIGURE 2 below shows a workpiece with a V-groove which has a 50° included angle and 45 mm in depth.

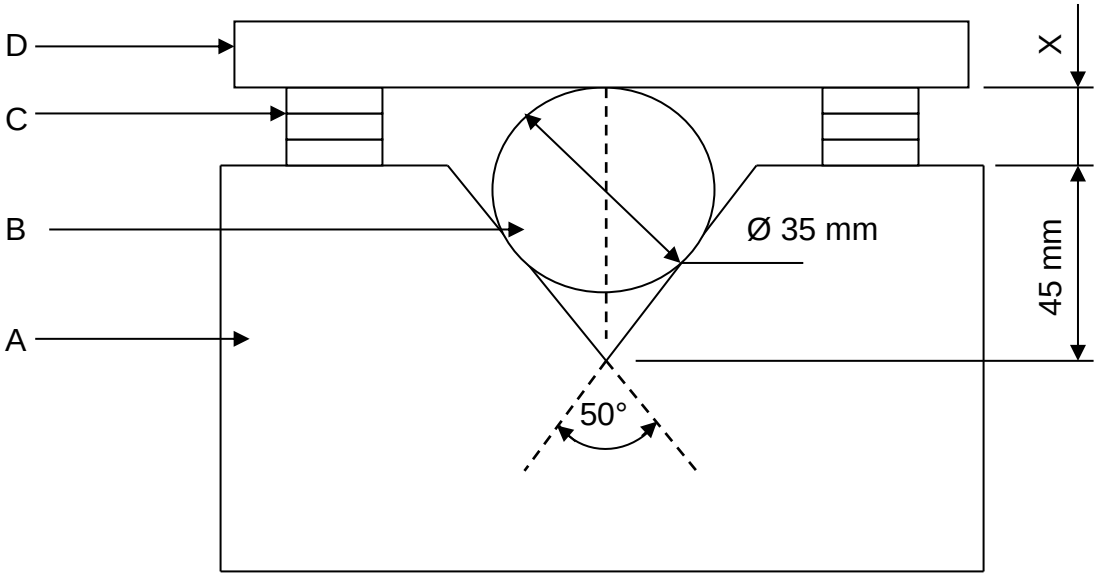


FIGURE 2

2.2.1 Refer to FIGURE 2 above and name the components labelled A – D in your ANSWER BOOK. (4)

2.2.2 Use the drawing to calculate the distance "X". (4)
[15]

QUESTION 3

An open flat belt drive is required to transmit 20 kW at 190 r/min. The diameters of the driving pulley and driven pulley are 180 mm and 140 mm respectively. Assume the contact angle of 175° and coefficient of friction of 0,36 to calculate the tension in the slack side of the driving belt. **[5]**

QUESTION 4

4.1 A gear train made of gear wheel and pinion has a centre distance of approximately 612 mm between shafts. Assume that the circular pitch is 38,5 and the velocity ratio is 5,3:1 and calculate:

4.1.1 Number of teeth for pinion and wheel gears (7)

4.1.2 The true centre distance between the shafts (2)

4.2 The compound gear system of a reduction gearbox is shown in FIGURE 3. It consists of an input gear A with 68 teeth rotating at 850 r/min, and intermediate shaft on which two gears B and C are mounted with 136 and 70 teeth respectively, and gear D with 100 teeth. If this gear system has a module of 6 mm, calculate the following:

