higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

(8190225)

5 December 2023 (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 section on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.

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QUESTION 1

An epicyclic gear train has two planetary gears with 36 teeth each and a sun gear with 14 teeth. The input shaft is connected to sun gear and transmits 3,8 kW of power at a speed of 230 r/min. The output shaft is connected to the carrier arm of the planetary gear. These planetary gears mesh with an outer ring gear. The annulus is fixed.

1.1 Calculate the number of internal teeth of the ring gear. (2)

1.2 Calculate the speed of the output shaft and the amount of torque that is transmitted if the efficient of the system is 92%. (8)

[10]

QUESTION 2

2.1 List SIX safety devices that are used to prevent rope haulages from reversing when stopped. (6)

2.2 An endless rope haulage is required to convey 600 tons of ore up an incline of 15° and 650 m long in an effective shift time of seven hours. The capacity of the tub is 1 ton and the mass of an empty tub is 500 kg. The rope speed is 70 m/min while the rolling resistance is 180 N/ton. The total friction of the rope on the rollers is 16 kN. Allow a factor of safety of 5. Determine the following:

2.2.1 The space between tubs (4)

2.2.2 The number of tubs on each side (3)

2.2.3 The breaking strength of the rope (7)

[20]

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QUESTION 3

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 1 000 r/min.

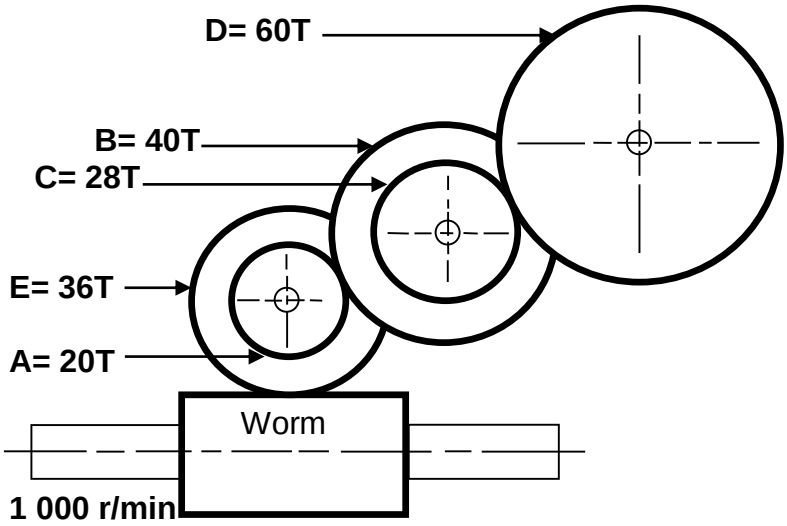

FIGURE 1

Calculate the following:

3.1	3.1	The delivery speed of the gearbox	(8)
3.2	3.2	The velocity ratio of the gearbox	(2)
			[10]

QUESTION 4

A four-ply open belt is 12 mm thick, 50 cm wide and has a density of 770 kg per cubic metre. It is attached to a driving pulley that is 0,75 m in a diameter and rotates at 140 r/min. The angle of wrap between the belt and the pulley is 135° and the coefficient of friction is 0,27. The radius of the driven pulley is 0,9 m. The efficiency of the system is 84%. The maximum allowable belt tension is 9 500 N/m.

Calculate

4.1	The length of the belt if the distance between the two pulleys is 12 m	(2)
4.2	The mass of the belt	(2)
4.3	The speed (neglect the thickness of the belt)	(3)
4.4	The tension of tight and slack of the belt, considering centrifugal force	(9)
4.5	The power in the belt	(4)
		[20]

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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

6.1 Name TWO categories of bucket elevators. (2)

6.2 A bucket elevator is used to lift coal with a density of 890 kg/m^3 at a rate of 550 ton/h through a vertical height of 65 m. The chain speed is 0,45 m/s and the spacing of the buckets is 1,2 m. The power of the driving motor is 125 kW.

Calculate the following:

6.2.1 The volume delivered per second (4)

6.2.2 The output power (6)

6.2.3 The efficiency of the system (3)

[15]

QUESTION 7

The loaded cage of a goods elevator has a 1 500 kg. The rope passes over a drum with a mass of 300 kg, radius of gyration of 500 mm and a diameter of 2,4 m. The cage and balance mass of 840 kg moves in guides. The frictional resistance for the cage is 500 N and that for the balance mass is 440 N. The frictional torque on the drum is 700 N.m.

Calculate the power required at an instant when the load has an upward velocity of 2 m/s and upward acceleration of 0,9 m/s^2. **[10]**

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QUESTION 8

8.1 What is the purpose of a flywheel in a motor car engine? (1)

8.2 A flywheel initially at rest is subjected to a constant angular acceleration of 1,5 rad/s^2 for 47 seconds. The flywheel is then decelerated until it comes to rest 68 seconds later.

Calculate the following:

8.2.1 The maximum angular velocity attained

8.2.2 The angular deceleration

(2 × 2) (4)
[5]

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

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

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

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

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

61. P = ω × 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 = μ × F × Re × n

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

71. T = μ × n × (Fc - S)R

72. Fc = m × ω^2 × γ

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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