higher education & training

Department:
Higher Education and Training
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE

MECHANICAL DRAWING AND DESIGN N6

(8090086)

5 December 2023 (X-paper)
09:00–13:00

OPEN-BOOK EXAMINATION

Nonprogrammable calculators may be used.

This question paper consists of 5 pages and 4 addenda.

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DEPARTMENT OF HIGHER EDUCATION AND TRAINING
REPUBLIC OF SOUTH AFRICA

NATIONAL CERTIFICATE
MECHANICAL DRAWING AND DESIGN N6
TIME: 4 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. Use only a blue or black pen.
5. Write neatly and legibly.

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QUESTION 1

An open flat-belt drive connects two shafts 900 mm apart mounted with pulleys with diameters of 800 mm and 250 mm, respectively. The 800-mm driving pulley is rotating at 240 m/s. The belt has a density, width and thickness of 1,8 mg/m^3, 60 mm and 6 mm, respectively. Due to belt slip on one of the pulleys, the rotational speed on a 250-mm driven pulley is only 700 r/min. The coefficient of friction between the belt and pulley is 0,3. The stress induced in the belt may not exceed 5 MPa. Neglect any sag in the belt as the driving pulley turns clockwise at 300 r/min.

Calculate the total power loss due to slippage. **[14]**

QUESTION 2

FIGURE 1 shows a line shaft of a punch machine, driven by pinion A transmitting 18-kW power when rotating at 1 000 r/min. Pinion A is meshing with gear B, which is vertically below it. Gear B is mounted on a line shaft and overhangs the left-hand bearing by 200 mm. A cam is at the centre of the line shaft, which is 400 mm from the left-hand bearing. A pulley driving an oil pump has an effective diameter of 350 mm and overhangs the right-hand bearing by 200 mm.

GEAR INFORMATION:
Both gears are made of cast iron with a basic stress of 50 MPa.
The module for the gears is 8 mm.
The gears have a 20° full-depth involute angle.
The number of teeth for pinion A and gear B are 24 and 40, respectively.
Pinion A is vertically below gear B.
Pinion A rotates clockwise.

BELT INFORMATION:
The mass of the pulley is 40 kg.
The coefficient of friction between the belt and the pulley is 0,25.
The belt is horizontal and parallel.

CAM INFORMATION:
The cam has a minimum diameter of 60 mm and a maximum fall of 30 mm.
The mass of the follower is 120 kg.
The spring lifting the follower has a stiffness of 160 N/mm.
The frictional force between the follower and the guide is 300 N.
Neglect the mass of the cam.

LINE SHAFT INFORMATION:
The maximum bending and shear stresses are 100 MPa and 45 MPa, respectively.
Neglect the shock and fatigue factors.

Calculate:

