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MECHANOTECHNICS N6

(8190236)

6 April 2020 (X-paper)
09:00–12:00

This question paper consists of 6 pages and a formula sheet of 2 pages.

112Q1A2006

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. Start each question on a new page.
5. Use only a black or blue pen.
6. Write neatly and legibly.

QUESTION 1: BRAKES

The block brake shown in FIGURE 1 is loaded with 100 kg at the end of the 800 mm lever to stop a drum transmitting 9 kW at 1 067,725 r/min clockwise.

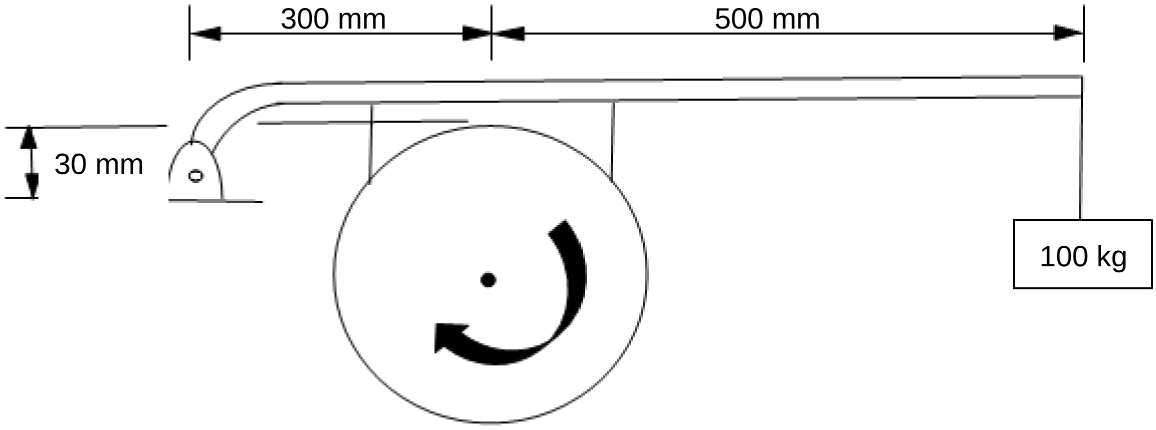

FIGURE 1

Calculate:

1.1 The torque required to brake the drum (2)

1.2 The diameter of the drum (5)
[7]

QUESTION 2: CLUTCHES

An engine is coupled to a single plate clutch mounted onto a shaft. The inner and outer diameters of the plate are 250 mm and 350 mm respectively. The axial force on the plate side is 1,4 kN and the coefficient of friction is 0,3. The clutch plate has friction surfaces on both sides. The engine develops a contact torque of 50 N·m and the moment of inertia is 2,662 kg.m^2. The resistance torque of the output shaft is 9 N·m and the moment of inertia is 6,08 kg.m^2. When the clutch is engaged the engine speed is 450 r/min and the output shaft is at rest. Assume uniform wear.

Calculate:

2.1 The torque transmitted by the clutch (3)

2.2 The combined speed of the engagement after clutch slip (8)

2.3 The duration of slipping (2)

2.4 The time taken for the output shaft to reach a speed of 450 r/min (5)
[18]

QUESTION 3: LINE SHAFTS

The line shaft shown in FIGURE 2 transmits 10 kW when supported between two bearings 1 m apart. The shaft is driven by a pinion A turning 500 r/min which is vertically below the driven gear B mounted 700 mm from the left bearing. The PCDs of the pinion A and the driven gear B are 100 mm and 250 mm respectively. The gear pressure angle is 20°. A flywheel with a mass of 120 kg is mounted 400 mm from the left bearing. A pulley with an effective diameter and mass of 300 mm and 60 kg respectively overhangs the right-hand bearing by 120 mm. The belt mounted on the pulley is horizontal and parallel. The coefficient of friction between the belt and the pulley is 0,25 and the angle of contact is 180°. Take the mass of the pulley into account.

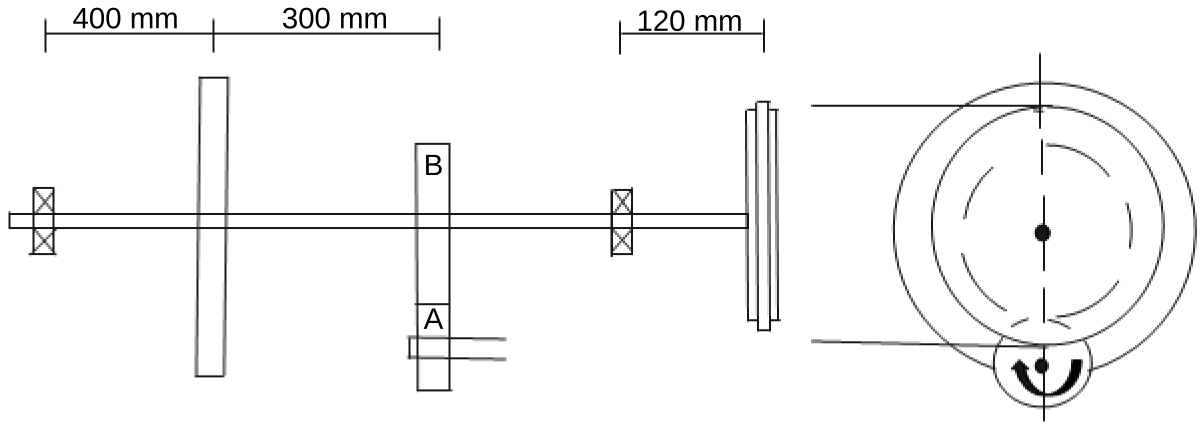

FIGURE 2

Calculate:

3.1 The torque transmitted by the shaft (4)

3.2 The tension on the tight and slick sides of the belt (5)

3.3 The radial force between the meshing gears (4)

3.4 The vertical reactions on the bearings (4)

3.5 The horizontal reaction on the bearings (4)

[21]

QUESTION 4: REDUCTION GEARBOXES

A reduction gearbox consists of a worm rotating at 100 r/min and transmitting output power of 25 kW. The worm has a double start screw thread of 70 mm mean diameter and a 12 mm pitch. The thrust of the worm is taken up by a collar of 80 mm diameter. The coefficient of friction for the collar and worm is 0,05.