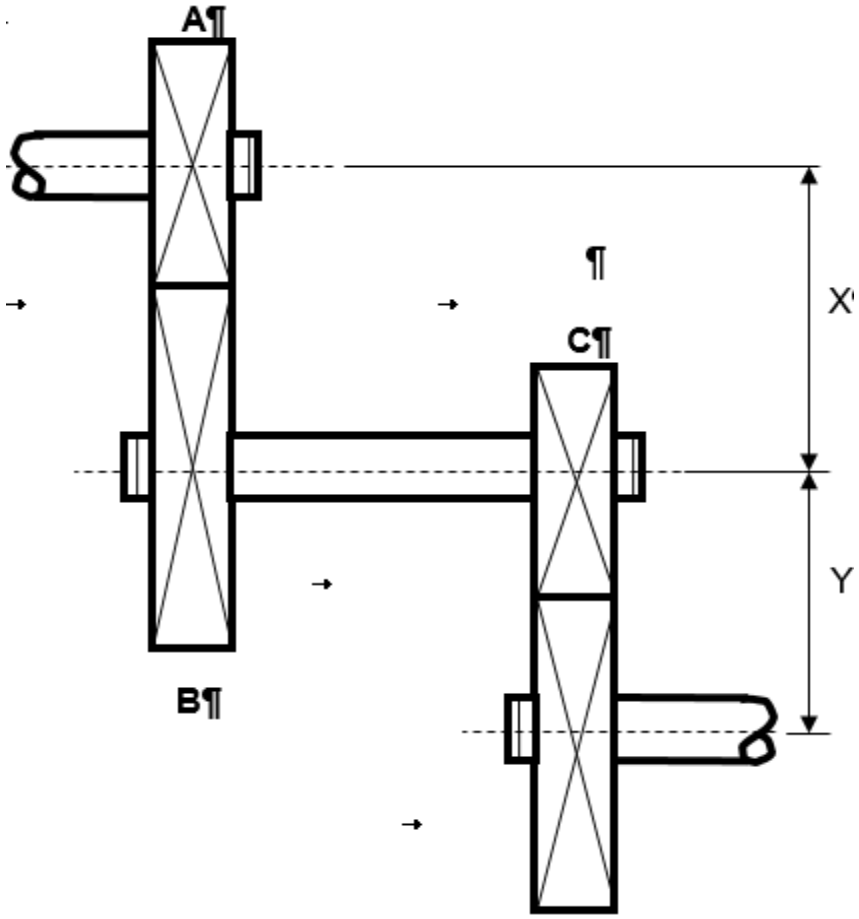


FIGURE 3

4.2.1 Rotational speed of Gears B, C and D (4)

4.2.2 The centre distance X (1)

4.2.3 The centre distance Y (1)

[15]

QUESTION 5

5.1 FIGURE 4 below shows a sharp-edged orifice in the side of a large tank. The orifice discharges water under a constant pressure head of 3 m. The orifice diameter on the side of a tank is 40 mm, while the *vena contracta* has a diameter of 30 mm.

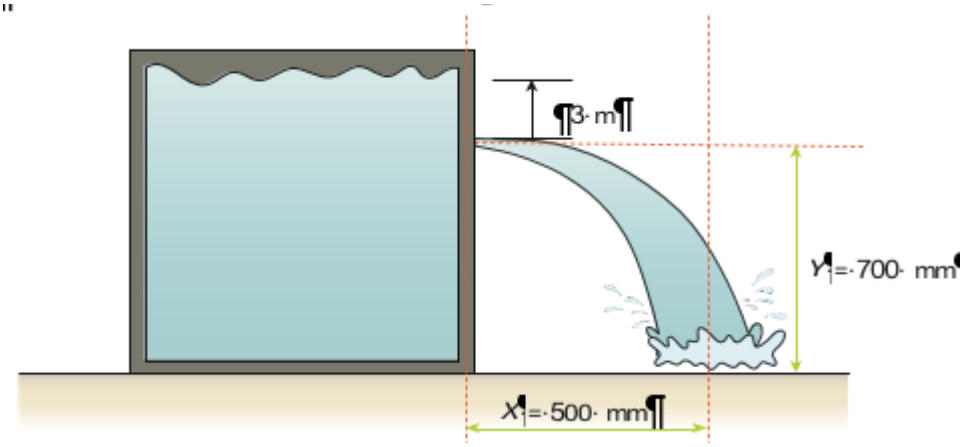


FIGURE 4

Calculate the following:

5.1.1 Theoretical and actual area of the jet (2)

5.1.2 Theoretical and actual velocity water (4)

5.1.3 Theoretical and actual delivery of the water through the orifice (4)

5.1.4 The coefficient of delivery (2)

5.1.5 The coefficient of contraction (2)

5.1.6 The coefficient of velocity (2)

5.2 A horizontally placed pipe is 300 mm in diameter and delivers 10 m^3/minute of water. The length of the pipe is 3 km and the resistance coefficient of the pipe is 0,006.

