University of Technology
Mechanical Engineering Department
First Attempt Examination 2015/2016

Subject: Machine Design I
Division: All Branches
Examiner: Design Group

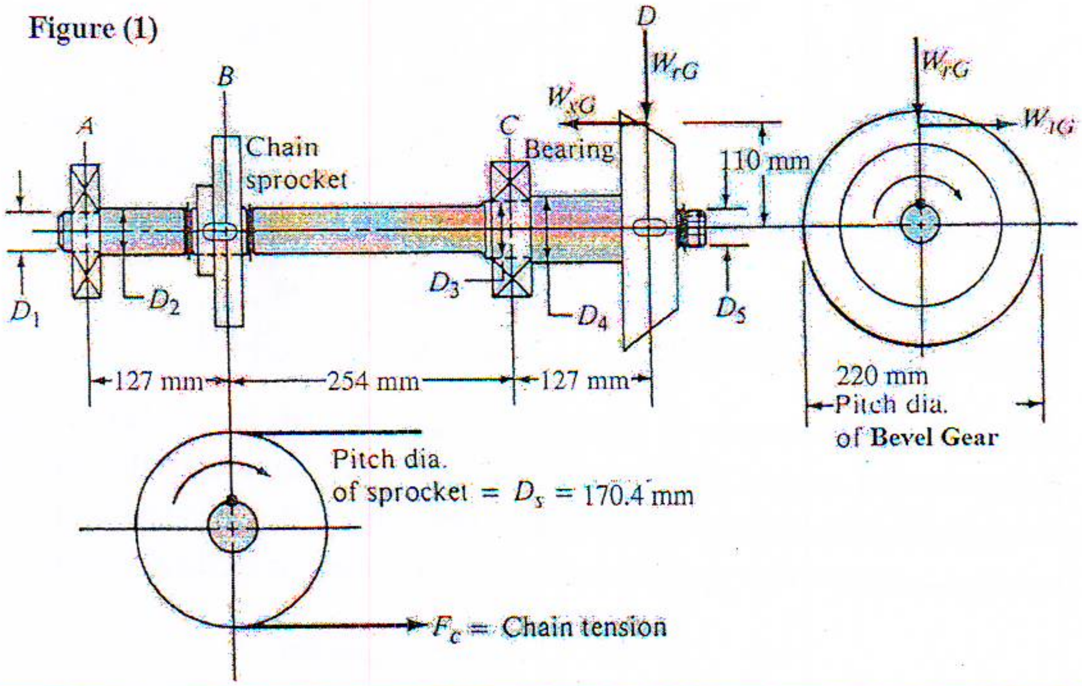
Year: Third Class
Exam Time: 3-hrs
Date: 15/5/2016

NOTE: Answer THREE Questions only

Q1: A Bevel gear is mounted at the end of the shaft as shown in Figure (1). The gear delivers (**4981 W**) to the shaft at a speed of (**101 rpm**). The magnitudes and directions of the forces on the shaft are given in the table below. The power is transmitted by a chain sprocket at **B** to drive a conveyor system. Material of shaft is AISI 1340 OQT 1000, having $S_U = \mathbf{992.9\ MPa}$, $S_Y = \mathbf{910.1\ MPa}$, $S_n' = \mathbf{223.4\ MPa}$ & Safety factor (N) = **3**

1. Which bearing gives the reaction of axial load?
2. Design the shaft by filling the empty cells in the table.

Figure (1)



Points	Torque (N.m)	Shearing forces V_x (N)	V_y (N)	Bending moment M_x (N.m)	M_y (N.m)	Axial load (N)	K_t	Loading condition	Diameter (mm)
A	?	2255	181.5	0	0	?	2.5	Static Vertical Shear	?
B	?	5524	0	286.5	23.05	?	3	?	?
C	?	7548	1748	544.1	69.16	?	1.5	?	?
D	471	4279	1566	0	129.7	1178	2.5	?	?

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Q2-A: Compute a size of welded joint to assemble two members of steel beams as shown in figure (**2A**) below. There are two welding joints locations at the top and the bottom of the beam. A force of (**6000 N**) has to apply at the end of the channel as shown below.

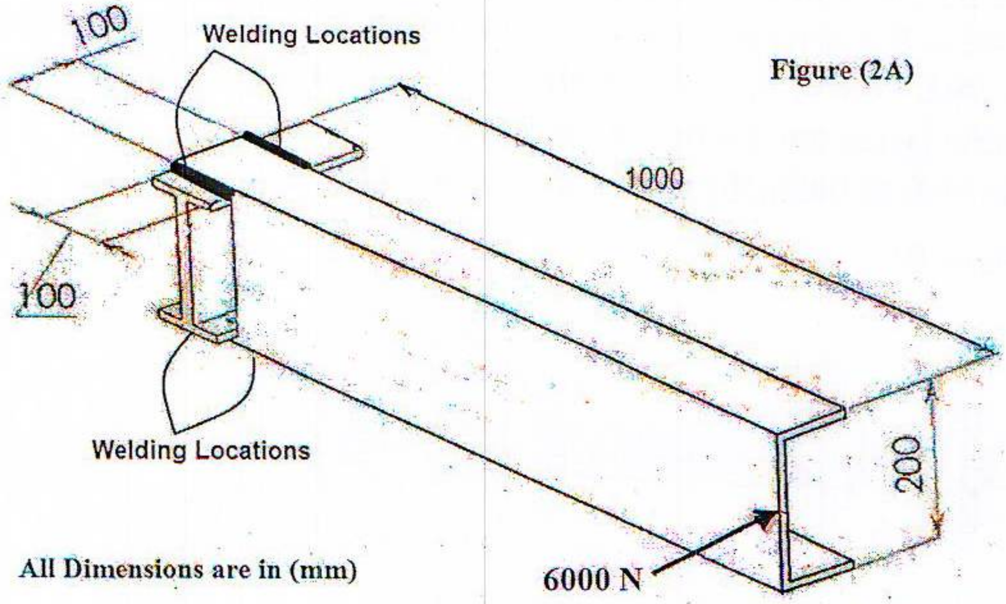

Figure (2A)

Q2-B: A shaft of **25 mm** diameter is shown the figure (**2B**). Pulley A delivers power to a machine causing tension in the tight side and the loose side of the belt, the acted forces as indicated in figure (**2B**). The torque is transmitted from pulley B which receives power from a motor. Find the Maximum Principal Stresses and Maximum Shear Stress at point **A**.

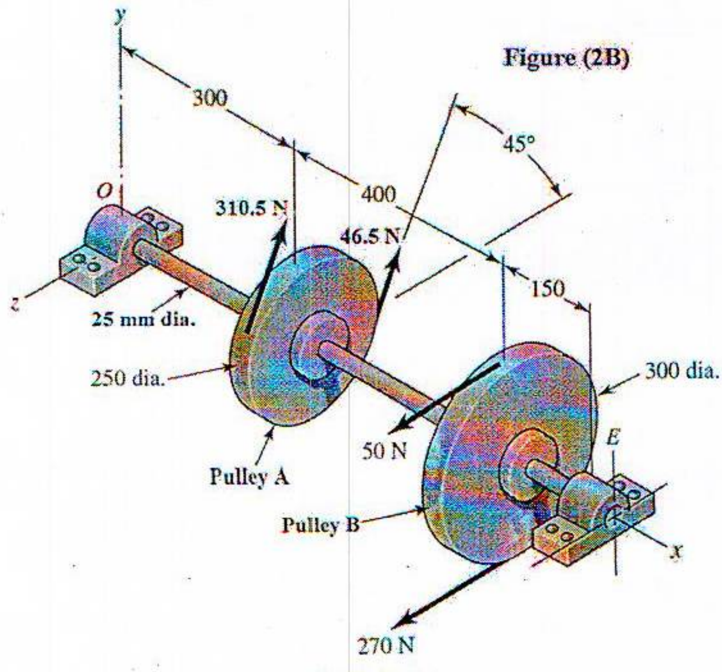

Figure (2B)

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Q3: Figure (3) shows a shoe drum brake system. The action of drum brake is applied by rotating the Acme thread power screw in reverse motion using two Nuts that receive their rotation from the handle. The drum brake lever rotates about fixed point O.

