higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

(8190225)

28 November 2022 (X-paper)
09:00–12:00

Nonprogrammable calculators may be used.

This question paper consists of 6 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. Start each question on a new page.
5. Use only a black or a blue pen.
6. Write neatly and legibly.

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QUESTION 1

In an epicyclic gear shown in FIGURE 1, the driving gear, A, has 18 teeth and the fixed annular gear, C, has 120 teeth. The number of teeth on gears E and D are 100 and 40 respectively.

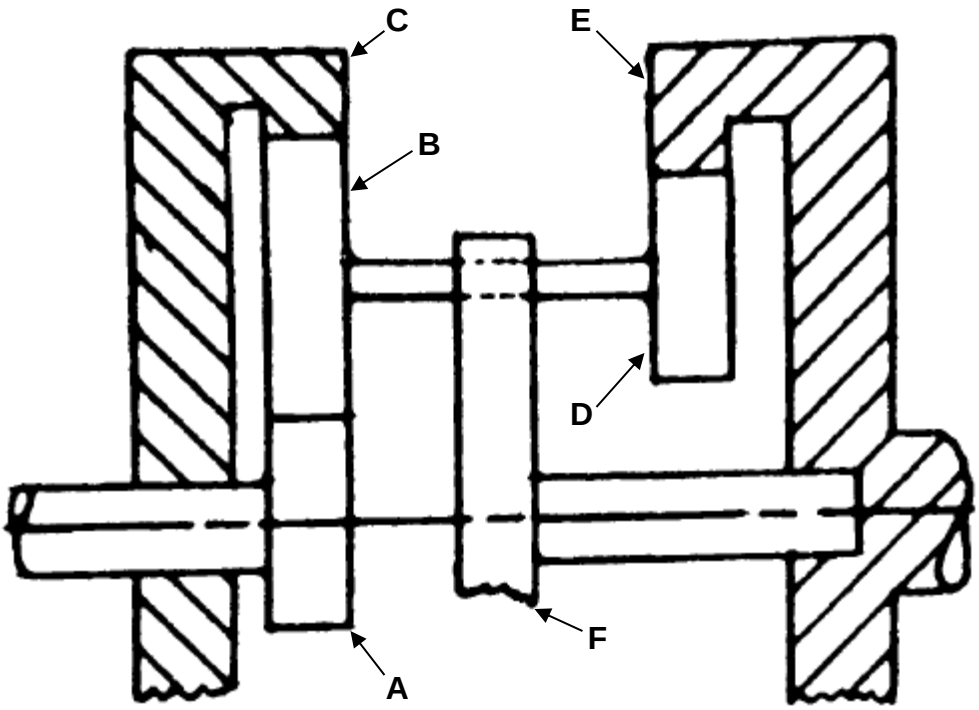

FIGURE 1

If 4 kW is supplied to gear A at 1 500 r/min,

Calculate the following:

1.1 The number of teeth of gear B. (2)

1.2 The speed and direction of rotation of gear E. (8)

[10]

QUESTION 2

2.1 State THREE advantages of pipe conveyors. (3)

2.2 A conveyor belt running at 95 r/min delivers broken stone at a rate of 290 ton/h. The belt, which is directed at 16° to the horizontal, has an effective incline length of 124 m. The belt forms a contact angle of 220° with the driving pulley and the coefficient of friction between the belt and the pulley is 0,3.
A force of 4,2 kN can be allowed to overcome friction.

Calculate the following:

2.2.1 The work done per second to overcome friction (2)

2.2.2 The work done per second to elevate the load (4)

2.2.3 The effective tension in the belt (2)

2.2.4 The belt tensions (T_1 and T_2) (7)

2.2.5 The power that is provided to the driving pulley (2)

[20]

QUESTION 3

3.1 State a function of the tensioning device fitted to a bucket elevator. (1)

3.2 The following details apply to a bucket elevator used to transmit coal:

Centre distance between the head and tail pulley	: 90 m
Bucket spacing	: 794 mm
Chain speed	: 80 r/min
Mass transported in an effective shift time of 7,5 hours	: 1 300 ton
Discharge of coal after top dead centre takes place	: 43°
Efficiency of drive	: 76%

Calculate the following:

3.2.1 The diameter of the head pulley (3)

3.2.2 The total length of the chain (assume that the top and the bottom pulleys are the same diameters) (2)

3.2.3 The number of buckets per second (2)

3.2.4 The mass conveyed by each bucket (3)

3.2.5 The driving motor power required (4)

[15]

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QUESTION 4

4.1 List FIVE advantages of aerial ropeways over other means of transport. (5)

4.2 A rope on a monocable carries 660 kg load at 115 m intervals. The span is 105 m and the sag with the load in the middle is 2,2 m.

