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higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANOTECHNICS N5

(8120003)

15 April 2020 (X-paper)
09:00–12:00

This question paper consists of 5 pages and a formula sheet of 3 pages.

253Q1A2015

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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. Write neatly and legibly.

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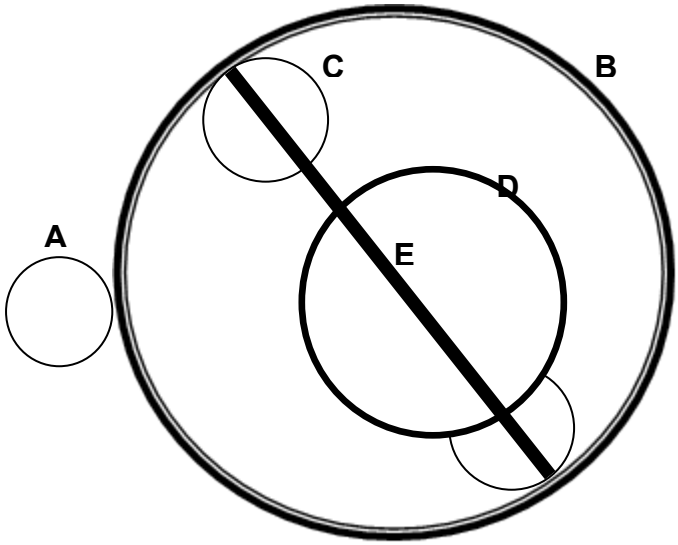
QUESTION 1

In the epicyclic gear train shown below gear B has 140 teeth externally and 100 teeth internally. The driver A has 30 teeth and the arm E is connected to the driven shaft. Gear D has 60 teeth. If gear A revolves at 130 r/min and gear D revolves at 35 r/min.



EPICYCLIC GEAR TRAIN

Calculate each of the following:

1.1 Number of teeth in gear C (2)

1.2 Speed of gear B (2)

1.3 Speed of arm E (11)

1.4 Torque output on arm E if gear D is now fixed and gear A transmits a torque of 20 N.m at 130 r/min (5)

[20]

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QUESTION 2

2.1 State THREE common problems regarding bucket elevators and bucket conveyors. (3 × 2) (6)

2.2 A bucket elevator lifts coal with a density of 900 kg/m^3 at a rate of 380 ton/h through a vertical height of 65 m. At a chain speed of 0,6 m/s the spacing of the bucket is 1 m and the head has an efficiency of 78%.

Calculate each of the following:

2.2.1 Volume of each bucket

2.2.2 Power of driving motor

(2 × 5) (10)
[16]

QUESTION 3

3.1 3.1.1 Describe a *pineapple roller*. (1)

3.1.2 What is the function of the pineapple roller? (2)

3.2 Endless rope haulage is required to deliver 600 tons of rock per eight-hour shift between two points 900 m apart on an average incline of 15°. The tubs have a mass of 240 kg when empty and 950 kg when full. The speed of the rope is 4,6 km/h, its mass is 2,5 kg/m and the tractive resistance of the tubs and contents is 240 N/ton. The track resistance is assumed to be 190 N/ton and the mechanical efficiency is 80%.

Calculate the power of the output of the driving motor under full load. (15)
[18]

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QUESTION 4

The cage of a goods elevator has a mass of 450 kg and hoists a mass of 650 kg. The rope passes over a drum at the top of the shaft and then to a balanced mass of 400 kg. The cage and balanced mass move on parallel guides and the friction force in each line may be taken as the same and the constant at 400 N. The drum has an effective diameter of 1,2 m between rope centres, a radius of gyration of 600 mm and the total mass-allowing rope is 550 kg. The maximum acceleration attained is 1,6 m/s^2 which occurs at a speed of 3,2 m/s. The maximum velocity is 4,8 m/s and retardation is at uniform rate from maximum velocity to rest over the last 4,8 m of travel.

Calculate each of the following:

4.1 Power required to drive the system at the condition of maximum acceleration (12)

4.2 Rope tension in both lines during deceleration (6)

[18]

QUESTION 5

A locomotive with a mass of 100 ton hauls a truck with a mass of 500 ton up a uniform incline of 0,7%. The locomotive carries 80% of its weight on the driving wheels and the coefficient of friction between the rails and the wheels is 0,3. The rolling resistance of the locomotive is 120 N/ton and that of the truck is 90 N/ton.

Calculate each of the following:

5.1 Tractive effort of the locomotive (3)

5.2 Available force for acceleration (8)

5.3 Time required to accelerate from rest to 30 km/h (4)

5.4 Distance travelled during the acceleration from rest to 30 km/h (3)

[18]

QUESTION 6

A flywheel initially at rest is subjected to a constant angular acceleration of 1,8 rad/s^2 for 55 seconds. The flywheel is then decelerated until it comes to rest 66 seconds later.

Calculate the total number of revolutions made by the flywheel during the acceleration and deceleration period. **[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. $h = m\left[1 - \frac{\pi}{4}(sin\,\theta\ Cos\,\theta)\right]$

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-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 = ω × T

62. ω = 2π × 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) ω_3 = $I_1\omega_1$ + $I_2\omega_2$

67. μ = Tan θ

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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