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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1110**(E)**(A10)T

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

(8190225)

10 April 2018 (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 N5
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.

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QUESTION 1

Endless rope haulage is required to deliver 800 ton of rock per eight-hour shift over a distance of 900 m on a 12° average incline. The speed of the rope is 3,5 km/h and its mass is 3 kg/m. The track resistance is assumed to be 180 N per ton and the mechanical efficiency is 82%. The tubs have a mass of 250 kg empty and 1 000 kg full.

Calculate:

1.1 The total number of tubs required (5)

1.2 The total mass in conveyance (5)

1.3 The motor power (8)
[18]

QUESTION 2

A bucket elevator used to transport coal has the following details:

The centre distance between the head and the tail pulley is 80 m with bucket spacing of 700 mm. A mass of 1 300 ton is transported at a chain speed of 95 m/min in an effective shift time of 7 hours. The discharge of the coal takes place at 30° after top dead centre.

Calculate:

2.1 The diameter of the head pulley (5)

2.2 The total length of the chain assuming the same diameter for both the head and tail pulleys and ignoring the deflection of the chain given by the tensioning device (3)

2.3 The driving motor power required if the drive is 75% efficient (10)
[18]

QUESTION 3

3.1 Calculate the torque to increase the speed of a flywheel with a mass of 1 300 kg and a radius of gyration of 810 mm from 110 r/min to 150 r/min in 40 seconds. (6)

3.2 A flywheel has a mass of 560 kg and a radius of gyration of 820 mm.

Calculate:

3.2.1 The kinetic energy required to give the flywheel a speed of 105 r/min from rest (3)

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3.2.2 The uniform torque required to accelerate the flywheel from 58 r/min to 120 r/min (3)

3.2.3 The time required to reach this acceleration (4)

[16]

QUESTION 4

A conveyor belt delivers 120 ton of crushed stone per hour into a storage bin. The distance between the main pulley centres is 100 m. The speed of the 650 mm troughed belt is 90 m/min. The coefficient of friction between the pulley and the belt is 0,25. The discharge is 12 m higher than the loading point. The snubber pulley provides a contact angle between the belt and the main pulley of 225°. The power required to overcome friction is 35% of the power required to lift the load against gravity. The drive is 80% efficient.

Calculate:

4.1 The power against gravity (3)

4.2 The power to overcome friction (2)

4.3 The power of the motor (3)

4.4 The belt tensions (T_1 and T_2) (6)

4.5 The number of plies in the belt if the allowable tension is 2,3 kN per metre width per ply (3)

[17]

QUESTION 5

An electric locomotive with a mass of 150 ton hauls trucks with a mass of 700 ton up an incline of 1 in 140. The locomotive has 72% of its mass on the driving wheels and it has a rolling resistance of 160 N/ton. The rolling resistance of the trucks is 120 N/ton.

Calculate:

5.1 The tractive effort of the locomotive if the coefficient of adhesion friction between the wheels and the rail is 0,3 (2)

5.2 The force required to accelerate the locomotive and trucks up the incline (5)

5.3 The time taken for the locomotive and the trucks to accelerate from rest to 36 km/h assuming that the tractive effort of the locomotive is 68% of its maximum during the acceleration period (7)

5.4 The distance travelled during this time (2)

[16]

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QUESTION 6

6.1 Give THREE reasons for placing the driving machine of a goods elevator on top of the hatchway. (3)

6.2 A rope passes over a drum with a mass of 400 kg, a radius of gyration of 0,6 m and a diameter of 980 mm. The loaded cage of a goods elevator has a mass of 1 600 kg and the balance mass of 850 kg moves in guides. The frictional torque on the drum is 320 N.m. The frictional resistance between the guides and the cage is 620 N and between the guides and the balance mass 480 N. The load has an upward velocity of 1,6 m/s and an upward acceleration of 0,6 m/s^2.

Calculate:

6.2.1 The total torque required on the drum (10)

6.2.2 The power required at an instant when the load has an upward velocity of 1,8 m/s and an upward acceleration of 0,8 m/s^2 (2)

[15]

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

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. $v = \omega \times r$

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

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

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. $P = \omega \times T$

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

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

77. $P_l = CmgL + mgh$

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