T1110(**E**)(N27)T

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

(8190225)

27 November 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 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.

Please turn over

QUESTION 1

1.1 State THREE factors that have to be taken into account when arranging a reduction gear train. (3)

1.2 FIGURE 1 below shows a reduction gearbox with a three-start worm, worm gear and four gears. The worm shaft is connected to an electric motor rotating at 800 r/min.
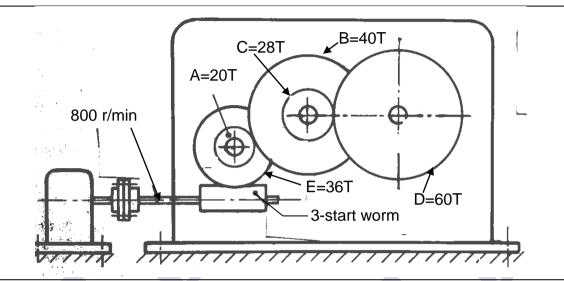

FIGURE 1

Calculate the following:

1.2.1 The delivery speed of the gearbox (9)

1.2.2 The velocity ratio of the gearbox (3)

[15]

QUESTION 2

2.1 Describe the purpose of a flywheel in a motor car engine. (2)

2.2 A flywheel of a rock crusher machine dispels 12 kJ of energy when the speed drops 7% below 160 r/min. The flywheel has a radius of gyration of 600 mm.

Calculate the following:

2.2.1 The initial angular velocity and the final angular velocity of the flywheel (5)

2.2.2 The moment of inertia (3)

2.2.3 The mass of the flywheel (2)

2.2.4 The torque required to increase the speed from rest to 160 r/min in 48 seconds (4)

[16]

QUESTION 3

3.1   A vehicle with a mass of 2 tons travels along a level road. The tractive efficiency of the vehicle is 2 kN and the rolling resistance between the wheels and the road is 95 N/ton of the vehicle mass.

         Calculate the following:

         3.1.1   The force available for acceleration   (2)

         3.1.2   The acceleration of the vehicle   (3)

3.2   An electric train with a total mass of 300 tons is accelerating at 0,05 m/s^2 up an incline of 1 in 120. The rolling resistance is 0,8% of mass of the train.

         Calculate the following:

         3.2.1   The tractive effort to overcome friction resistance   (2)

         3.2.2   The tractive effort to overcome gravity   (2)

         3.2.3   The tractive effort to accelerate the train   (2)

         3.2.4   The power required at a speed of 65 km/h   (4)

         3.2.5   The kinetic energy of the locomotive at 65 km/h   (2)
                                                                                   [17]

QUESTION 4

4.1   Name THREE types of bucket elevators.   (3)

4.2   A bucket elevator is used to lift coal with a density of 850 kg/m^3 at a rate of 350 tons per hour through a vertical height of 65 m. The chain speed is 0,6 m/s and the spacing of buckets is 1 m.

         Determine the following:

         4.2.1   The volume of each bucket   (10)

         4.2.2   The required power of the driving motor if the head has an efficiency of 90%   (5)
                                                                                   [18]

QUESTION 5

Endless rope haulage is required to deliver 850 tons of rock per eight-hour shift over a distance of 950 m on an average incline of 10°. When empty, the tubs have a mass of 300 kg, and when full they have a mass of 1 000 kg. The rope has a speed of 4,6 km/h and a mass of 3,5 kg/m. The track resistance is assumed to be 200 N per ton and the mechanical efficiency is 75%.

Calculate the following:

5.1   The total number of tubs required   (4)

5.2   The total mass in conveyance   (4)

5.3   The power of the motor   (10)

[18]

QUESTION 6

6.1   Explain the main difference between a *passenger elevator* and a *goods elevator.*   (6)

6.2   The drum of a mine hoisting machine has a moment of inertia of 100 kg.m and is in the process of hoisting a goods elevator cage with a mass of 1,2 tons. The acceleration is 1,7 m/s^2 and the drum has a diameter of 1,1 m.