2.1 The force exerted by the cam on the follower, so that the follower could fall with maximum displacement (4)

2.2 The power transmitted by the cam (5)

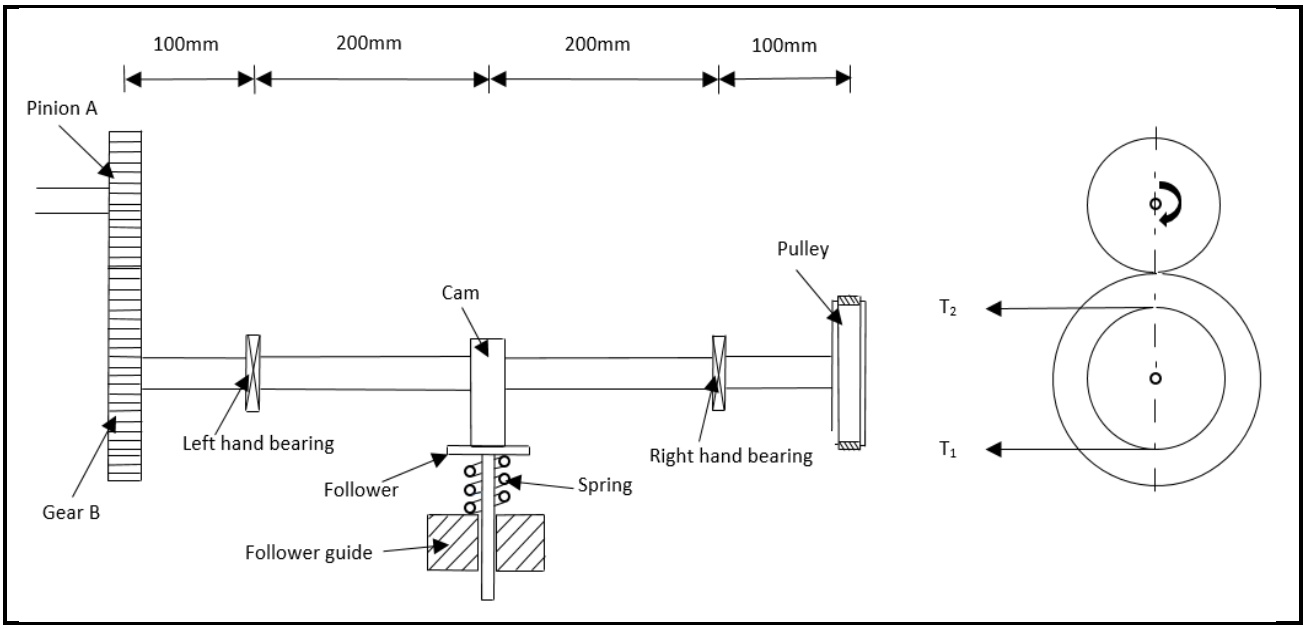
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2.3 The tension on the slack and the tight side of the belt (6)

2.4 The suitable diameter for a line shaft under bending and shearing (27)

2.5 Whether there is interference between pinion A and gear B (5)

2.6 Using the Lewis formula, the gears' face width and check whether it is suitable (8)



[55]

FIGURE 1

QUESTION 3

A horizontal shaft with a diameter of 45 mm is rotating at 900 r/min and supported by two journal bearings 8 metres apart. A pulley of mass 40 kg, driving a machine vertically below it, is mounted at the centre of the shaft. The tensions at the tight and the slack side of the belt are 1 200 N and 400 N, respectively. The allowable pressure on each bearing is 185 kPa. The lubricating oil operational temperature is 95° and the bearing temperature is 60°. The bearing is well ventilated and an H9/f7 fit is used between the bearing and the shaft.

Calculate:

3.1 The coefficient of friction between the shaft and each journal bearing under these conditions (12)

3.2 The suitable SAE number of the lubricating oil (using the McKee equation) (6)
[18]

QUESTION 4

A multiplate clutch has four discs on the driving shaft and three on the driven shaft. Each disc has an internal and external diameter of 120 mm and 250 mm, respectively. The clutch transmits 20 kW when rotating at 1 000 r/min and the coefficient of friction on the contact surface is 0,3. Assume uniform pressure theory.

Calculate:

4.1 The force pressing each pair of plates together (5)

4.2 If there are six springs each with a stiffness of 8 N/mm and each of the contact surfaces wear 1,1 mm, the power transmitted by the clutch after wearing (8)
[13]

