higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

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NATIONAL CERTIFICATE

MECHANOTECHNICS N6

(8190236)

3 April 2019 (X-Paper)
09:00–12:00

This question paper consists of 7 pages and a formula sheet of 3 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 at least have THREE steps e.g. formula, substitution and answer.
6. Draw a line after each completed subsection.
7. Use $g = 9{,}81\ m/s^2$
8. Start each question on a NEW page.
9. Write neatly and legibly.

QUESTION 1: BRAKES

FIGURE 1 below shows a simple block brake with a load of 50 kg at the end of the lever needed for braking the drum with a diameter of 300 mm. The coefficient of friction between the block and the drum is 0,32.

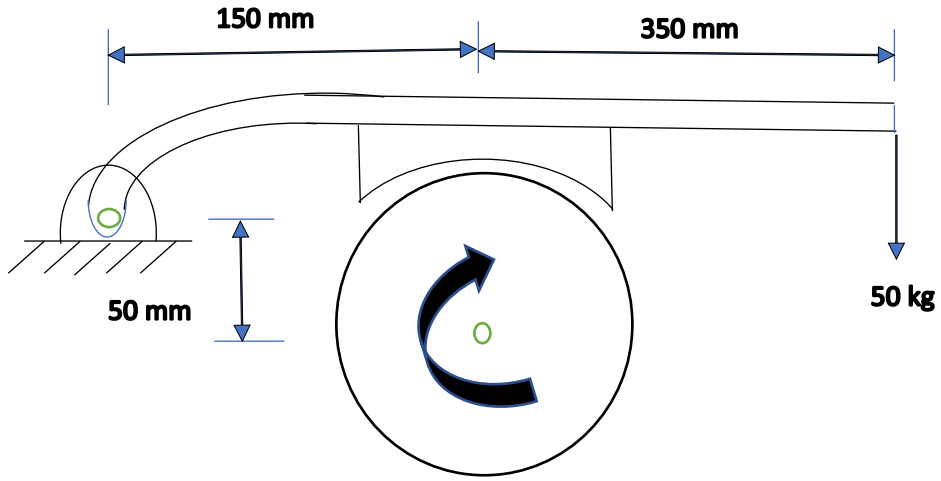

FIGURE 1

Calculate the following:

1.1 The normal reaction of the drum (4)

1.2 The torque generated (2)

1.3 The power transmitted by the brake, if the drum is turning at 1 440 r/min (2)
[8]

QUESTION 2: FRICTION CLUTCH

A centrifugal friction clutch has four blocks which slide radially in a spider keyed to the driving shaft transmitting 25 kW at 950 r/min. The internal drum diameter is 400 mm and the center of gravity of each block is 150 mm from the axis of rotation of the driving shaft. The engagement begins at 70% of the running speed. The coefficient of friction between the lining of the block and the drum is 0,3.

Calculate the following:

2.1 The mass of each block (8)

2.2 The torque transmitted at 950 r/min, if the stiffness of each spring is 160 N/mm and each block gained 3 mm, with no adjustment made. (7)
[15]

QUESTION 3: LINE SHAFTS

FIGURE 2 below shows a line shaft supported horizontally by two bearings with a centre line 900 mm apart. The shaft is driven by gear A with a PCD of 120 mm and transmitting 543 Nm and mesh horizontally with a driven gear B mounted on the line shaft 600 mm from the left bearing, which transmits 296 Nm. The gears' pressure angle is 20˚. A flywheel with a mass of 100 kg is mounted 600 mm from the right bearing. A pulley with effective diameter of 300 mm mounted with a belt that is at an angle of 30° from the vertical plain and parallel. The pulley overhangs the right hand bearing by 150 mm. The belt tension ratio is 3,5. Neglect the mass of the pulley.