Data:

Force (S) = **3000 N**

Major diameter of power screw = **15.875 mm**

Coefficient of friction between screw and nut = **0.15**

Acme thread angle (2ϕ) = **29°**

$$T_u = F * \frac{D_P}{2} * \frac{\cos\emptyset \tan\lambda + f}{\cos\emptyset - f\tan\lambda} \quad ; \quad f' = \frac{4 * f * \sin\theta}{2\theta + \sin 2\theta}$$

Coefficient of friction between drum and shoe brake = **0.35**

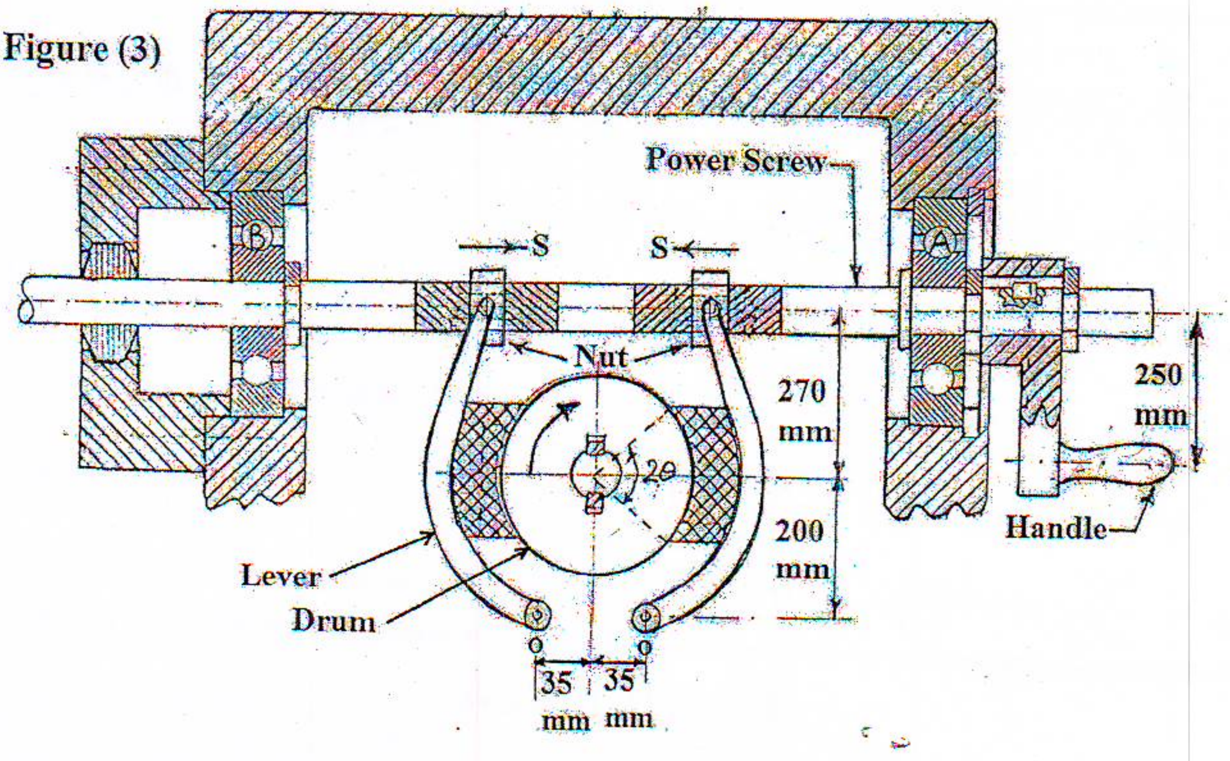
Angle of contact of shoe drum (2θ) = **100°**

Diameter of drum = **330 mm**

Requirement:

1. Find the torque of the drum.
2. Find the width of shoe brake if the pressure between drum and shoe is (**5 MPa**).
3. Find the force that rotates the handle that required rotating the screw and stopping the drum.
4. Find the life of bearing (**L_d**) **A** & **B**, if the radial load on A & B is (**3000 N**) and the power screw rotates at (60 rpm).

Figure (3)



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Q4-A: A set of three bolts is to be used to provide a clamping force of (**51 KN**) between hydraulic cylinder and its cover. The load is shared equally among the three bolts. The external load inside the cylinder is varied from (**0 – 39 KN**). Assume the stiffness of the clamping member is three times that of the bolt. The pressure inside the cylinder is (**1.5 MPa**). The endurance strength (S'_n) for bolt is (**260 MPa**), ultimate tensile strength for bolt is (**520 MPa**) and safety factor (**N=2**).

<u>Requirement</u>:

1. Find the size of bolts according to Goodman equation.
2. Find the thickness of cylinder, if the material of cylinder is the same as for the bolt.
3. Draw a section of whole system showing all parts (cylinder, covers, bolts and piston).

Q4-B: Evaluate the performance of a helical compression spring made from 17-gage ASTM A229 steel wire that has an outside diameter of (**13.33 mm**). It has a free length of (**31.75 mm**), squared and ground ends, and a total of (**7.0**) coils. Compute the spring rate and the deflection and stress when carrying (**44.48 N**). At this stress level, for what service (light, medium, or severe) would the spring be suitable? **G=77.2 GPa**

$$D=\left[\frac{32N}{\pi}\sqrt{\left[\frac{K_t M}{S'_n}\right]^2+\frac{3}{4}\left[\frac{T}{S_y}\right]^2}\right]^{\frac{1}{3}} \quad ; M_{eq}=\sqrt{M_x^2+M_y^2} \quad or \quad M_{total}=M_{eq}+\frac{F_a * d}{8}$$

$$\sigma_1=\frac{\sigma_x+\sigma_y}{2}+\sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2+\tau_{xy}^2}=\frac{\sigma_x}{2}+\sqrt{\left(\frac{\sigma_x}{2}\right)^2+\tau_{xy}^2}$$

$$\tau_{max}=\sqrt{\left(\frac{\sigma_x-\sigma_y}{2}\right)^2+\tau_{xy}^2}=\sqrt{\left(\frac{\sigma_x}{2}\right)^2+\tau_{xy}^2} \quad ; \quad \frac{K_t\,\sigma_a}{S'_n}+\frac{\sigma_m}{S_y}=\frac{1}{N} \quad ; \quad \frac{K_t\,\sigma_a}{S'_n}+\frac{\sigma_m}{S_u}=\frac{1}{N}$$

$$\tau_{max}=\frac{16}{\pi d^3}\sqrt{\left(M+\frac{F_a * d}{8}\right)^2+T^2} \quad \ldots Max. Shear\ stress\ theory$$

$$\grave{\sigma}=\sqrt{{\sigma_x}^2+3\tau_{xy}^2} \quad ; \quad \sigma_{max}=\frac{32}{\pi d^3}\sqrt{\left(M+\frac{F_a * d}{8}\right)^2+\frac{3}{4}T^2} \quad \ldots Von-Mises\ theory$$

$$\sigma_{max}=\frac{16}{\pi d^3}\left[\left(M+\frac{F_a * d}{8}\right)+\sqrt{\left(M+\frac{F_a * d}{8}\right)^2+T^2}\right] \quad \ldots Max. Normal\ stress\ theory$$