TOTAL: 100

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ADDENDUM 1

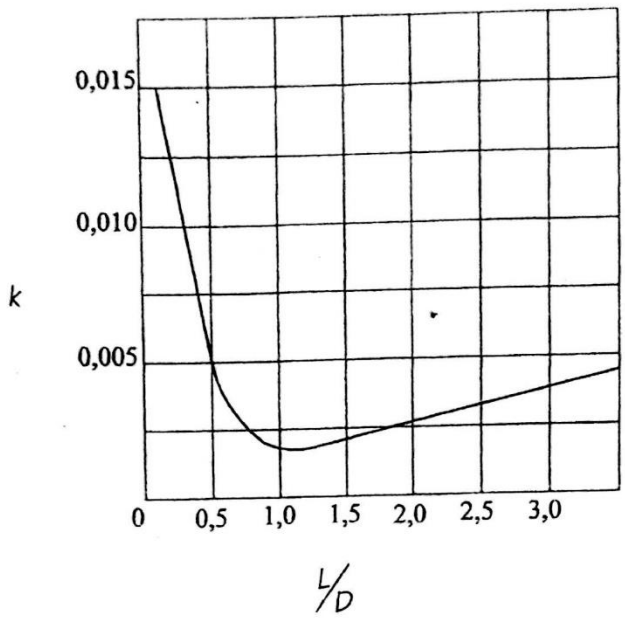
FORM FACTORS (y) FOR INVOLUTE TEETH

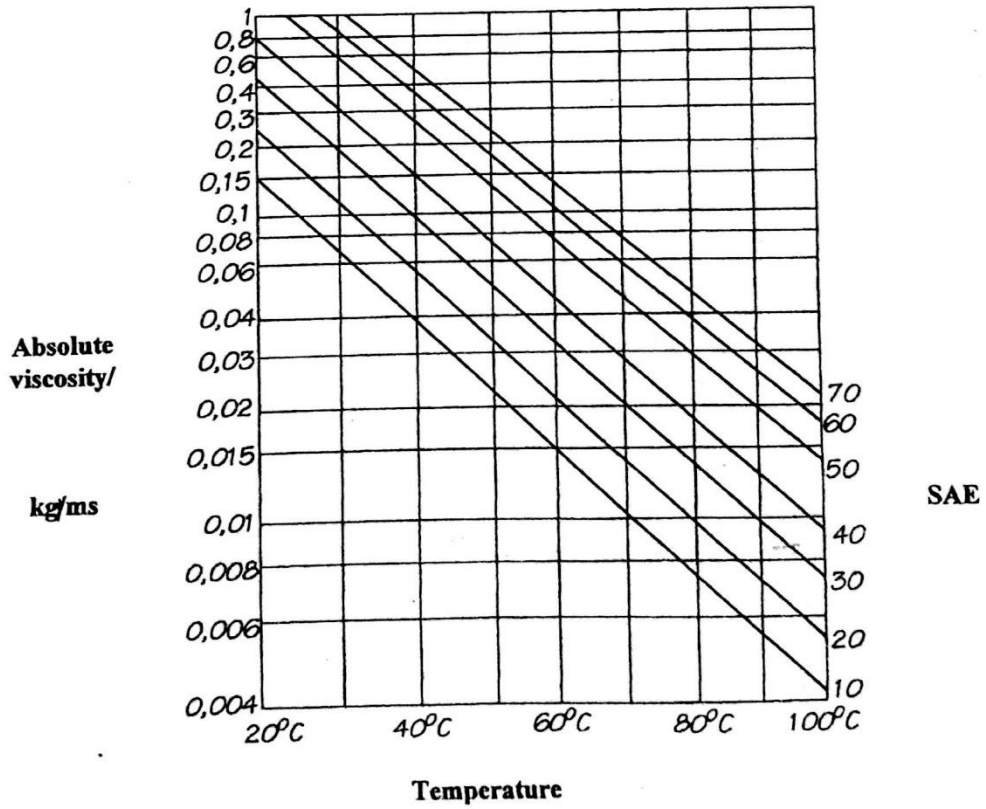
Number of teeth	14,5° full depth	20° full depth
13	0,071	0,083
14	0,075	0,088
15	0,078	0,092
16	0,081	0,094
17	0,084	0,096
18	0,086	0,098
19	0,088	0,100
20	0,090	0,102
21	0,092	0,104
22	0,093	0,105
23	0,094	0,106
24	0,096	0,107
25	0,097	0,108
26	0,098	0,109
27	0,099	0,111
28	0,100	0,112
29	0,101	0,113
30	0,101	0,114
31	0,101	0,115
32	0,101	0,116
33	0,103	0,117
34	0,104	0,118
35	0,104	0,119
36	0,105	0,120
37	0,105	0,121
38	0,106	0,122
39	0,107	0,123
40	0,107	0,124
50	0,110	0,130
55	0,112	0,132
60	0,113	0,134
65	0,114	0,135