TOP VIEW

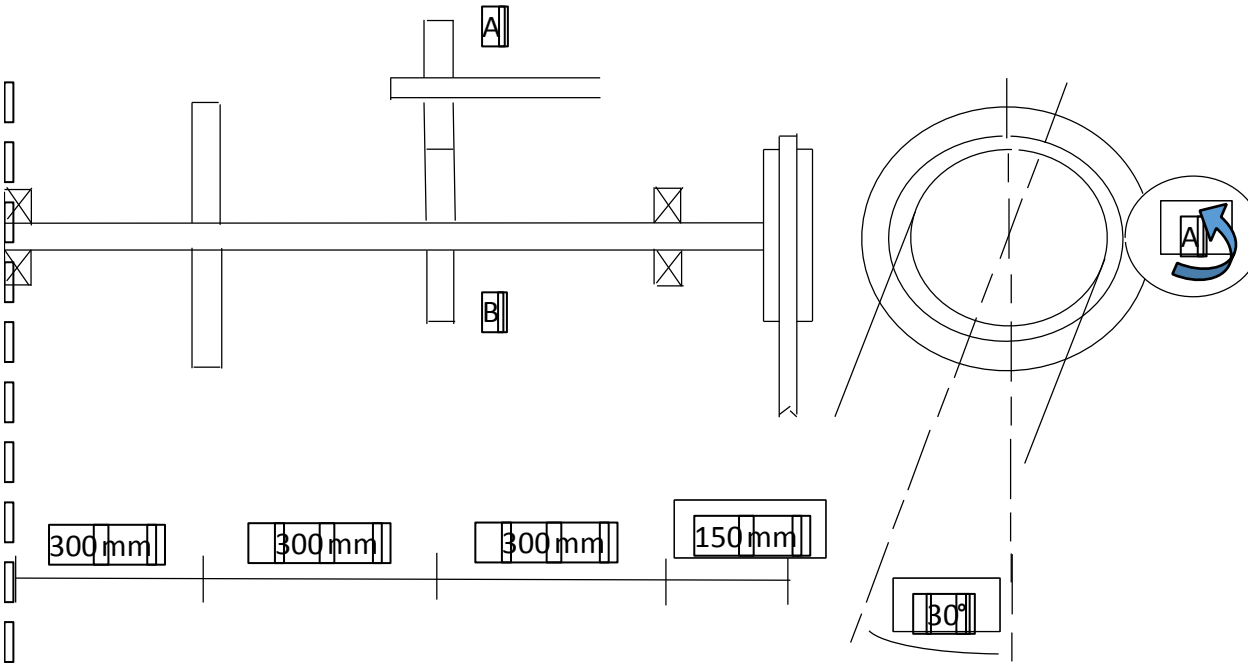

FIGURE 2

Calculate the following:

3.1 The tangential force between gears (1)

3.2 The radial force between gears (1)

3.3 The belt tensions on the slack and tight side (3)

3.4 The vertical reaction on the bearings (4)

3.5 The horizontal reaction on the bearings (4)

[13]

QUESTION 4: FLYWHEELS

FIGURE 3 below shows a flywheel with 8 spokes keyed to a shaft with a diameter of 120 mm and length of 1,2 meters. The flywheel and the shaft are made of the same material with a density of 7 800 kg/m³. The boss is 120 mm wide, 60 mm thick and has an inside diameter of 120 mm. The rim is 100 mm wide 90 mm thick and has an inside diameter of 650 mm. Each spoke has a cross-sectional area of 1 300 m².