Good Luck

Geometry Factors for for weld analysis

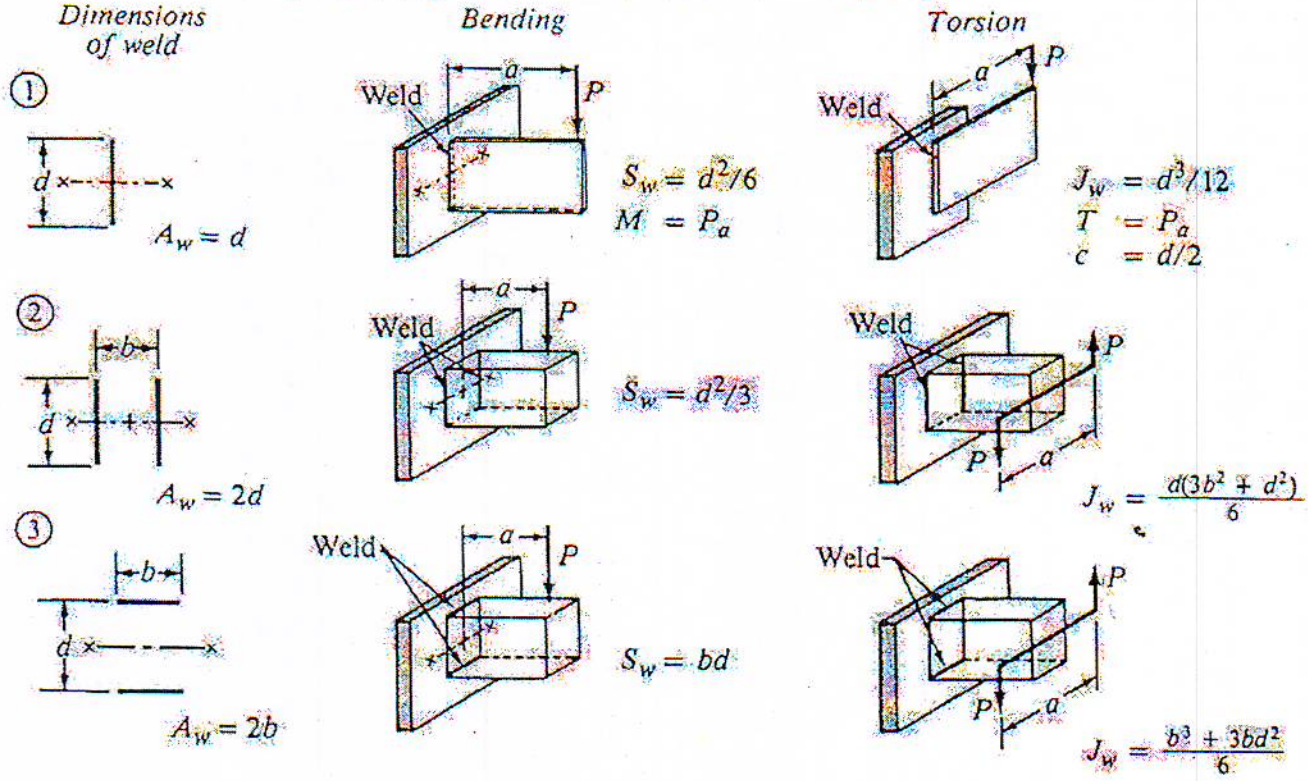

TABLE 20–3 Allowable shear stresses and forces on welds

Base metal ASTM grade	Electrode	Allowable shear stress		Allowable force per inch of leg	
		psi	MPa	lb/in	N/mm
Building-type structures:					
A36, A441	E60	13 600	93.77	9 600	1681
A36, A441	E70	15 800	108.94	11 200	1961
Bridge-type structures:					
A36	E60	12 400	85.50	8 800	1541
A441, A242	E70	14 700	101.36	10 400	1821

TABLE 17–1 Preferred Acme screw threads

Nominal major diameter, D (in)	Threads per in, n	Pitch, $p = 1/n$ (in)	Minimum minor diameter, D_r (in)	Minimum pitch diameter, D_p (in)	Tensile stress area, A_t (in^2)	Shear stress area, A_s (in^2)[a]
1/4	16	0.0625	0.1618	0.2043	0.026 32	0.3355
5/16	14	0.0714	0.2140	0.2614	0.044 38	0.4344
3/8	12	0.0833	0.2632	0.3161	0.065 89	0.5276
7/16	12	0.0833	0.3253	0.3783	0.097 20	0.6396
1/2	10	0.1000	0.3594	0.4306	0.1225	0.7278
5/8	8	0.1250	0.4570	0.5408	0.1955	0.9180
3/4	6	0.1667	0.5371	0.6424	0.2732	1.084
7/8	6	0.1667	0.6615	0.7663	0.4003	1.313
1	5	0.2000	0.7509	0.8726	0.5175	1.493
$1\frac{1}{8}$	5	0.2000	0.8753	0.9967	0.6881	1.722
$1\frac{1}{4}$	5	0.2000	0.9998	1.1210	0.8831	1.952
$1\frac{3}{8}$	4	0.2500	1.0719	1.2188	1.030	2.110
$1\frac{1}{2}$	4	0.2500	1.1965	1.3429	1.266	2.341
$1\frac{3}{4}$	4	0.2500	1.4456	1.5916	1.811	2.803
2	4	0.2500	1.6948	1.8402	2.454	3.262
$2\frac{1}{4}$	3	0.3333	1.8572	2.0450	2.982	3.610
$2\frac{1}{2}$	3	0.3333	2.1065	2.2939	3.802	4.075
$2\frac{3}{4}$	3	0.3333	2.3558	2.5427	4.711	4.538
3	2	0.5000	2.4326	2.7044	5.181	4.757
$3\frac{1}{2}$	2	0.5000	2.9314	3.2026	7.388	5.700
4	2	0.5000	3.4302	3.7008	9.985	6.640
$4\frac{1}{2}$	2	0.5000	3.9291	4.1991	12.972	7.577
5	2	0.5000	4.4281	4.6973	16.351	8.511

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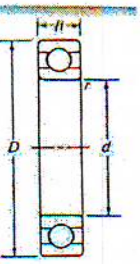
TABLE 14–3 Bearing selection data for single-row, deep-groove, Conrad-type ball bearings

A. *Series* 6200



Bearing number	Nominal bearing dimensions d (mm)	d (in)	D (mm)	D (in)	B (mm)	B (in)	r^* (10^{-3} mm)	Preferred shoulder diameter Shaft (mm)	Housing (mm)	Bearing weight (N)	Basic static load rating, C_o (kN)	Basic dynamic load rating, C (kN)
6200	10	0.3937	30	1.1811	9	0.3543	609	12.70	12.7	0.31	2.31	3.94
6201	12	0.4724	32	1.2598	10	0.3937	609	14.68	13.7	0.35	3.00	5.25
6202	15	0.5906	35	1.3780	11	0.4331	609	17.85	15.2	0.44	3.51	5.87
6203	17	0.6693	40	1.5748	12	0.4724	609	19.98	17.8	0.62	4.49	7.38
6204	20	0.7874	47	1.8504	14	0.5512	990	24.61	20.8	1.02	6.22	9.83
6205	25	0.9843	52	2.0472	15	0.5906	990	27.95	23.3	1.29	7.16	10.81
6206	30	1.1811	62	2.4409	16	0.6299	990	33.53	28.4	1.96	10.31	14.90
6207	35	1.3780	72	2.8346	17	0.6693	990	38.49	33.0	2.85	14.01	19.79
6208	40	1.5748	80	3.1496	18	0.7087	990	43.19	72.9	3.65	16.23	22.46
6209	45	1.7717	85	3.3465	19	0.7480	990	47.89	78.0	3.96	18.46	25.13
6210	50	1.9685	90	3.5433	20	0.7874	990	52.58	83.0	4.54	20.68	26.91
6211	55	2.1654	100	3.9370	21	0.8268	990	58.21	91.5	6.05	26.02	33.36
6212	60	2.3622	110	4.3307	22	0.8661	1498	64.79	101.5	7.69	32.24	40.25
6213	65	2.5591	120	4.7244	23	0.9055	1498	69.47	111.5	9.69	35.58	44.04
6214	70	2.7559	125	4.9213	24	0.9449	1498	74.17	116.5	10.27	39.14	48.04
6215	75	2.9528	130	5.1181	25	0.9843	1498	78.87	121.3	11.74	43.14	50.71
6216	80	3.1496	140	5.5118	26	1.0236	2006	83.56	129.9	13.74	46.70	56.04
6217	85	3.3465	150	5.9055	28	1.1024	2006	89.19	140.0	17.66	54.71	64.94
6218	90	3.5433	160	6.2992	30	1.1811	2006	93.89	150.0	21.08	63.16	73.84
6219	95	3.7402	170	6.6929	32	1.2598	2006	100.47	157.9	25.48	72.50	83.62
6220	100	3.9370	180	7.0866	34	1.3386	2006	105.15	167.9	30.87	82.73	93.85
6221	105	4.1339	190	7.4803	36	1.4173	2006	109.85	178.0	36.25	92.90	102.30
6222	110	4.3307	200	7.8740	38	1.4961	2006	114.55	188.0	42.66	104.08	110.75
6224	120	4.7244	215	8.4646	40	1.5748	2006	123.94	202.9	50.71	116.53	119.65

TABLE 18–5 Metric thread dimensions

Basic major diameter (mm)	Coarse threads Pitch (mm)	Coarse threads Tensile stress area (mm²)	Fine threads Pitch (mm)	Fine threads Tensile stress area (mm²)
1	0.25	0.460		
1.6	0.35	1.27	0.20	1.57
2	0.4	2.07	0.25	2.45
2.5	0.45	3.39	0.35	3.70
3	0.5	5.03	0.35	5.61
4	0.7	8.78	0.5	9.79
5	0.8	14.2	0.5	16.1
6	1	20.1	0.75	22.0
8	1.25	36.6	1	39.2
10	1.5	58.0	1.25	61.2
12	1.75	84.3	1.25	92.1
16	2	157	1.5	167
20	2.5	245	1.5	272
24	3	353	2	384
30	3.5	561	2	621
36	4	817	3	865
42	4.5	1121		
48	5	1473		

FIGURE 19–10
Design shear stresses for ASTM A229 steel wire, oil-tempered (Reprinted from Harold Carlson, *Spring Designer's Handbook*, p. 146, by courtesy of Marcel Dekker, Inc.)