Calculate the head lost owing to pipe friction. (4)

[20]

Copyright reserved

QUESTION 6

6.1 Draw and label a neat sketch of the graph of bearing subjected to each of the following loads:



(i) Linear fluctuating load
(ii) Fluctuating stepped load
(iii) Continuously fluctuating load
(iv) Sinusoidal fluctuating load (2 × 4) (8)

6.2 A gear with a 20° pressure angle and a pitch circle diameter of 200 mm is situated between two bearings. The gear is driven by a 120 kW power source and rotates at 150 r/min.

Calculate the following:

6.2.1 The torque transmitted (2)

6.2.2 The tangential force on the gear (2)



6.2.3 The normal force on the gear (2)

6.2.4 The radial force on the gear (1)
[15]

Copyright reserved

QUESTION 7

FIGURE 5 below shows the set-up of the cutting tool held in the tool holder of a shaping machine. The ram of the shaping machine has a mass of 110 kg and in operation a cutting stroke length of 230 mm. The total work done during one cutting stroke is equal to 130 J and the coefficient of friction between the ram and the slides is 0,2.

Calculate the following:

7.1 The work done to overcome the friction between the ram and the slides (4)

7.2 The cutting force exerted on the cutting tool (4)

7.3 The forces exerted on the two contact points A and B if the clamping force in the clamping screw is 1 000 N. Test your answers. (7)

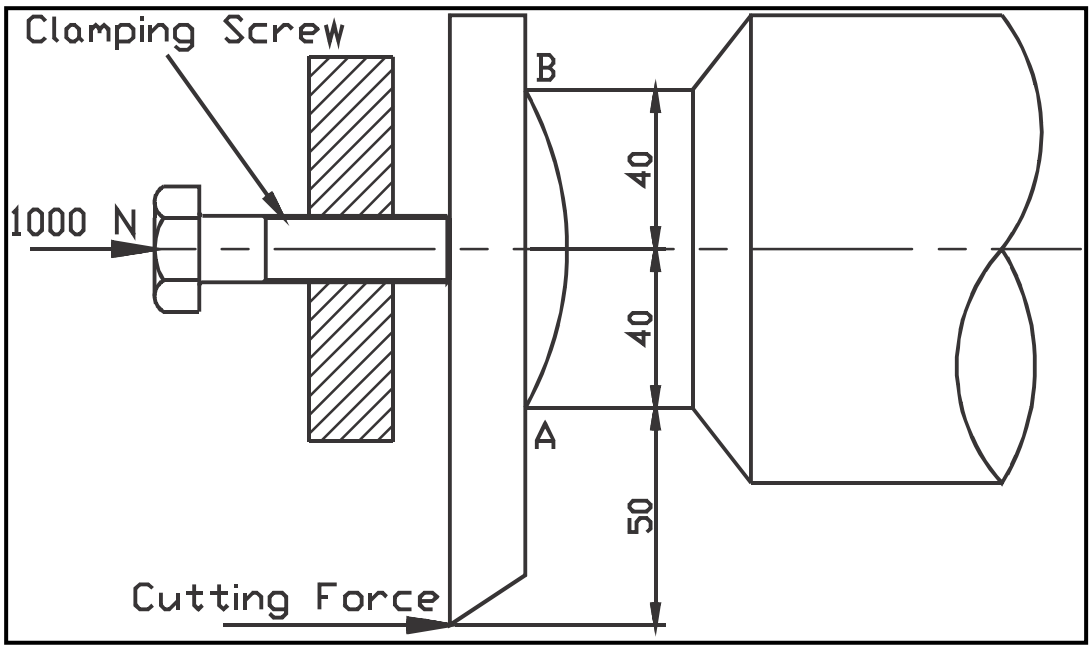


FIGURE 5

[15]

TOTAL: 100

Copyright reserved

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. $v = T \times r$

Copyright reserved

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

Copyright reserved

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* $= Fc\mathrm{Cos}\,\theta - mg\ \mathrm{Sin}\theta$

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

77. $P_l = CmgL + mgh$

78. $P_r = X.F_r + Y.F_a$

79. $L_0 = \left(\frac{1\times10^6}{60\times n}\right) \times \left(\frac{C_r}{P_r}\right)^p$

80. $L_0 = \left(\frac{C_r}{P_r}\right)^p$

81. $F_N = \frac{F_T}{Cos20^0}$

82. $F_r = F_T \times \tan 20^0$

83. $F_N = \frac{F_r}{Cos20^0}$

84. $T = F_T \times \frac{PCD}{2}$

Copyright reserved