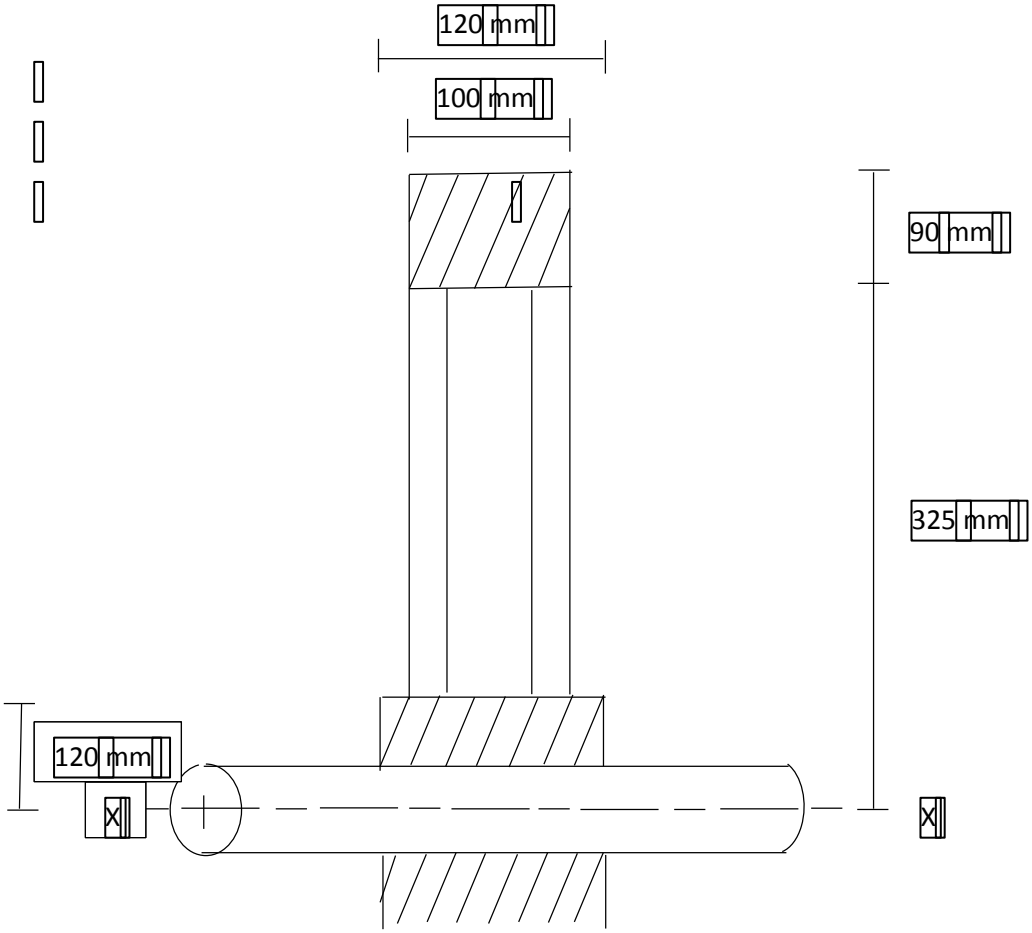

FIGURE 3

Calculate the moment of inertia about the center of shaft X-X for the following:

4.1 The shaft (4)

4.2 The boss (4)

4.3 The rim (4)

4.4 The spokes (4)

4.5 The assembly (1)

[17]

QUESTION 5: BALANCING

A rotating shaft carries four masses, A, B, C and D. The mass A is 4kg at the radius of 280 mm, mass B is 5kg at 220 mm, mass C is m kg at 200 mm and mass D is 3 kg at 250 mm. The axial distance between B and C is 350 mm, between C and D 400 mm. The angle between A and B is 90°.

Determine the following:

5.1 The angle between A and D as well as the axial distance between A and B. (11)

5.2 The angle between B and C as well as the magnitude of the unknown mass C. (7)

[18]

QUESTION 6: REDUCTION GEARBOX

A three-start worm with a PCD of 60 mm and pitch of 10 mm, transmits 20 kW at 600 r/min. The worm efficiency is 70%.

Calculate the following:

6.1 The coefficient of friction between the worm and the worm wheel (8)

6.2 The torque transmitted by the worm shaft (2)

6.3 The end thrust on the worm shaft (2)

[12]

QUESTION 7: KINEMATICS

FIGURE 4 below shows a linkage. The arm AB has a clockwise angular velocity and acceleration of 10 rad/s and 15 rad/s². The lengths of AB = 80 mm, BC =200 mm and CD = 120 mm. Fixed points A and D are on the same horizontal plain and 230 mm apart.

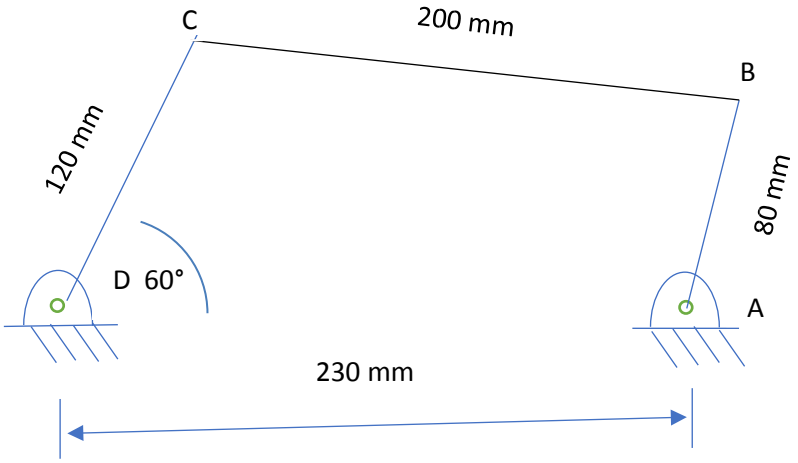

FIGURE 4

7.1	Draw the space diagram.	(3)
7.2	Calculate the velocity of a link AB at B.	(1)
7.3	Draw the velocity diagram using the scale 1 m/s = 60 mm.	(3)
7.4	Calculate the centripetal acceleration of each link.	(3)
7.5	Calculate the tangential acceleration for link AB.	(1)
7.6	Draw the acceleration diagram.	(6)
		[17]

TOTAL: 100

MECHANOTECHNICS N6

FORMULAE 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. $P_l = CmgL + mgh$