higher education
& training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

T1110**(E)**(A8)T

# NATIONAL CERTIFICATE

# MECHANOTECHNICS N5

(8190225)

**8 August 2019 (X-Paper)**
**09:00–12:00**

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

# DEPARTMENT OF HIGHER EDUCATION AND TRAINING
# REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
MECHANOTECHNICS N5
TIME: 3 HOURS
MARKS: 100

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**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

An epicyclic gear train has a sun wheel with 20 teeth and two planet wheels of 40 teeth each, the latter meshing with the internal teeth of a fixed annulus. The input shaft carrying the sun wheel transmits 4 kW at 300 r/min. The output shaft is connected to an arm that carries the planet wheels.

1.1 Calculate the speed of the output shaft. (6)

1.2 Calculate the torque transmitted if the overall efficiency is 95%. (6)

1.3 If the annulus is rotated independently, what should its speed be to make the output shaft rotate at 10 r/min? (4)

**[16]**

## QUESTION 2

2.1 Explain the following code in the construction of a steel-wire rope used to hoist elevators:

6 × 19 (12.6.1) (3)

2.2 The thickness of a four-ply leather belt is 14 mm and it transmits 50 kW from a pulley that is 1,6 m in diameter and has a speed of 230 r/min. The angle of wrap is 175° and the coefficient of friction between the belt and the pulley is 0,4. The density of the belt material is 800 kg/m$^3$. The maximum allowable belt tension is 14 kN/m widths per ply.

Consider 1 m width of the belt and calculate:

2.2.1 The speed of the belt (2)

2.2.2 The belt mass per metre length (2)

2.2.3 The belt tensions $T_1$ and $T_2$ (consider centrifugal tension) (7)

2.2.4 The power transmitted by 1 m belt width (2)

2.2.5 The actual belt width (2)

**[18]**

 

## QUESTION 3

3.1 State THREE common problems experienced with bucket elevators and bucket conveyors. (3 × 2) (6)

3.2 A bucket elevator is used to lift coal with a density of 800 kg/m$^3$ at a rate of 300 ton/h through a vertical height of 60 m. The chain speed is 0,4 m/s and the spacing of the bucket is 1 m. The head has an efficiency of 88%.

Calculate:

3.2.1 The volume of each bucket (6)

3.2.2 The power of the driving motor (4)
**[16]**

## QUESTION 4

Endless rope haulage is required to deliver 800 ton of rock per eight-hour shift over a distance of 900 m on a 12° average incline. The speed of the rope is 3,5 km/h and its mass is 3 kg/m. The track resistance is assumed to be 180 N per ton and the mechanical efficiency is 82%. The tubs have a mass of 250 kg empty and 1 000 kg full.

Calculate:

4.1 The total number of tubs required (4)

4.2 The total mass in conveyance (5)

4.3 The motor power (7)
**[16]**

## QUESTION 5

5.1 Give TWO main differences in the construction of *goods elevators* and *passenger elevators*. (2 + 2) (4)

5.2 The loaded cage of a good 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 500 kg. The cage and balance mass move in guides and the friction force at each guide is 600 N. The drum has a diameter of 1,6 m, a mass of 700 kg and a radius of gyration of 0,6 m. The maximum acceleration that occurs at a speed of 2,4 m/s is 1,9 m/s$^2$.

Calculate:

5.2.1 The motor power required to drive the drum at maximum acceleration (8)

5.2.2 The rope tensions during deceleration if the maximum velocity is 5 m/s and deceleration is at a uniform rate from maximum velocity to rest over the last 4 m of travel (6)
**[18]**

 

**QUESTION 6**

6.1 Calculate the torque required to increase the speed of a flywheel with a mass of 1 200 kg and a radius of gyration of 800 mm from 120 r/min to 160 r/min in 40 seconds. (8)

6.2 A flywheel has a mass of 580 kg and a radius of gyration of 810 mm.

Calculate:

6.2.1 The kinetic energy required to give the flywheel a speed of 110 r/min from rest (2)

6.2.2 The uniform torque required to accelerate the flywheel from 56 r/min to 120 r/min (2)

6.2.3 The time required for this acceleration (4)

**[16]**

**TOTAL: 100**

## FORMULA SHEET

1. $m = \frac{PCD}{T}$

2. DO = m × (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 × TA = NB × TB

9. $Ft = \frac{2 \times T}{PCD}$

10. Fr = Ft × Tan $\phi$

11. Fn = Ft × Sec $\phi$

12. Ie = IA + $(VR)^2$ IB + $(VR)^2$ IC + $(VR)^2$ ID

13. T $\alpha$ = Ie × $\alpha$ 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 = π × (d + t) × N

22. P = Te × v

23. $\frac{T1}{T2} = e^{\mu\theta}$

24. T1 = $\delta$ × A

25. Tc = m × $v^2$

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 × g × sin $\phi$

29. v = $\omega$ × 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 × t × L × $\rho$

38. T1 = w × n × ft

39. P = Pg + Pμ

40. $t = \dfrac{I \times \omega}{T}$

41. $P = \dfrac{2 \times \pi \times N \times T}{60}$

42. T = F × 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. $Vol.\,bucket\ \dfrac{m \times s}{p \times v}$

56. L = 2C + πD

57. $Self - weight\ \dfrac{m1 \times g \times S^2}{8 \times h}$

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

59. T (acc load) = (T1 – T2)R

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

 

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. $\mu = \text{Tan}\,\theta$

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. $Fc = \frac{mv^2}{\gamma}$

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. $P_l = CmgL + mgh$