higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

MECHANOTECHNICS N6

(8190236)

1 August 2019 (X-Paper)
09:00–12:00

This question paper consists of 5 pages, 1 diagram sheet and a formula sheet of 2 pages.

DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
MECHANOTECHNICS N6
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. Questions can be answered in any order, but keep subsections together.
5. ALL calculations must have at least THREE steps, for example a formula, the substitution and an answer.
6. Draw a line after each completed subsection.
7. Start each question on a NEW page.
8. Use $g = 9{,}81\ m/s^2$.
9. Write neatly and legibly.

QUESTION 1: BRAKES

In the block-and-band brake, shown in FIGURE 1 on the DIAGRAM SHEET (attached), there are 10 evenly spaced blocks. The circular width of each block is 1,5 times the circular width of the spacing. The coefficient of friction between the 800 mm drum and the block brakes is 0,2. The brake is required to absorb 150 kW at 250 r/min.

Calculate the:

1.1 Angle of contact for each block (3)

1.2 Braking torque (2)

1.3 Tension ratio (3)

1.4 Force required at the end of the lever (6)
[14]

QUESTION 2: FRICTION CLUTCH

A conical clutch transmits 15 kW at 1 440 r/min. The inside diameter of the clutch is 140 mm with a cone semi-angle of 18°. The surface width of the cone is 80,9 mm. The coefficient of friction between the contact surfaces is 0,3. Assume uniform wear.

Calculate the:

2.1 Outside diameter of the cone (3)

2.2 Axial force to engage the clutch (7)

2.3 Maximum pressure at the inner diameter (2)
[12]

QUESTION 3: LINE SHAFTS

The line shaft, shown in FIGURE 2 on the DIAGRAM SHEET (attached), is supported by two bearings 1 meter apart. The shaft is driven by a gear A with a PCD of 140 mm transmitting 40 kW at 1 000 r/min in a clockwise direction. The driving gear A meshes with a driven gear B with a PCD of 280 mm mounted 800 mm from the left bearing. The two gears mesh at an angle of 30° from the vertical. The gears' pressure angle is 20°. A flywheel with a mass of 90 kg is mounted 300 mm from the left bearing. A pulley with a mass of 20 kg and effective diameter of 350 mm is mounted with a belt that is horizontal, parallel and overhangs the right-hand bearing by 250 mm. The coefficient of friction between the belt and the pulley is 0,43 and the angle of contact is 180°.

Calculate the:

3.1 Torque transmitted by the driving gear A (2)

3.2 Torque transmitted by the driven gear B (4)

3.3 Tangential force between the gears (1)

3.4 Belt tensions on the slack and tight side (5)

3.5 Vertical reaction on the bearings (4)

3.6 Horizontal reaction on the bearings (4)
[20]

QUESTION 4: FLYWHEEL

A flywheel with a mass of 500 kg accelerates from rest to 450 r/min in 8 seconds. The diameter of the flywheel is 1,2 m and the radius of gyration is 300 mm.

Calculate the:

4.1 Angular acceleration of the flywheel (3)

4.2 Torque required to accelerate the flywheel from rest to 450 r/min (3)

4.3 Kinetic energy stored in the flywheel when turning from rest to 450 r/min (2)

4.4 Final line velocity of the flywheel (2)
[10]

QUESTION 5: BALANCING

Three masses, A, B and C, are mounted on a shaft rotating at 120 r/min. The shaft is supported by two bearings *x* and *y* 1,2 meters apart. The magnitude and radii of the masses A, B and C are as follows: 10 kg at 70 mm, 8 kg at 90 mm and 12 kg at 60 mm respectively. B is at an angle of 110° and C at an angle of 260°. Both angles are from plain A. A is mounted at 0,25 m to the left of bearing *x*. C is 0,2 m to the right of bearing *y* and B is at the midpoint of the two bearings.

Calculate the:

5.1 Dynamic reaction on the left bearing (11)

5.2 Dynamic reaction on the right bearing (9)
[20]

QUESTION 6: DYNAMICS

A vehicle has a total mass of 1,8 ton and a wheel base of 3,2 m. The centre of gravity is 700 mm above road level. The front wheels carry 40% of the total weight. The coefficient of friction between the wheel and the road is 0,4.

Calculate the:

6.1 Normal road reaction on the rear wheel when:

6.1.1 All four wheels are fully braked (6)

6.1.2 The front wheels are fully braked (4)

6.2 Normal road reaction on the front wheel when the rear wheels are fully braked (4)
[14]

QUESTION 7: KINEMATICS

FIGURE 3 on the DIAGRAM SHEET (attached) shows a part of a mechanism with a sliding block A. AB = 450 mm and OB = 120 mm. The crank OB rotates clockwise at 100 r/min.

Calculate the velocities at point B and C using the instantaneous-centre method from the given position. **[10]**