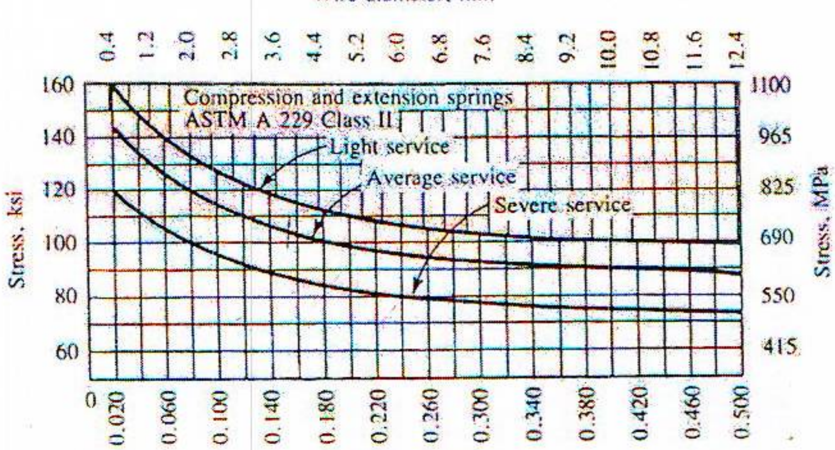


TABLE 19–2 Wire gages and diameters for springs

Gage no.	U.S. Steel Wire Gage (*in*)[a]	Music Wire Gage (*in*)[b]	Brown & Sharpe Gage (*in*)[c]	Preferred Metric Diameters (*mm*)[d]
7/0	0.4900			13.0
6/0	0.4615	0.004	0.5800	12.0
5/0	0.4305	0.005	0.5165	11.0
4/0	0.3938	0.006	0.4600	10.0
3/0	0.3625	0.007	0.4096	9.0
2/0	0.3310	0.008	0.3648	8.5
0	0.3065	0.009	0.3249	8.0
1	0.2830	0.010	0.2893	7.0
2	0.2625	0.011	0.2576	6.5
3	0.2437	0.012	0.2294	6.0
4	0.2253	0.013	0.2043	5.5
5	0.2070	0.014	0.1819	5.0
6	0.1920	0.016	0.1620	4.8
7	0.1770	0.018	0.1443	4.5
8	0.1620	0.020	0.1285	4.0
9	0.1483	0.022	0.1144	3.8
10	0.1350	0.024	0.1019	3.5
11	0.1205	0.026	0.0907	3.0
12	0.1055	0.029	0.0808	2.8
13	0.0915	0.031	0.0720	2.5
14	0.0800	0.033	0.0641	2.0
15	0.0720	0.035	0.0571	1.8
16	0.0625	0.037	0.0508	1.6
17	0.0540	0.039	0.0453	1.4
18	0.0475	0.041	0.0403	1.2
19	0.0410	0.043	0.0359	1.0
20	0.0348	0.045	0.0320	0.90
21	0.0317	0.047	0.0285	0.80
22	0.0286	0.049	0.0253	0.70

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Answer three questions only:

Note: 1- Assume any missing data
2- Give your opinion about the results

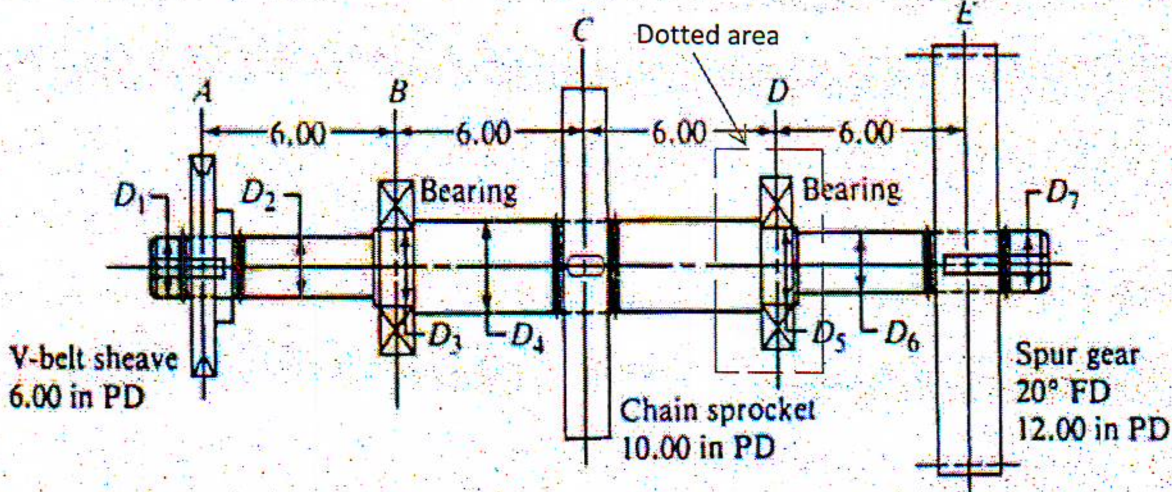
Q1: The shaft shown in figure **(1)** receives **(82 Kw)** from a water turbine through a chain sprocket at point **C**. The spur gear pair at E delivers **(59.5 Kw)**, to an electric generator.
The V- belt sheave at **A** delivers **(22.5 Kw)** to a bucket elevator that carries grain to an elevated hopper. The shaft rotates at **(178 rad/s).**

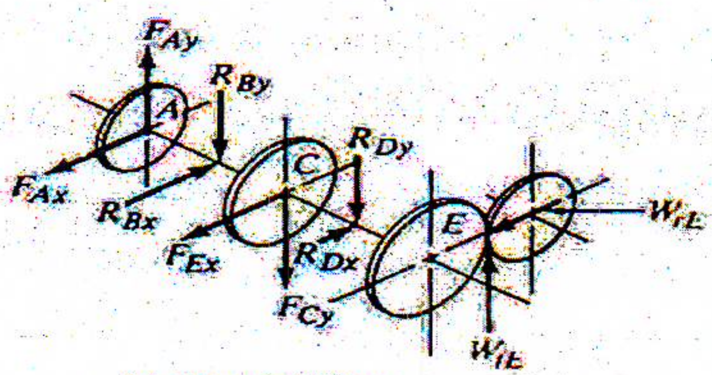
Data:

Material of shaft is **AISI 1040 cold-drawn steel** with:
(S_y= 489.5 MPa), (S_u = 551.6 MPa) and ($S_{n'}$ = 142.4 MPa)
Radial factor X=0.56

Requirements:

1- Compute the minimum acceptable diameters at (A) and at (D). (9 Marks)
2- Select a single –row deep groove ball bearing at point (D) then find its life. (5 Marks)
3- Draw dotted area in details showing fixation of outer and inner races of ball bearing at D. (3 Marks)





(a) Pictorial view showing forces

F_{Ay}= 2144 N	F_{Ax}= 1237 N
R_{By}= 729.5 N	R_{Bx}= 2620 N
F_{Cy}= 2775.6 N	F_{Cx}= 2331 N
R_{Dy}= 836.2 N	R_{Dx}= 1748 N
W_{Ey}=W_{tE}= 2197 N	W_{Ex}=W_{rE}= 800.6 N

Figure (1)

Q2: A part of a conveyor system for a production operation is shown in Figure (2a) and (2b). The empty fixture weights **378 N**. A cast iron engine block weighting**1000 N** is hung on the fixture to carry it from one process to another where it is then removed. It is expected that the system will experience many thousands of cycles of loading and unloading of the engine blocks.