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ADDENDUM 2

ANNEXURE





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ADDENDUM 3

LIMITS OF TOLERANCE FOR SELECTED HOLES
LIMIETE VAN TOLERANSIE VIR GEKOSE GATE

ES = Upper deviation/*boonste afwwyking*
EI = Lower deviation/*onderste afwyking* **Unit/*eenheid* = 0,001 mm**

Nominal sizes *Nominale groottes*		**H7**		**H8**		**H9**		**H11**	
Over/ ***Bo*** mm	**Up to and including/** ***Tot by*** mm	**ES** +	**EI**	**ES** +	**EI**	**ES** +	**EI**	**ES** +	**EI**
0	3	10	0	14	0	25	0	60	0
3	6	12	0	18	0	30	0	75	0
6	10	15	0	22	0	36	0	90	0
10	18	18	0	27	0	43	0	110	0
18	30	21	0	33	0	52	0	130	0
30	50	25	0	39	0	62	0	160	0
50	80	30	0	46	0	74	0	190	0
80	120	35	0	54	0	87	0	220	0
120	180	40	0	63	0	100	0	250	0
180	250	46	0	72	0	115	0	290	0
250	315	52	0	81	0	130	0	320	0
315	400	57	0	89	0	140	0	360	0
400	500	63	0	97	0	155	0	400	0

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ADDENDUM 4

E

LIMITS OF TOLERANCE FOR SELECTED SHAFTS
LIMIETE VAN TOLERANSIE VIR GEKOSE ASTE

es = Upper deviation/*boonste afwyking*
ei = Lower deviation/*onderste afwyking*
Unit/*eenheid* = 0,001 mm

Nominal sizes/ ***Nominale groottes***		**c11**		**d10**		**e9**		**f7**		**g6**		**h6**	
Over/ ***Bo*** mm	**To/** ***Tot by*** mm	es -	ei -	es -	ei -	es -	ei -	es -	ei -	es -	ei -	es -	ei -
-	3	60	120	20	60	14	39	6	16	2	8	0	6
3	6	70	145	30	78	20	50	10	22	4	12	0	8
6	10	80	170	40	98	25	61	13	28	5	14	0	9
10	18	95	205	50	120	32	75	16	34	6	17	0	11
18	30	110	240	65	149	40	92	20	41	7	20	0	13
30	40	120	280	80	180	50	112	25	50	9	25	0	16
40	50	130	290	80	180	50	112	25	50	9	25	0	16
50	65	140	330	100	220	60	134	30	60	10	29	0	19
65	80	150	340	100	220	60	134	30	60	10	29	0	19
80	100	170	390	120	260	72	159	36	71	12	34	0	22
100	120	180	400	120	260	72	159	36	71	12	34	0	22
120	140	200	450	145	305	85	185	43	83	14	39	0	25
140	160	210	460	145	305	85	185	43	83	14	39	0	25
160	180	230	480	145	305	85	185	43	83	14	39	0	25
180	200	240	530	170	355	100	215	50	96	15	44	0	29
200	225	260	550	170	355	100	215	50	96	15	44	0	29
225	250	280	570	170	355	100	215	50	96	15	44	0	29
250	280	300	620	190	400	110	240	56	108	17	49	0	32
280	315	330	650	190	400	110	240	56	108	17	49	0	32
315	355	360	720	210	440	125	265	62	119	18	54	0	36
355	400	400	760	210	440	125	265	62	119	18	54	0	36
400	450	440	840	230	480	135	290	68	131	20	60	0	40
450	500	480	880	230	480	135	290	68	131	20	60	0	40

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