TOTAL: 100

DIAGRAM SHEET

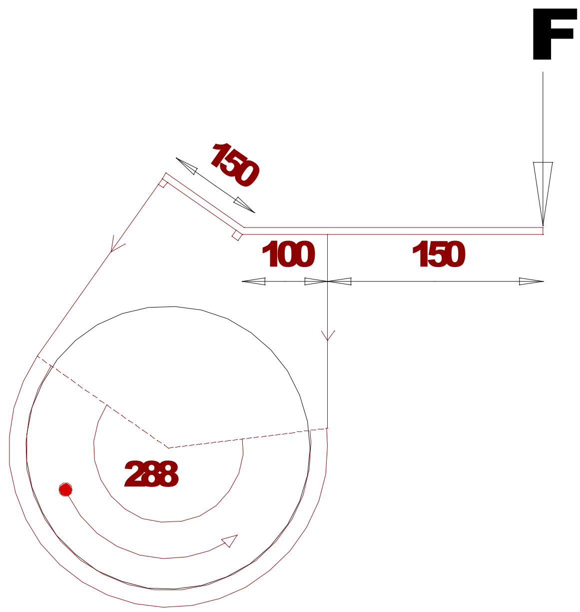

FIGURE 1

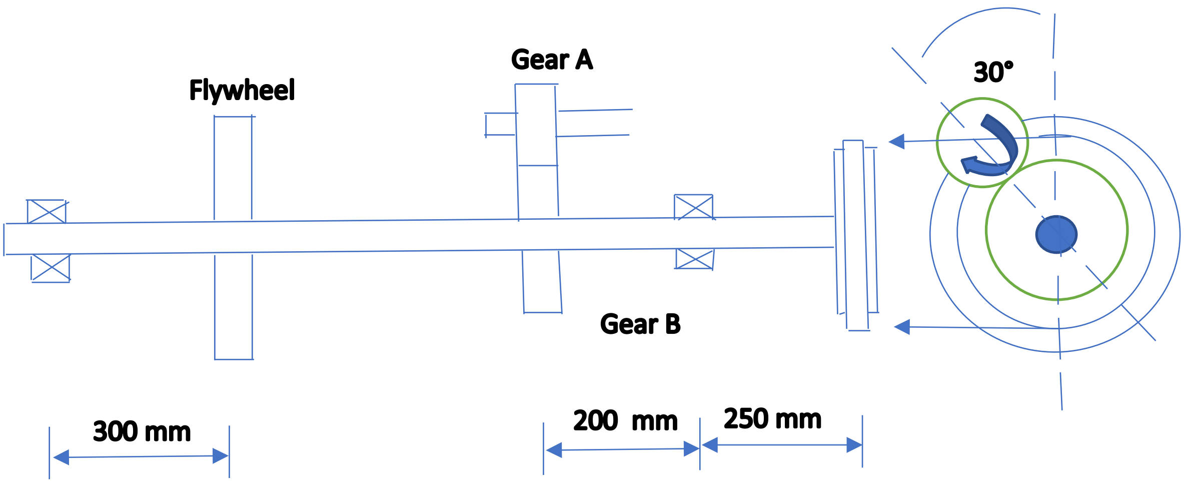

FIGURE 2

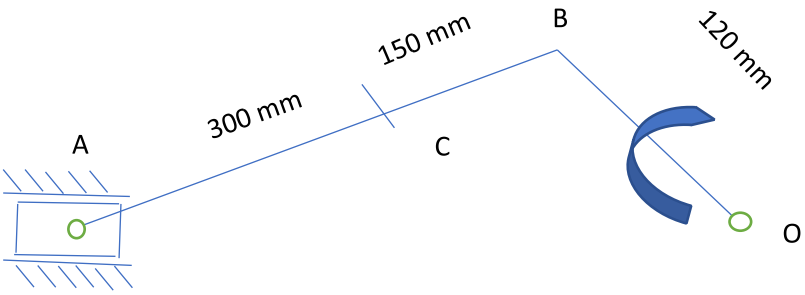

FIGURE 3

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. $Fr = Ft \times \tan \emptyset$

11. $Fn = Ft \times \sec \emptyset$

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

13. $T \propto = Ie \times \alpha A$

14. $T\alpha = TA + \frac{(NB)}{(NA)} \frac{TBC}{\eta 1} + \frac{(ND)}{(NA)} \frac{TD}{\eta 1 \eta 2}$

15. $\frac{NB}{NA} = \frac{wB}{wA} = \frac{\alpha B}{\alpha A} = \frac{IA}{IB}$

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. $Tg = m \times g \times \sin \emptyset$

29. $v = w \times r$

30. $v = \sqrt{\mu \times g \times r}$

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

32. $v = \sqrt{gr[\frac{\mu + \tan\theta}{1 - \mu \tan\theta}]}$

33. $v = \sqrt{gr[\frac{h \tan\theta + b/2}{h - b/2 \tan\theta}]}$

34. $\frac{T1}{T2} = [\frac{1 + \mu \tan\theta}{1 - \mu \tan\theta}]^n$

35. $\cos\frac{\theta}{2} = \frac{R - r}{C}$

36. $\cos\frac{\emptyset}{2} = \frac{R + r}{C}$

37. $m = w \times t \times L \times \rho$

38. $T1 = w \times n \times ft$

39. $P = Pg + P\mu$

40. $t = \frac{I \times w}{T}$

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. $h = m[1 - \frac{\pi}{4}(\sin\theta\cos\theta)]$

47. $\frac{P1}{Rho} + \frac{(v1)^2}{2} + gh1 = \frac{P2}{R} + \frac{(v2)^2}{2} + gh2$

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. $T(acc\ load) = (T1 - T2)R$

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

61. $P = w \times T$

62. $w = 2\pi \times N$

63. $Ke = \frac{1}{2}I \times w^2$

64. $Ke = \frac{work\ done}{efficiency}$

65. $P = Ke \times operations/sec$

66. $(I_1 + I_2)w_3 = I_1w_1 + I_2w_2$

67. $\mu = \tan\theta$

68. $\eta = \frac{\tan\theta}{\tan(\theta + \emptyset)}$

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. $Fc = m \times w^2 \times y$

73. $Fc = \frac{mv^2}{y}$

74. $Tractive\ effort = mass\ on\ driving\ wheels \times \mu \times g$

75. $Side\ thrust = Fc\cos\theta - mg\sin\theta$

76. $\mu = \frac{Fc\cos\theta - mg\sin\theta}{mg\cos\theta + Fc\sin\theta}$

77. $P_l = CmgL + mgh$