higher education & training

Department:
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REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

(8190225)

20 April 2021 (X-paper)
09:00–12:00

This question paper consists of 6 pages, 1 information sheet 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. Write neatly and legibly.

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QUESTION 1

1.1 Name THREE types of gears used in reduction gearboxes. (3)

1.2 FIGURE 1 shows two shafts, C and D; in the same line, geared together through an intermediate parallel shaft E. The gears connecting C and E have a module of 6 mm and those connecting E and D have a module of 8 mm. The pinion that meshes with gear K has 20 teeth. The speed of D is one tenth of the speed of C and the ratio at each reduction is the same.

Calculate each of the following:

1.2.1 Number of teeth on gear F and gear G. (11)

1.2.2 Actual reduction (2)

1.2.3 Centre distance from shaft E to C and D. (2)

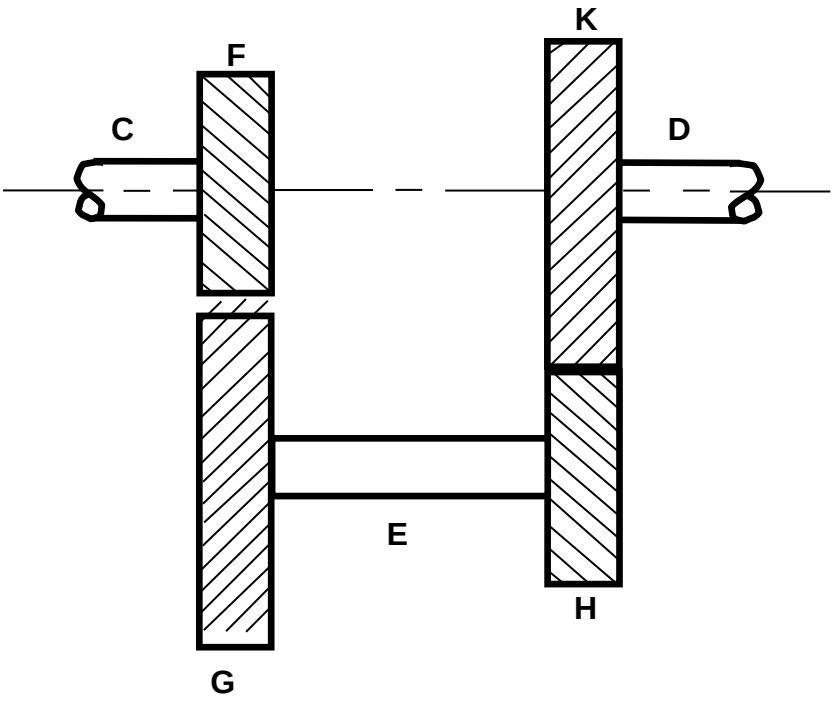

FIGURE 1 **[18]**

QUESTION 2

A conveyor belt delivers 110 ton of crushed stones per hour to a storage bin. The distance between the main pulley centres is 90 m. The speed of the 750 mm width troughed belt is 85 m/min and the coefficient of friction between the pulley and the belt is 0,25. The discharge is 12 m higher than the loading point. The snub pulley provides a contact angle between the belt and the main pulley of 220°. The power to overcome friction is 35% of the power required to lift the load against gravity. The drive is 75% efficient.

Calculate each of the following:

2.1 Power against gravity (3)

2.2 Power required to overcome friction (2)

2.3 Power of the motor (3)

2.4 Belt tensions (T_1 and T_2) (6)

2.5 Number of plies in belt if allowable tension is 2 kN per metre width per ply (3)

[17]

QUESTION 3

3.1 List FOUR safety aspects to consider in the design of the driving gear of mechanical rope haulage. (4)

3.2 The rope-way on a monocable system carries 460 kg loads at 90 m intervals. The span is 90 m and the sag with the load in the middle is 2,6 m. The ultimate strength of the cable is 600 kN and the stress is not to exceed 1 300 MPa.

Calculate each of the following:

3.2.1 Diameter of the rope of a 6/7 construction (4)

3.2.2 Mass of the rope per meter (2)

3.2.3 Tension due to self-weight (2)

3.2.4 Tension due to one load (2)

3.2.5 Factor of safety (4)

[18]

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QUESTION 4

A bucket elevator is used to transport coal. The centre distance between the head and the tail is 85 m with a bucket spacing of 800 mm. A mass of 1 450 tons is transported in an effective shift time of 7,5 hours at a chain speed of 70 m/min. The discharge of the coal takes place at 30° after top dead centre.

Calculate each of the following:

4.1 Diameter of head pulley (4)

4.2 Total length of chain. (Assume the same diameter for both the head and tail pulleys. Ignore the deflection of the chain given by the tensioning device.) (2)

4.3 Driving motor power required if the drive is 76% efficient (10)

[16]

QUESTION 5

A locomotive with a mass of 100 ton ascends an incline of 0,8% at a constant speed. The coefficient of friction between the driving wheels of the locomotive and the rails is 0,29 and 80% of the locomotive mass is supported on the driving wheels. The tractive resistance is 80 N/ton.

Calculate each of the following:

5.1 Tractive effort of locomotive (3)

5.2 Power developed by locomotive at a speed of 90 km/h (2)

5.3 Time taken from rest to attain a speed of 90 km/h up an incline (10)

5.4 Distance locomotive would travel during the time calculated in QUESTION 5.3. (3)

[18]

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QUESTION 6

6.1 What is the function of a flywheel in a rock crusher machine? (1)

6.2 A flywheel of a rock crusher machine dispels 20 kJ of energy. When the speed drops 6% below 200 r/min; the flywheel has a radius of gyration of 800 mm.

Calculate each of the following:

6.2.1 Initial velocity (ω_1) and final velocity of flywheel

6.2.2 Moment of inertia

6.2.3 Mass of flywheel

6.2.4 Torque required to increase the speed from rest to 200 r/min in 70 seconds.

(4 × 3) (12)
[13]

TOTAL: 100

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MECHANOTECHNICS N5

INFORMATION SHEET

SUMMARY OF ROPE AREAS

NO	TYPE OF ROPE	MASS/METRE LENGTH	ULTIMATE STRENGTH
1.	6/7 construction	$\frac{d^2}{250} = kg/m$	*Rope area* x ultimate stress $0{,}36D^2 \times \sigma$
2.	Locked coil type	$\frac{d^2}{175} = kg/m$	$0{,}6D^2 \times \sigma$
3.	Spiral rope type	$\frac{d^2}{195} = kg/m$	$0{,}55D^2 \times \sigma$
4.	Flexible type	$\frac{d^2}{290} = kg/m$	$0{,}31D^2 \times \sigma$

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

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

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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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