higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

MECHANOTECHNICS N4

(8190194)

26 July 2018 (X-Paper)
09:00–12:00

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

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. Sketches must be large, neat and fully labelled.
5. Write neatly and legibly.

QUESTION 1

1.1 The layout of a workshop involves placing of the various machines and related equipment in the different work areas, as well as arranging for storage space or stores, staff facilities and administrative offices. The placing of machines on the floor of a workshop must comply with important requirements.

Name and briefly discuss FIVE requirements for the placing of machines on the floor of a workshop. (5 × 2) (10)

1.2 State FIVE advantages for the use of ball and roller bearings in preference to ordinary journal bearings. (5)

1.3 Ball and roller bearings sometimes overheat during use.

Give FIVE reasons for this occurrence. (5)

1.4 1.4.1 Make a labelled drawing of electrostatic spray painting. (6)

1.4.2 State TWO advantages of electrostatic spray painting. (2)

1.4.3 State TWO disadvantages of electrostatic spray painting. (2)
[30]

QUESTION 2

The following applies to a flat-belt drive:

The width is 250 mm
The thickness is 6 mm
The tension in the tight side of the belt is two and half times more than that in the slack side.
The safe working stress is 350 kPa.
The centre distance between two shaft carrying pulleys with a diameter of 1 500 mm and 500 mm respectively, is 2 m.
The larger pulley rotates at 150 r/min.

Calculate the following:

2.1 The power transmitted (10)

2.2 The length of the open belt drive (2)

2.3 The length of the belt if the drive is changed to crossed-belt drive (2)
[14]

QUESTION 3

3.1 A workpiece with a diameter of 250 mm is machined in a lathe at a spindle speed of 200 r/min. The cutting depth is 5 mm and the feed of the cutting tool is 0,5 mm per revolution of the workpiece. A cutting force of 2,5 kN is exerted by the cutting tool on the workpiece.

Calculate the following:

3.1.1 The cutting pressure on the tool (N/mm^2) (3)

3.1.2 The power required to machine the workpiece (kW) (3)

3.1.3 The motor power if the motor has an efficiency of 80% (2)

3.2 The belt drive from an electric motor transmits an effective driving force of 800 N to the 250 mm diameter driving pulley on a milling machine. The torque to overcome friction on the driving parts of the machine can be assumed as 8 Nm.

Determine the following:

3.2.1 Torque transmitted to the machine pulley

3.2.2 Torque that is available at the milling cutter

3.2.3 The effective cutting force that can be executed by the 115 mm diameter of the cutter

(3 × 2) (6)
[14]

QUESTION 4

4.1 An ISO 150 screw thread of 3,5 mm pitch has an effective diameter of 30 mm. The three-wire method is used for checking the effective diameter. The best wire size method is used for the test wires.

Calculate the micrometer reading over the three wires. (6)

4.2 4.2.1 Explain step by step how you would go about to check the correctness of the teeth of a gear wheel with a module of 10 mm and a pressure angle of 20. Use a gear tooth vernier caliper and apply the constant-chord method of checking. (3)

4.2.2 Make the necessary calculations for the above test by using the constant chord method of checking. (5)
[14]

QUESTION 5

The epicyclic gear system shown in FIGURE 1 consists of a ring gear (annulus) (T_a) with 100 teeth, a sun gear (T_s) with 40 teeth and a planetary gear (T_p) with 30 teeth mounted on an arm (D).

5.1 Determine the speed and direction of the sun gear (T_s) if the annulus (T_a) is fixed and the arm (D) rotates at +30 r/min. (9)

5.2 Determine the speed and direction of the annulus (T_a) if the sun gear (T_s) is fixed and the arm (D) rotates at +30 r/min.

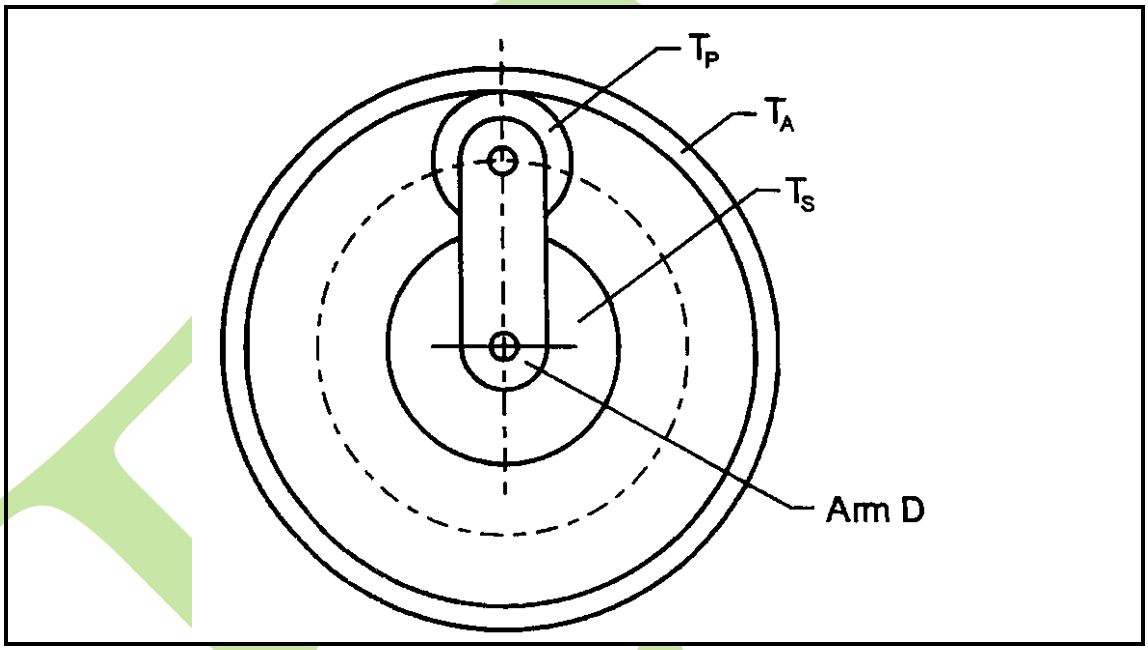

FIGURE 1

(5)
[14]

QUESTION 6

6.1 Water flows through a pipe with a diameter of 25 mm and a length of 50 m at a velocity of 2,5 m/s.

Use Darcy's formula to determine the loss of head due to friction. Assume that the coefficient of friction has a value of 0,005. Test the answer by using the Chezy formula. (9)

6.2 A horizontal pipeline with a diameter of 75 mm conveys water at a rate of 0,015 m/s with a pressure drop of 50 kPa for every 30 metres of pipe length.

Calculate the value of the coefficient of friction (f) for the above-mentioned circumstances by using Darcy's formula. (5)
[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. $VR = \frac{PCD\ of\ gear}{PCD\ of\ pinion}$

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

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

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

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. $P_l = CmgL + mgh$