Calculate:

4.1 The efficiency of the worm (6)

4.2 The frictional power loss on the collar and the worm (9)

4.3 The input power of the gearbox (1)
[16]

QUESTION 5: BALANCING

A rotating shaft carries masses A, B, C and D. Mass A is 3 kg at a 250 mm radius, mass B 4 kg at a 300 mm radius, mass C is unknown at a 200 mm radius and mass D 2 kg at a 350 mm radius. The angle between A and D is 90°. The axial distance between B and C is 450 mm and 400 mm between C and D.

Determine:

5.1 The magnitude of the axial distance between A and B (10)

5.2 The magnitude of the angle between A and B (1)

5.3 The magnitude of the unknown mass C (6)
[17]

QUESTION 6: DYNAMICS

A vehicle with a centre of gravity and base wheel distance of 750 mm and 1,2 respectively is negotiating a curve with a radius of 90 m on a flat road. The coefficient of friction between the road and the wheels is 0,4.

Calculate the maximum speed at which the vehicle can negotiate the curve without:

6.1 Skidding

6.2 Overturning

6.3 Skidding if the road is now banked at an angle of 18°

6.4 Overturning if the road is now banked at an angle of 16° without skidding
(4 × 2) **[8]**

QUESTION 7: KINEMATICS

FIGURE 3 shows a crank OA rotating at 100 r/min clockwise. OA = 120 mm, AC = 450 mm, BC = 250 mm and CD = 320 mm. The crank OA makes an angle of 30° from the horizontal. Block D slides horizontally.

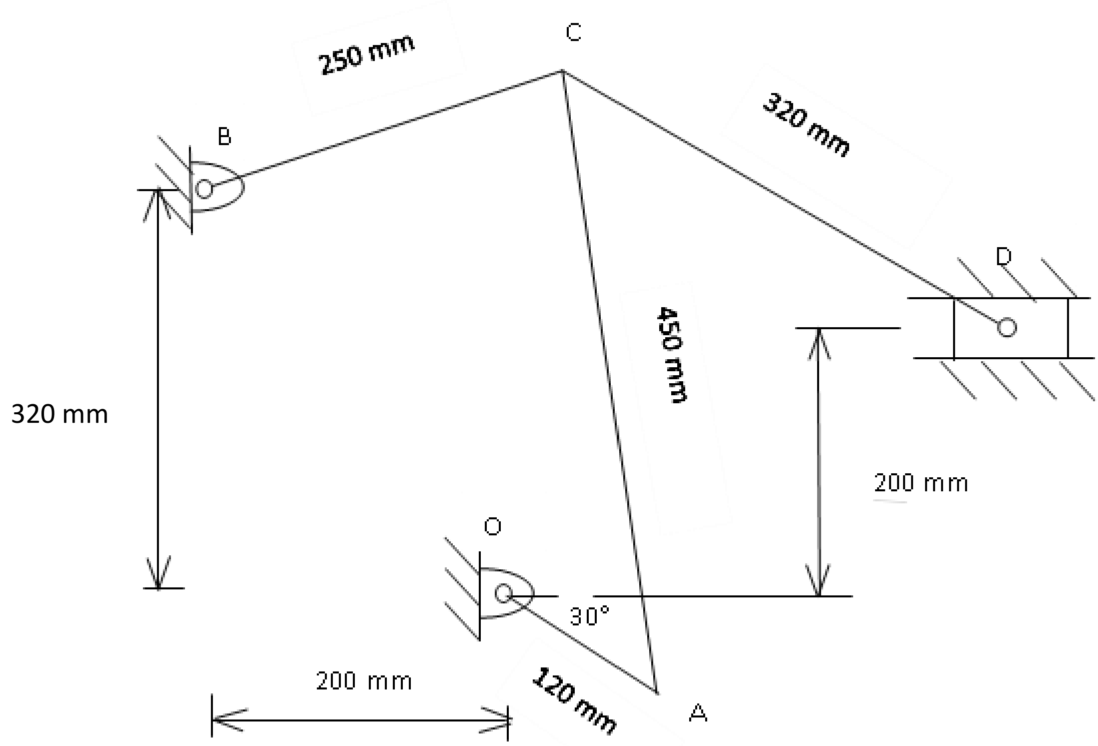

FIGURE 3

7.1	Calculate the liner velocity of the crank OA.	(2)
7.2	Draw the space diagram of the mechanism.	(3)
7.3	Draw the velocity diagram of the mechanism in the given position.	(4)
7.4	Determine the velocity of the sliding block D.	(2)
7.5	Calculate the centripetal acceleration of link CD.	(2) **[13]**

TOTAL: 100

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. $(I_1 + I_2)w_3 = I_1 w_1 + I_2 w_2$

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. $P_l = CmgL + mgh$