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Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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APRIL EXAMINATION

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

(8190225)

8 April 2016 (X-Paper)
09:00–12:00

This question paper consists of 5 pages, 1 diagram sheet and 1 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. Write neatly and legibly.

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QUESTION 1

In the epicyclic gear train shown in FIGURE 1, DIAGRAM SHEET 1 (attached), gear B has 120 teeth externally and 104 teeth internally. The driver A has 20 teeth and arm E is connected to the driven shaft. Gear D has 44 teeth.

If gear A revolves at 130 r/min and gear D revolves at 30 r/min, calculate the following:

1.1 The number of teeth in gear C (2)

1.2 The speed of gear B (2)

1.3 The speed of arm E (11)

1.4 The torque output on arm E, if gear D is now fixed and gear A transmits a torque of 26 N.m at 130 r/min (5)

[20]

QUESTION 2

The thickness of a 4-ply leather belt is 16 mm and it transmits power from a pulley that is 1,6 m in diameter and the speed of this pulley is 240 r/min. The angle of wrap is 160° and the coefficient of friction between the belt and the pulley is 0,35. The density of the belt material is 800 kg/m^3. Take the maximum allowable belt tension as 8 kN/m width per ply.

Calculate the following:

2.1 The belt speed (2)

2.2 The mass of the belt in kg/m (2)

2.3 The centrifugal force (2)

2.4 The tensions T_1 and T_2 (take centrifugal force into account) (6)

2.5 The power transmitted by the drive if the efficiency of the drive is 75% (4)

2.6 The power transmitted if 5% slip occurs (2)

[18]

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QUESTION 3

3.1 There are three main types of bucket elevators, each of which has a particular recommended speed.

What bucket elevator is recommended for:

3.1.1 Low speed

3.1.2 Medium speed

3.1.3 High speed

(3 × 1) (3)

3.2 A bucket elevator is used to lift coal of density 900 kg/m^3 at a rate of 430 tons/hour through a vertical height of 50 m. The chain speed is 0,3 m/s and the spacing of the buckets is 1,2 m. The power of the driving motor is 90 kW.

Calculate the following:

3.2.1 The volume delivered per second (4)

3.2.2 The output power (8)

3.2.3 The efficiency (2)

[17]

QUESTION 4

4.1 Discuss the operation of a dead-weight tensioning device as used with rope haulage. (3)

4.2 An endless rope haulage is required to convey 1 380 tons of ore up an incline of 1 : 15 and 1,37 km long in an effective shift of 7 hours. The mass of the rope is 1,5 kg/m and the tractive resistance of the tubs and contents is 240 N/ton. The rope resistance is 380 N/ton. Take the rope speed as 3 km/h and the mass of the empty tub as 880 kg, while the up-going tubs carry a load of 1,3 ton. The factor of safety is 7 and the ultimate stress for the rope is 1 350 MPa. The efficiency of the haulage is 84%.

Calculate the following:

4.2.1 The number of tubs required (5)

4.2.2 The motor power (8)

[16]

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QUESTION 5

5.1 Goods elevators are constructed for the purpose of moving heavy loads.

5.1.1 What is the maximum permissible capacity of goods elevators in kg?

5.1.2 What is the maximum speed that goods elevators can make in m/min?

(4)

5.2 The loaded cage of a goods elevator has a mass of 1,45 ton. The rope passes over a drum with a mass of 0,25 ton, a radius of gyration of 400 mm and a diameter of 900 mm. The cage and balance mass of 0,65 ton move in guides. The frictional resistance between the guides and the cage is 500 N and between the guides and the balance mass 300 N. The frictional torque on the drum is 200 Nm. The load has an upward velocity of 3 m/s and an upward acceleration of 0,94 m/s^2.

Calculate the following:

5.2.1 The total torque required on the drum (10)

5.2.2 The power required at an instant when the load has an upward velocity of 3 m/s and an upward acceleration of 0,94 m/s^2 (3)

[17]

QUESTION 6

A flywheel, initially at rest, is subject to a constant angular acceleration of 3 rads/s^2 for 75 seconds. The flywheel is then decelerated until it comes to rest 93 seconds later.

Calculate the following:

6.1 The maximum angular velocity attained (2)

6.2 The angular deceleration (2)

6.3 The number of revolutions made by the flywheel during the acceleration (4)

6.4 The number of revolutions made by the flywheel during the deceleration (4)

[12]

TOTAL: 100

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DIAGRAM SHEET 1

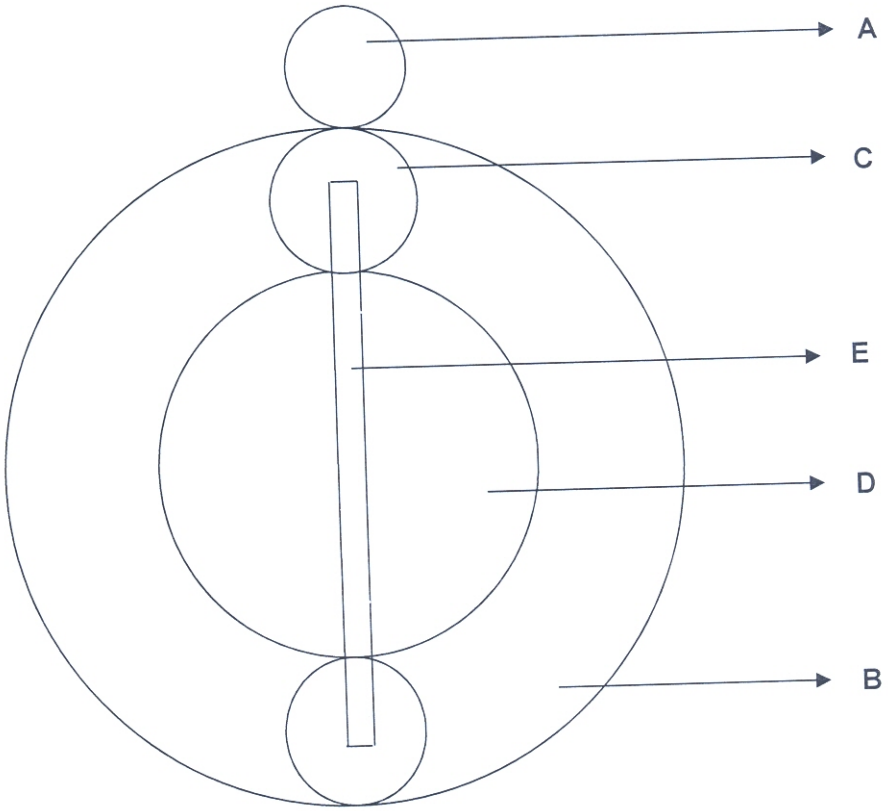

FIGURE 1

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MECHANOTECHNICS N5

FORMULAE

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. $Side\ thrust = Fc Cos\theta - mg\ Sin\theta$

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

77. $P_l = CmgL + mgh$

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