Calculate the following:

6.2.1   The torque exerted at the drum   (6)

6.2.2   The power required to accelerate the system for a period of 3,5 s from rest. Assume an efficiency of 85%.   (4)

[16]

TOTAL: 100

FORMULA SHEET

1. $m = \dfrac{PCD}{T}$

2. $DO = m \times (T + 2)$

3. $C = \dfrac{m}{2} \times (TA + TB)$

4. $Ke = \dfrac{1}{2} mv^2$

5. $VR = \dfrac{TA}{TB}$

6. $VR = \dfrac{PCD \ of \ gear}{PCD \ of \ pinion}$

7. $VR = \dfrac{NB}{NA}$

8. $NA \times TA = NB \times TB$

9. $Ft = \dfrac{2 \times T}{PCD}$

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. $T\alpha = TA + \dfrac{(NB)}{(NA)} \dfrac{TBC}{\eta 1} + \dfrac{(ND)}{(NA)} \dfrac{TD}{\eta 1 \eta 2}$

15. $\dfrac{NB}{NA} = \dfrac{\omega B}{\omega A} = \dfrac{\alpha B}{\alpha A} = \dfrac{IA}{IB}$

16. $T_{OUTPUT} = T_{INPUT} \times GR \times \eta$

17. $P = \dfrac{\pi \times PCD}{n}$

18. $Ti + To + Th = 0$

19. $TA = TS + 2TP$

20. $\dfrac{Input \ speed}{Output \ speed} = \dfrac{Teeth \ on \ driven \ gears}{Teeth \ on \ driving \ gears}$

21. $v = \pi \times (d + t) \times N$

22. $P = Te \times v$

23. $\dfrac{T1}{T2} = e^{\mu\theta}$

24. $T1 = \delta \times A$

25. $Tc = m \times v^2$

26. $\dfrac{T1 - TC}{T2 - TC} = e^{\mu\theta cosec \ \alpha}$

27. $L = \dfrac{\pi}{2} \times (D + d) + \dfrac{(D \pm d)^2}{4 \times C} + 2C$

28. $Tg = m \times g \times sin\phi$

29. $v = \omega \times r$

30. $v = \sqrt{\mu \times g \times r}$

31. $v = \sqrt{\dfrac{g \times b \times r}{2 \times h}}$

32. $v = \sqrt{gr\left[\dfrac{\mu + Tan\,\theta}{1 - \mu Tan\,\theta}\right]}$

33. $v = \sqrt{gr\left[\dfrac{hTan\theta + b/2}{h - b/2\,tan\,\theta}\right]}$

34. $\dfrac{T1}{T2} = \left[\dfrac{1 + \mu Tan\,\theta}{1 - \mu Tan\,\theta}\right]^{n}$

35. $Cos\,\dfrac{\theta}{2} = \dfrac{R - r}{C}$

36. $Cos\,\dfrac{\phi}{2} = \dfrac{R + r}{C}$

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

38. $T1 = w \times n \times ft$

39. $P = Pg + P\mu$

40. $t = \dfrac{I \times \omega}{T}$

41. $P = \dfrac{2 \times \pi \times N \times T}{60}$

42. $T = F \times r$

43. $w = do + 3d - 1{,}5155P$

44. $do = de + 0{,}65P$

45. $w = \dfrac{\pi \times m}{2}(cos^{2}\,\theta)$

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

47. $\dfrac{p1}{Rho} + \dfrac{(v1)^{2}}{2} + gh1 = \dfrac{p2}{Rho} + \dfrac{(v2)^{2}}{2} + gh2$

48. $Vw\,(Va) = \sqrt{\dfrac{gx^{2}}{2y}}$

49. $v = C\sqrt{mi}$

50. $hf = \dfrac{4 \times f \times \ell \times v^{2}}{2 \times g \times d}$

51. $hf = \dfrac{f \times \ell \times O^{2}}{3{,}026 \times d^{5}}$

52. $Q = \dfrac{Cd \times A \times a \times \sqrt{(2gh)}}{\sqrt{(A^{2} - a^{2})}}$

53. $Q = Cd \times A \times \dfrac{\sqrt{(2gh)}}{\sqrt{(m^{2} - 1)}}$

54. $V = \sqrt{(g \times R \times Cos\theta)}$

55. $Vol.\ bucket = \dfrac{m \times s}{\rho \times v}$

56. $L = 2C + \pi D$

57. $Self\text{-}weight = \dfrac{m1 \times g \times S^{2}}{8 \times h}$

58. $One\ load = \dfrac{m2 \times g \times S}{4 \times h}$

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

60. $T \text{ (acc drum)} = I \times \alpha = mk^2 \times \dfrac{a}{R}$

61. $P = \omega \times T$

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

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

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

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. $\eta = \dfrac{Tan\ \theta}{Tan\ (\theta + \phi)}$

70. $T = \dfrac{\mu \times F \times Re}{sin\ \theta}$

69. $T = \mu \times F \times Re \times n$

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

71. $T = \mu \times n \times (Fc - S)R$

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

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

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

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

77. $P_l = CmgL + mgh$