higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N6

(8190236)

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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 N6
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.

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QUESTION 1

A conical friction clutch, lined with material giving a friction coefficient of 0,25, has a mean diameter of the contact surfaces of 300 mm with a conical surface width of 40 mm. The semi-angle of the cone is 20° and the intensity of the normal pressure between the contact surfaces is limited to 60 kPa. Assume uniform wear and that the maximum pressure will occur at the inner radius.

Determine:

1.1	Inner and outer diameters of the cone	(6)
1.2	The torque transmitted by the clutch	(6)
1.3	Power transmitted at a speed of 1 200 r/min	(3)
		[15]

QUESTION 2

A band brake is fitted to the circumference of a wheel with a diameter of 750 mm. The angle of contact is 210° and the coefficient of friction is 0,3. The band is fixed at one end and a pull of 150 N is applied at one end. The wheel has a mass of 450 kg with a gyration radius of 300 mm. The drum rotates at 370 r/min before the application of the brake.

Determine:

2.1	The brake torque	(6)
2.2	Time required to bringing the wheel to rest when the brake is applied at 370 r/min	(6)
2.3	Number of revolutions the drum completes from the instant the brake is applied until the drum comes to a halt	(3)
		[15]

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QUESTION 3

Bearings are used to support a shaft at both ends. The shaft transmits 32 kW of power at 280 r/min. A 740 N pulley with a 350 mm diameter is mounted 75 mm from the right-hand bearing, and this pulley is used in a horizontal belt drive. The distance between the two bearings is 300 mm. A flywheel with a mass of 140 kg is mounted 50 mm from the left-hand bearing. The angle of contact between the belt and the pulley is 210° and the belt-tension ratio is 3:1.

Determine:

3.1	Torque transmitted	(4)
3.2	Tension in the belts	(4)
3.3	Vertical reactions on the bearings	(5)
3.4	Horizontal reactions on the bearings	(6)

[19]

QUESTION 4

A flywheel with a diameter of 2 m is accelerated uniformly from 300 r/min to 500 r/min in 18 seconds.

Determine:

4.1	Angular acceleration	(4)
4.2	Angle turned to reach 1 000 r/min in radian	(4)
4.3	Final linear velocity	(3)
4.4	Tangential acceleration in m/s^2 after 18 seconds.	(3)

[14]

QUESTION 5

In a worm-and-wheel gear system there is a load drum of 100 mm in diameter keyed to the wheel spindle, and an effort drum of 65 mm in diameter is keyed to the worm shaft. The wheel has 40 teeth. The efficiency of the system is 30% and the lifted load has a weight of 2 000 N.

Determine the following:

5.1	Velocity ratio of the system	(5)
5.2	Effort needed to lift the load	(4)

[9]

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QUESTION 6

A locomotive with a mass of 35 ton is equipped with driving wheels that each has a diameter of 800 mm. The rolling resistance is 150 N/ton of the mass of the locomotive. The engine develops 95 kW at 1 100 r/min. The total mass of the locomotive is carried on the driving wheels. Assume that the engine torque remains constant, and that the transmission efficiency is 75%.

Calculate the time taken to reach full speed from rest on a level track. **[10]**

QUESTION 7

The following information pertains to four masses attached to a shaft:

	A	B	C	D
Mass in kg	x	21	30	6
Radius in mm	100	130	85	200

The axial distance between the four masses is 250 mm.

Determine:

7.1 Taking Mass A as a reference plane, and using a scale of 5 mm = 0,2 kg/m^2, compile the required table using the given data. Draw the couple polygon as well. (9)

7.2 Draw a force diagram using scale 5 mm = 0,1 kg.m. (4)

7.3 Calculate the minimum value of Mass A. (2)

7.4 Use the end view to indicate the relative angular positions of the centre of Masses A and D to ensure complete dynamic balance for the rotating shaft. Indicate the angular positions of the masses with respect to Mass B taken in a clockwise direction. (3)

[18]

TOTAL: 100

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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. $v = T \times r$

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

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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 × μ × g*

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

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

77. $P_l = CmgL + mgh$

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