Calculate the following:

4.2.1 The diameter of a spiral strand rope with an ultimate strength of 720 kN and ultimate stress of 1 465 MPa (4)

4.2.2 The rope mass per meter (2)

4.2.3 The tension due to self weight (2)

4.2.4 The tension due to one load (3)

4.2.5 The factor of safety (4)

[20]

QUESTION 5

An electric train with a total mass of 330 ton is accelerating at 0,065 m/s^2 up an incline of 1 in 125. The rolling resistance is 0,9% of the mass of the train.

Calculate the following:

5.1 The tractive effort to overcome frictional resistance (2)

5.2 The tractive effort to overcome gravity (2)

5.3 The tractive effort to accelerate the train (2)

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

[10]

QUESTION 6

A flywheel of a hydraulic press has a mass of 825 kg and a radius of gyration of 500 mm. It rotates at 95 r/min. The speed is uniformly accelerated from 95 r/min to 120 r/min during 25 seconds by applying a certain torque.

Calculate the following:

6.1 The angular acceleration (3)

6.2 The applied torque (2)

[5]

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QUESTION 7

FIGURE 2 shows a reduction gearbox with a two-start worm shaft, worm gear and four gears. The worm shaft is connected to an electric motor rotating at 500 r/min.

Calculate the following:

7.1 The delivery speed of the gearbox (7)

7.2 The velocity ratio of the gearbox (3)

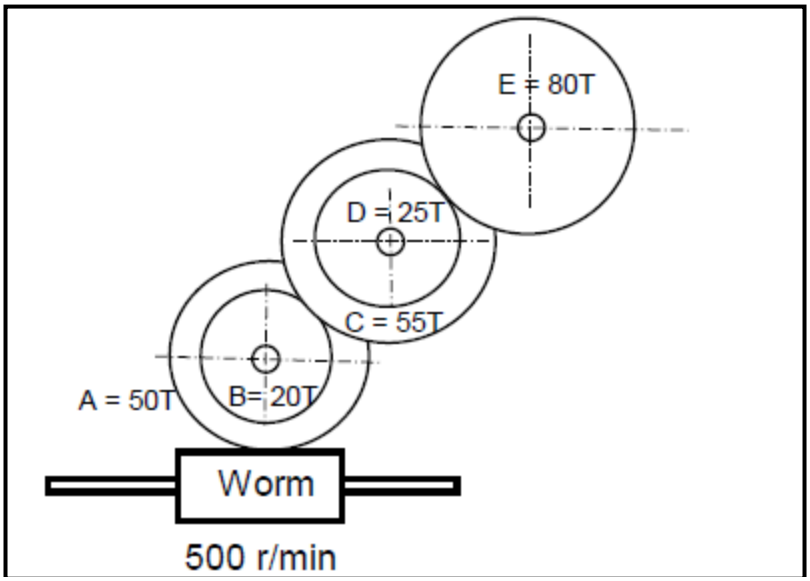

FIGURE 2 **[10]**

QUESTION 8

The loaded cage of a goods hoist has a mass of 1 500 kg. The rope passes over a drum at the top of the shaft and then to a balance mass of 600 kg. The cage and the balance mass move in guides and the frictional force at each guide is 500 N. The drum has a diameter of 1,6 m, a mass of 800 kg and a radius of gyration of 0,5 m. The maximum acceleration attained is 2 m/s^2, which occurs at a speed of 2,8 m/s.

Take acceleration due to gravity as 10 m/s^2.

Calculate the following:

8.1 The tensions T_1 and T_2 (2)

8.2 The torque to hold dead load and the torque to accelerate drum (2)

8.3 The motor power required to drive the drum at maximum acceleration (3)

8.4 The rope tension during deceleration, if the maximum velocity is 4 m/s and deceleration is at a uniform rate from the maximum velocity to rest over the last 2 m of travel. (3)

[10]

TOTAL: 100

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MECHANOTECNICS N5

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

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-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 × 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 × 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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