Data: for the horizontal beam:

1-Material, steel **(AISI 1020 cold drawn S_y = 350 MPa and S_u = 420 MPa).**

2-Assume:

a- **C_m =1, C_{st} = 1, C_R =1 and C_s = 1.**

b- The factor of safety **(N) = 4** for mild shock.

c- The stress concentration factor (K_t) = 1.

3- Note: neglect the effect of the hole in the middle of the horizontal arm.

4- Use electrode **(E60)**with allowable force per **(mm)** of leg = **(66N/mm).**

Find:

1- Thickness (t) & (h) for the horizontal arm. (10 Marks)

2- Size of the weld shown in view (A-A) assuming the load is static and equal to **(1378 N).** (7 Marks)

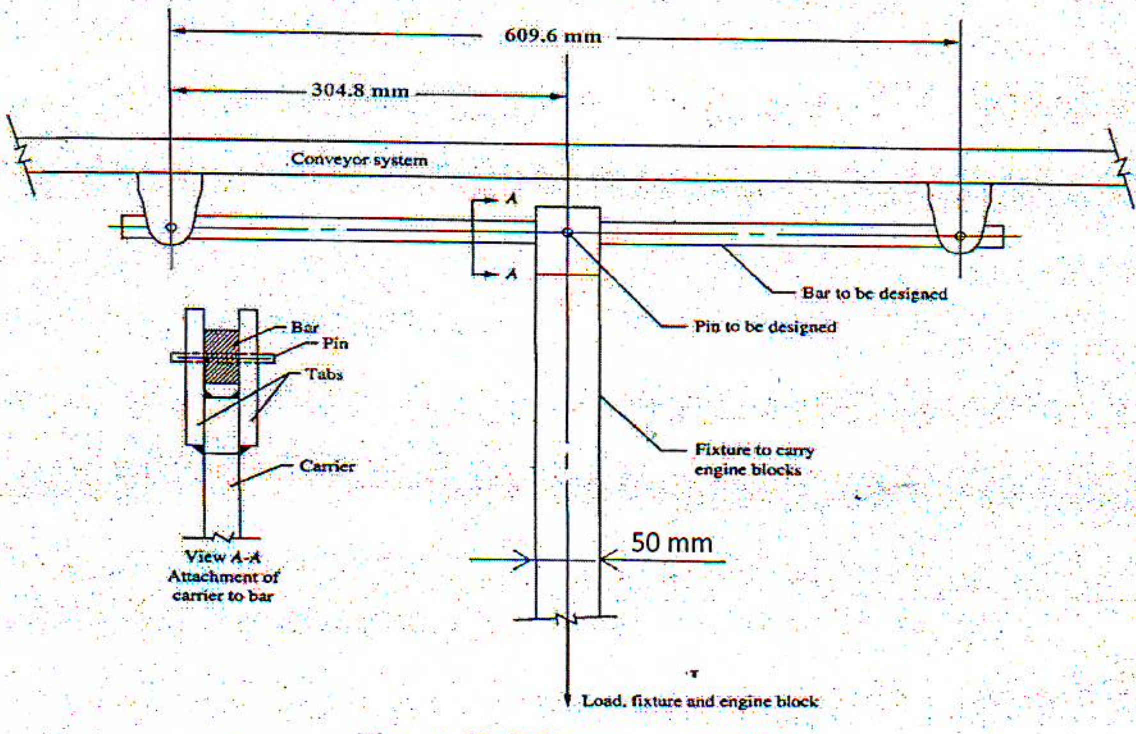


Figure (2a) Fixture assembly

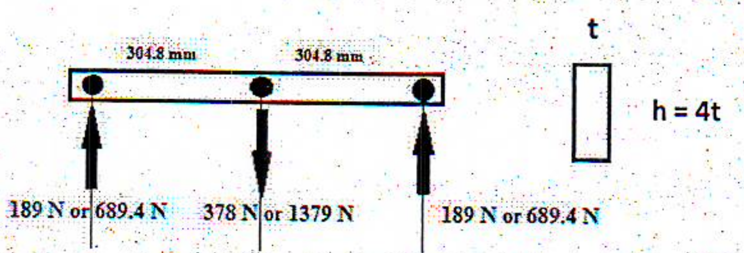


Figure (2b) Horizontal arm

FIGURE 19–8
Design shear stresses for ASTM A227 steel wire, hard-drawn (Reprinted from Harold Carlson, *Spring Designer's Handbook*, p. 144, by courtesy of Marcel Dekker, Inc.)

