higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

**NATIONAL CERTIFICATE**

# MECHANOTECHNICS N5

(8190225)

**11 August 2021 (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.**

261Q1G2111

Copyright reserved

# 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. Only use a black or blue pen.
6. Write neatly and legibly.

---

Copyright reserved 

## QUESTION 1

In the epicyclic gear shown in FIGURE 1, the driving wheel A has 18 teeth and the fixed annular wheel C has 120 teeth. Wheels E and D have 100 teeth and 40 teeth respectively.

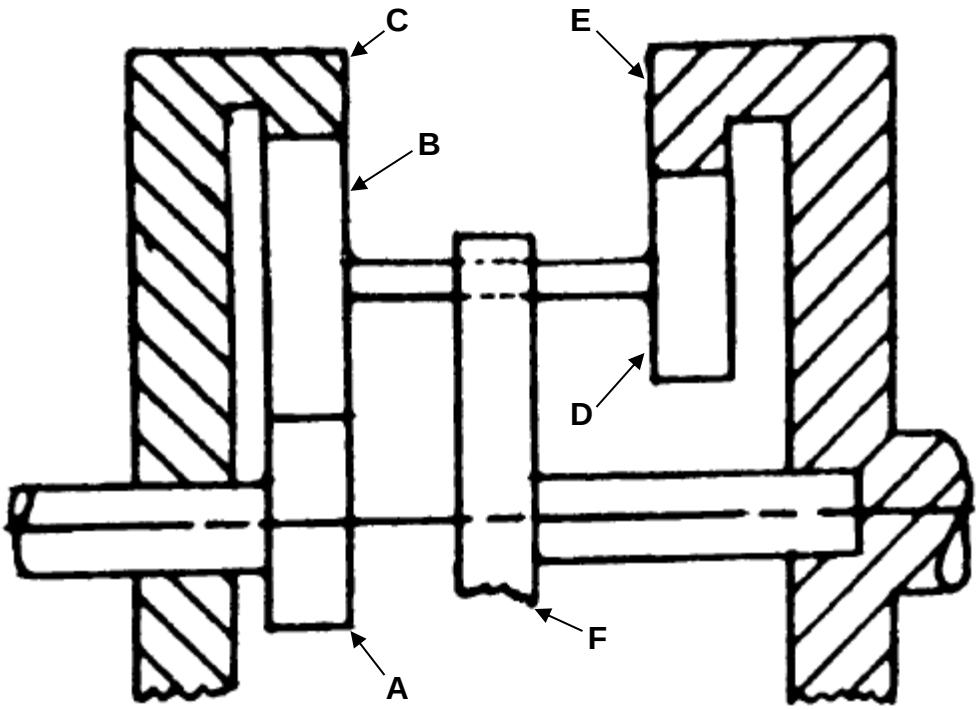


**FIGURE 1**

If 4 kW is supplied to gearwheel 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 gearwheel E (8)

**[10]**

Copyright reserved 

## QUESTION 2

2.1 State THREE advantages of pipe conveyors. (3)

2.2 A conveyor belt running at 95 r/min delivers broken stones at the rate of 290 ton/h. The belt is directed at 16° with the horizontal and 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 (3)

2.2.3 The effective tension in the belt (2)

2.2.4 The belt tensions ($T_1$ and $T_2$) (8)

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

**[20]**

## QUESTION 3

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 m/min |
| Mass transported in an effective shift time of 7,5 hours: | 1 300 ton |
| Discharge of coal after top dead centre is reached: | 43° |
| Efficiency of drive: | 76% |

Calculate the following:

3.1 The diameter of the head pulley (4)

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

3.3 The number of buckets per second (2)

3.4 The mass conveyed by each bucket (3)

3.5 The driving motor power required (4)

**[15]**

Copyright reserved 

## QUESTION 4

4.1 List FIVE factors that affect rope haulages. (5)

4.2 A rope on a monocable carries 660 kg loads 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 (5)

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 (2)

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. The flywheel 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 angular acceleration. **[5]**

Copyright reserved 

## QUESTION 7

The drum of a mine hoisting machine has a moment of inertia of 100 kg.m$^2$ and is in the process of hoisting a goods elevator cage with a mass of 1,2 ton. The acceleration is 1,7 m/s$^2$ and the drum has a diameter of 1,1 m.

Calculate the following:

7.1 The torque exerted by the drum (6)

7.2 The power required to accelerate the system for a period of 3,5 s from rest, assuming an efficiency of 85%. (4)

**[10]**

## QUESTION 8

FIGURE 2 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.

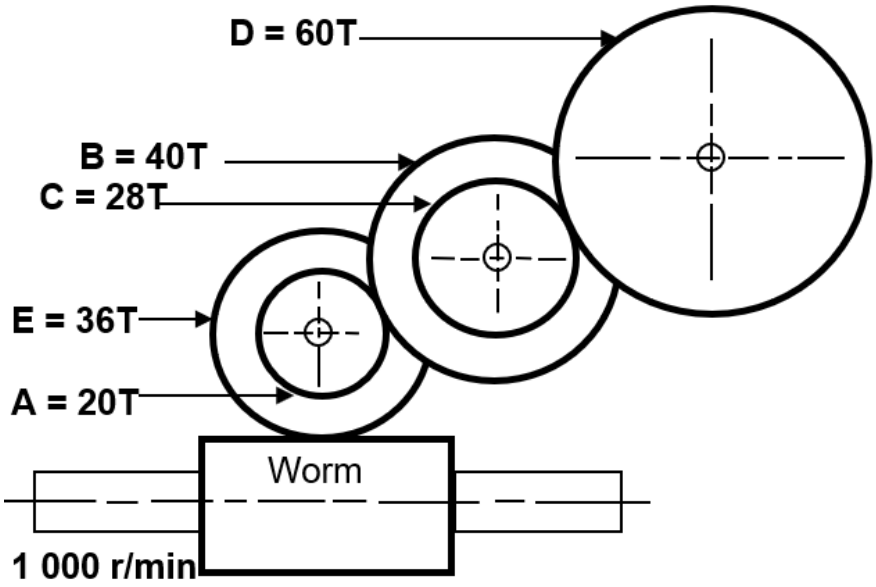


**FIGURE 2**

Calculate the following:

8.1 The delivery speed of the gearbox (8)

8.2 The velocity ratio of the gearbox (2)

**[10]**

**TOTAL: 100**

Copyright reserved

**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. $v = \omega \times r$

Copyright reserved 

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

Copyright reserved 

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

61. P = $\omega$ × T

62. $\omega$ = 2$\pi$ × 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. μ = 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 × $\omega^2$ × $\gamma$

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. $P_l = CmgL + mgh$

Copyright reserved