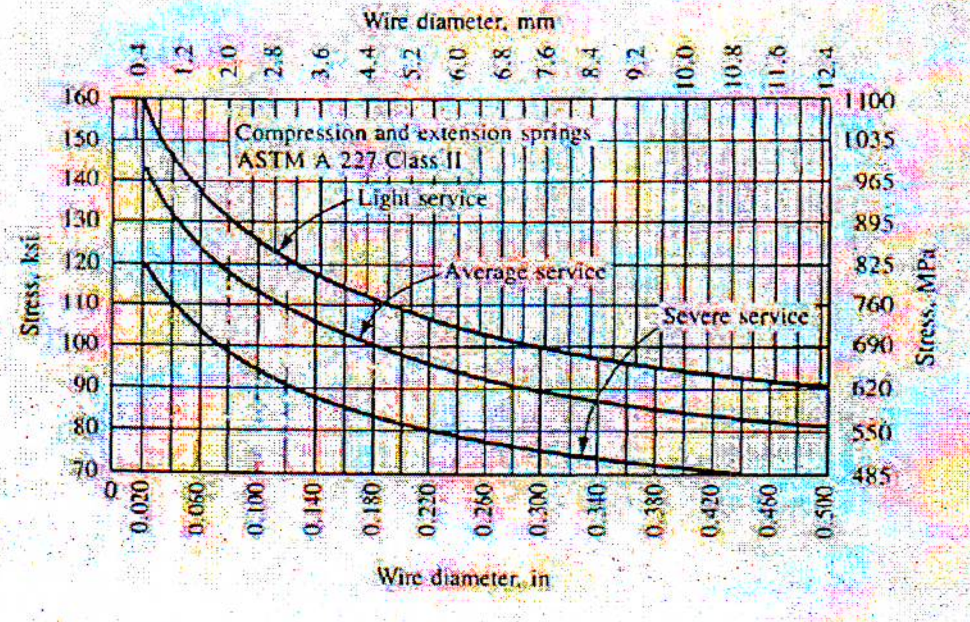


FIGURE 19–14
Wahl factor vs. spring index for round wire

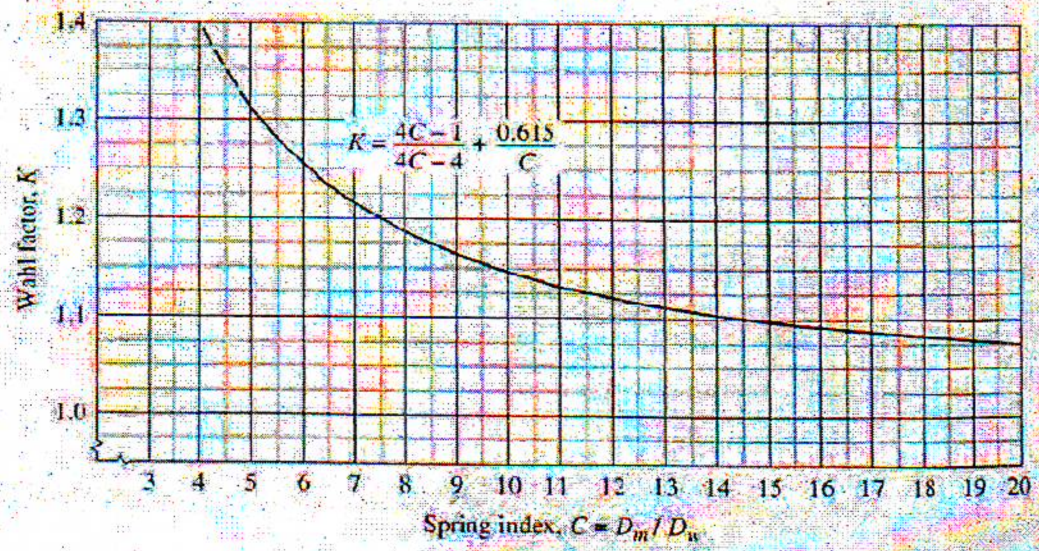
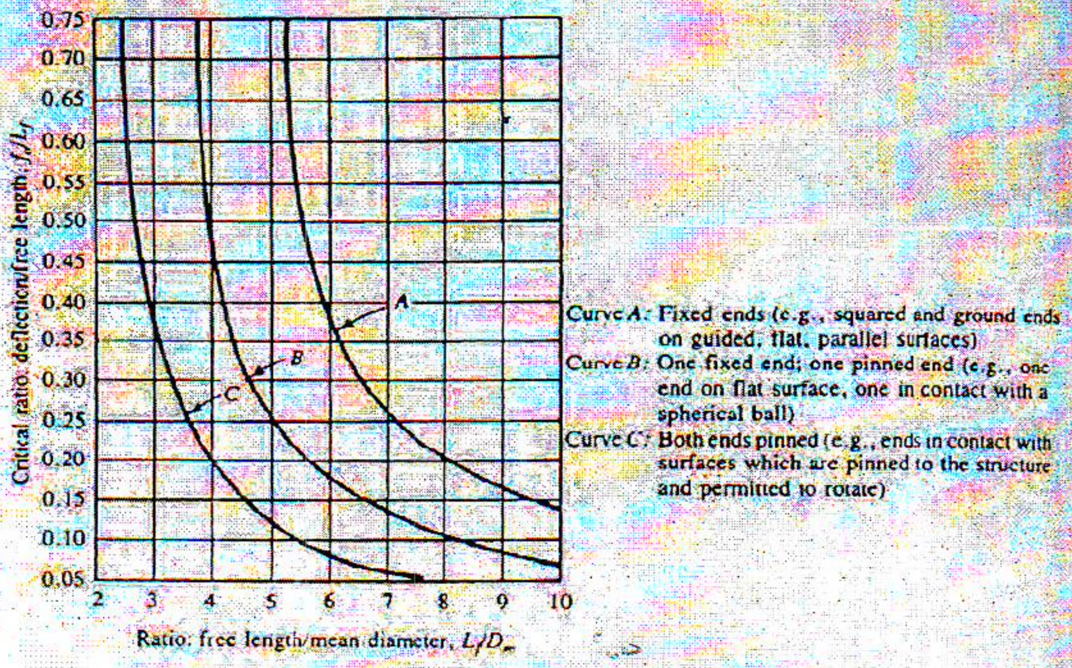


FIGURE 19–15
Spring buckling criteria. If the actual ratio of f_o/L_f is greater than the critical ratio, the spring will buckle at operating deflection.



Q4:

A: A (40 mm) power screw having square threads with **(double start)** screw with a pitch of (6 mm). The nut is to move at a velocity of (48 mm/s) and move a load of (F= 10 kN). The frictional coefficient are (0.1) for threads and (0.15) for the collar. The frictional diameter of collar is (60 mm).

Requirements:

1- The power required to drive the power screw. (5Marks)
2- Draw complete construction of the system showing all parts. (4 Marks)

B: A steam engine of effective diameter of (300 mm) is subjected to a steam pressure of (3 N/mm^2). The cylinder head is connected by (8 bolts). The bolts are tightened with an initial load of (1.5 times the steam load). A soft copper gasket is used between cover and cylinder.

Assuming:

Equivalent stiffness = 0.5

Yield strength for bolts and cylinder = 300 Mpa

Solve for static loading with safety factor = 2.

Requirements:

1- Find the size of the bolt. (4 Marks)
2- Find the thickness of the cylinder. (4 Marks)

Q3: The figure (3) below shows a disc clutch with the following data:
Torque on clutch = 35.72 N.m
The normal force between the friction surfaces = 1500 N
The coefficient of friction = 0.25
Rotational speed of clutch = 80 rad/sec
Number of springs around the pressure plate = 5
When the clutch disc are in contact (engaged) the spring will have a length = 65 mm
When the clutch is disengaged the spring will have a length = 55 mm
The force on each spring when the clutch is disengaged = 450 N
Material of spring is ASTM (A 227)
The spring will actuates several million of cycles during working
G = modulus of elasticity in shear for spring = 79.3 Gpa

Recommended

- $R_o/R_i = 1.2 - 2.5$
- WR = 0.046 for frequent applications (cons. Rate)
- WR = 0.116 for average services
- WR = 0.46 for infrequent applications
- Use square and grounded ends for springs ($N = N_a + 2$) & $L_F = PN_a + 2D_w$

Requirements:

1- Find outer and inner diameter of the clutch(3 Marks)
2- Check for wear rating for clutch (2 Marks)
3- Compute spring rate (1 Marks)
4- Compute free length for spring (1 Marks)
5- Compute suitable wire diameter for spring(3 Marks)
6- Compute number of active coils (1 Marks)
7- Compute solid length of spring (1 Marks)
8- Compute the pitch of spring and the pitch angle(2 Marks)
9- Check for spring buckling (1 Marks)
10-free hand sketch of section (X-X) (2Marks)

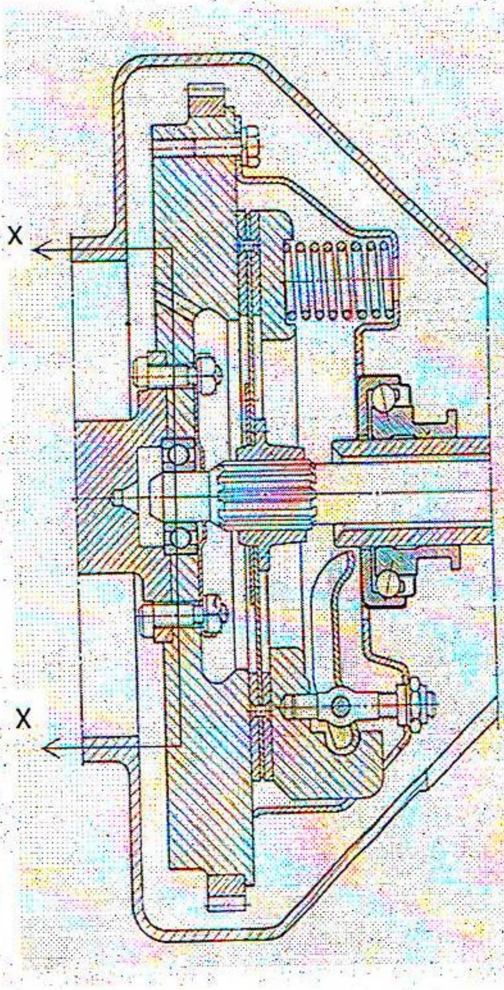


Figure (3)

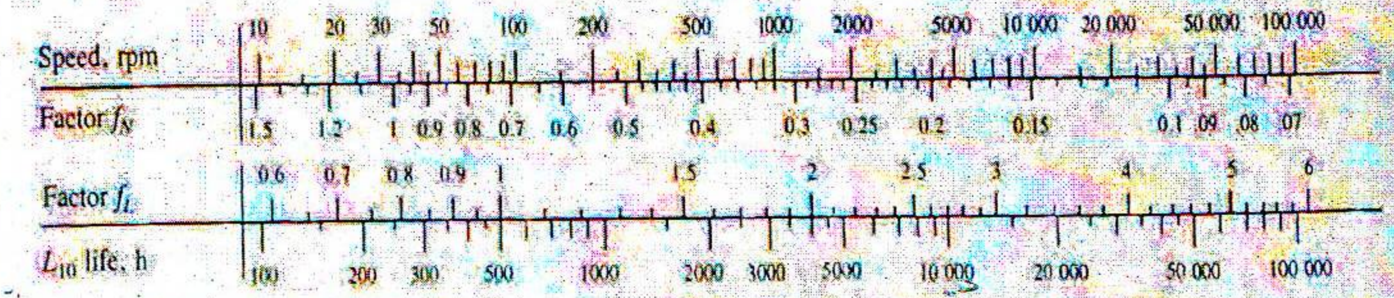
points	torque	Shearing forces		Bending moment		Axial load	K_t	Loading condition
		V_y (N)	V_x (N)	M_y (N.m)	M_x (N.m)			
A		2144	1237	0	0		1.6	
B	126.4	729.5	2620	326.8	-188.5	0	1.5	
C	460.6	2775.6	2331	542.4	22.4	0	1.6	
D		836.2	1748	334.9	-122		1.5	
E	334.2	2197	800.6	0	0	0	1.6	

TABLE 14–3 Bearing selection data for single-row, deep-groove, Conrad-type ball bearings

A. *Series* 6200

Bearing number	Nominal bearing dimensions							Preferred shoulder diameter		Bearing weight	Basic static load rating, C_o	Basic dynamic load rating, C
	d		D		B		r*	Shaft	Housing			
	mm	in	mm	in	mm	in	10^{-3} mm	mm	mm	N	kN	kN
6200	10	0.3937	30	1.1811	9	0.3543	609	12.70	12.7	0.31	2.31	3.94
6201	12	0.4724	32	1.2598	10	0.3937	609	14.68	13.7	0.35	3.00	5.25
6202	15	0.5906	35	1.3780	11	0.4331	609	17.85	15.2	0.44	3.51	5.87
6203	17	0.6693	40	1.5748	12	0.4724	609	19.98	17.8	0.62	4.49	7.38
6204	20	0.7874	47	1.8504	14	0.5512	990	24.61	20.8	1.02	6.22	9.83
6205	25	0.9843	52	2.0472	15	0.5906	990	27.95	23.3	1.29	7.16	10.81
6206	30	1.1811	62	2.4409	16	0.6299	990	33.53	28.4	1.96	10.31	14.90
6207	35	1.3780	72	2.8346	17	0.6693	990	38.49	33.0	2.85	14.01	19.79
6208	40	1.5748	80	3.1496	18	0.7087	990	43.19	72.9	3.65	16.23	22.46
6209	45	1.7717	85	3.3465	19	0.7480	990	47.89	78.0	3.96	18.46	25.13
6210	50	1.9685	90	3.5433	20	0.7874	990	52.58	83.0	4.54	20.68	26.91
6211	55	2.1654	100	3.9370	21	0.8268	990	58.21	91.5	6.05	26.02	33.36
6212	60	2.3622	110	4.3307	22	0.8661	1498	64.79	101.5	7.69	32.24	40.25
6213	65	2.5591	120	4.7244	23	0.9055	1498	69.47	111.5	9.69	35.58	44.04
6214	70	2.7559	125	4.9213	24	0.9449	1498	74.17	116.5	10.27	39.14	48.04
6215	75	2.9528	130	5.1181	25	0.9843	1498	78.87	121.3	11.74	43.14	50.71
6216	80	3.1496	140	5.5118	26	1.0236	2006	83.56	129.9	13.74	46.70	56.04
6217	85	3.3465	150	5.9055	28	1.1024	2006	89.19	140.0	17.66	54.71	64.94
6218	90	3.5433	160	6.2992	30	1.1811	2006	93.89	150.0	21.08	63.16	73.84
6219	95	3.7402	170	6.6929	32	1.2598	2006	100.47	157.9	25.48	72.50	83.62
6220	100	3.9370	180	7.0866	34	1.3386	2006	105.15	167.9	30.87	82.73	93.85
6221	105	4.1339	190	7.4803	36	1.4173	2006	109.85	178.0	36.25	92.90	102.30
6222	110	4.3307	200	7.8740	38	1.4961	2006	114.55	188.0	42.66	104.08	110.75
6224	120	4.7244	215	8.4646	40	1.5748	2006	123.94	202.9	50.71	116.53	119.65

(*a*) Ball bearings



University of Technology
Department of Machines and Equipment Engineering
Final Year Examination 2013/2014

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Examiner(s): Design Group

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Answer Three Questions only

Note: Give your opinion for unreasonable results

Q1): A): Find the diameter of shaft at point A, B, and D in figure (1). It is machined from AISI 1144 OQT 1000 steel. The shaft is part of drive for large blower system supplying air to the furnace. Gear A receives 150kW and gear C delivers the power. The shaft rotates at 62.8 rad/sec. **(18 marks)**

Data:

S_y=572 MPa for shaft and key.
N= factor of safety = 3
Allowable bearing stress between key and gear A=90 MPa.
W_{tA}=Tangential load on point A=9340 N
W_{rA}=Radial load on point A=3398 N
W_{tB}=Tangential load on point B=2054 N
W_{rB}=Radial load on point B=2037 N
W_{tC}=Tangential load on point C=18680 N
W_{rC}=Radial load on point C=6800 N
W_{tD}=Tangential load on point D=7472 N
W_{rD}=Radial load on point D=5439 N
M_{tB}=Bending moment in vertical plane on point B=2373 N.m
M_{rB}=Bending moment in horizontal plane on point B=863 N.m
M_{tC}=Bending moment in vertical plane on point C=1898 N.m
M_{rC}=Bending moment in horizontal plane on point C=1381 N.m
K_t=stress concentration = 1.5 (well-rounded fillet)
K_t=stress concentration = 2 (profile key seat)

Answer two branches only:

(B) Find the length of the key used to rotate the shaft at A. Assuming the key is square (20mm X 20mm). **(8 marks)**

(C) Compute the required basic dynamic load rating (c) of the ball bearing on shaft at region B if a design life of 20,000 hours is desired. **(8 marks)**

(D) Draw complete construction of the system showing all missing parts, i.e. keys, bearings,...etc, With necessary mountings and fixations. **(8 marks)**

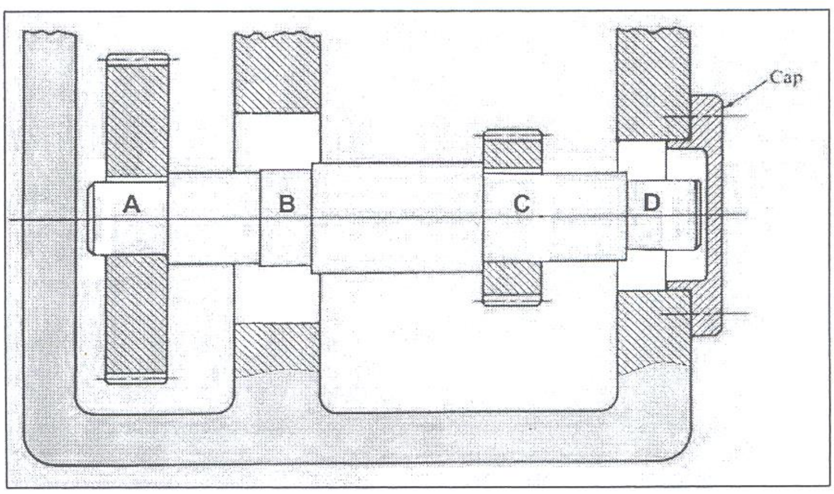

Figure (1)

اقلب الصفحة رجاءً

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Q2): A): The band brake shown in figure (2) has the following data:

L =381mm, a = r =127 mn, θ = 225,
f = 0.25, W = 139 N
$P_{max} = 0.172\ N/mm^2$
(maximum pressure between band and drum).

Requirements

1) Find p_1, p_2 and firction torque (T_f) **(5 marks)**
2) Find width of band (**w**) **(3 marks)**
3) Find the friction power while slowing the drum from 120 rpm **(3 marks)**

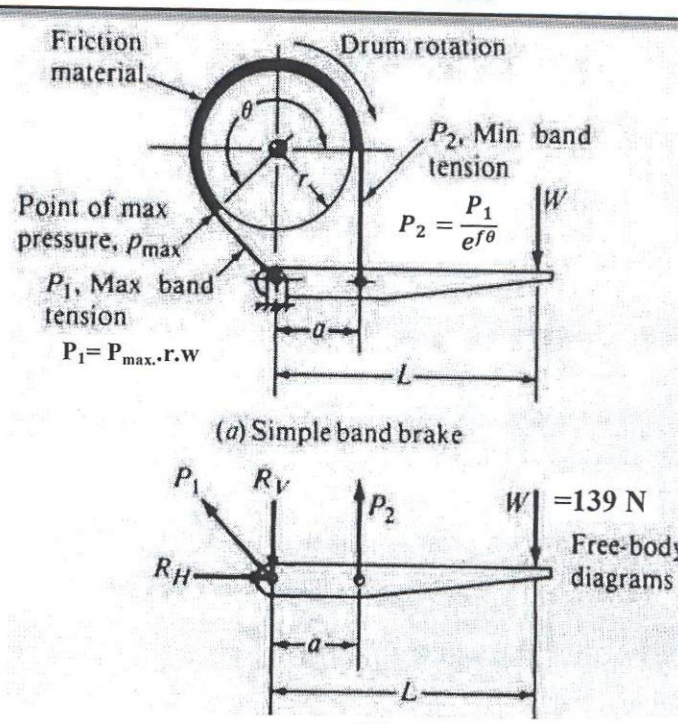

Figure (2)

B): The multiple dise clutch shown in figure (3) has the following data:

Data:

r_1=150 mm, r_2 =100mm, n_1 = 5, n_2 = 4, f = 0.2
Rotational speed of clutch = 900 rpm.
Springs will provide normal force of (1500 N) between friction surfaces.
Number of helical springs situated at mean radius of plate = 6
Spring index = 6 , permissible stress of spring = 420 Mpa,
Modulus of rigidity of steel spring = 84 KN/mm^2
Compression of spring to keep it engaged = 12.5 mm, wahle factor (k = 1.25)

Requirements: (Answer two branches only):

1) Find axial pressure on discs and power transmitted by the clutch .... **(11marks)**
2) Find wire diameter and number of active coils ....**(11 marks)**
3) Draw section (x-x) showing all details ...... **(11 marks)**

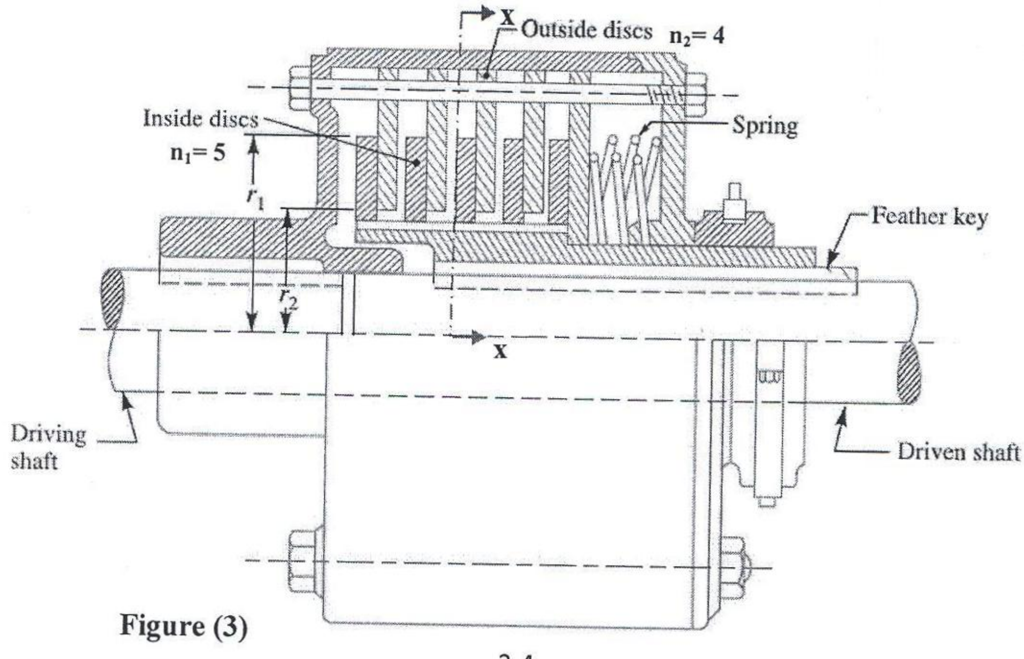

Figure (3)

Q3): A): A single square – thread power screw is to raise a load of 70 KN . The screw has a major diameter 36 mm and a pitch of 6 mm . The frictional coefficients are 0.13 for the threads and 0.1for the collar. If the collar frictional diameter is 90 mm and the screw turns at a speed of 1 rev/second , Find:

(i) The power input to the screw **(13 marks)**

(ii) The combined efficiency of the screw and a collar. **(4 marks)**

B): A portion of machine member is shown in figure (4). It is loaded by completely reversed axial force F . The material is steel S_u = 440 Mpa , S_y= 372 Mpa . for 90 percent reliability and long life with factor of safety 1.3, C_m = 1, C_R= 0.9, C_s= 1, C_{st}= 1 and K_t= 2.5, Find:

(i) The maximum fatigue load that can be applied. **(11 marks)**

(ii) The maximum static load by using same factor of safety. **(5 marks)**

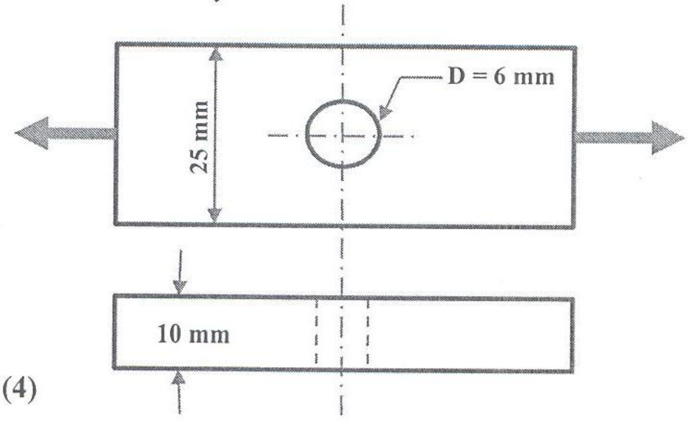

Figure (4)

Q4): Answer two branches only:

A): Find the value of P for the joint shown in Figure (5) based on a working shear stress of 100 MPa for the rivets. **(17 marks)**

Data:

The four rivets are equal each of 20 mm diameter.

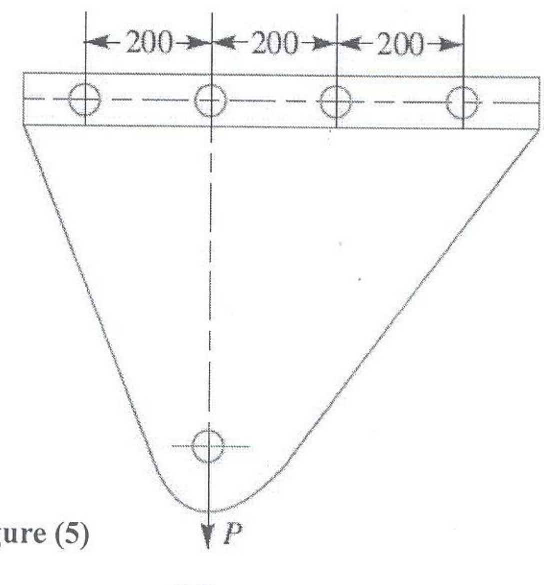

Figure (5)

اقلب الصفحة رجاءً

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B): A bracket, as shown in Figure (6), is fixed to a vertical steel column by means of five standard bolts.

Requirements:

(i) The diameter of the fixing bolts (12 marks)

(ii) The thickness of the arm of the bracket. (5 marks)

Assume safe working stresses of 70 MPa in tension and 50 MPa in shear.

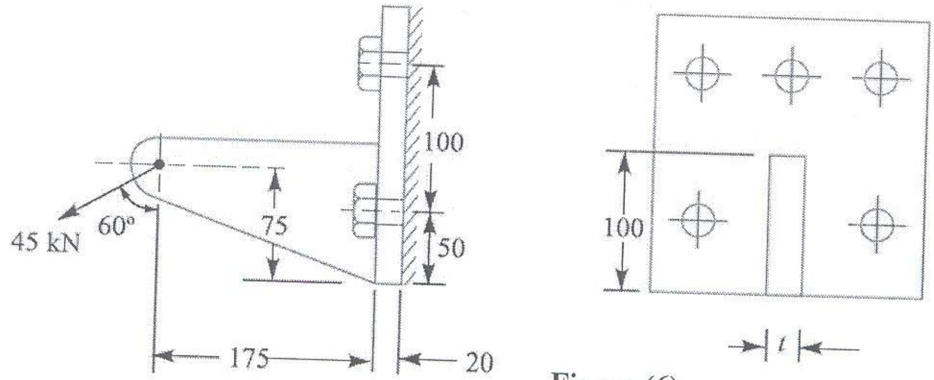

Figure (6)

C): Evaluate the design shown in Figure (7) with regard to stress in the welds. All parts of the assembly are made of ASTM A36 structural steel and are welded with an E60 electrode. The 10000 N load is a dead load.

(17 marks)

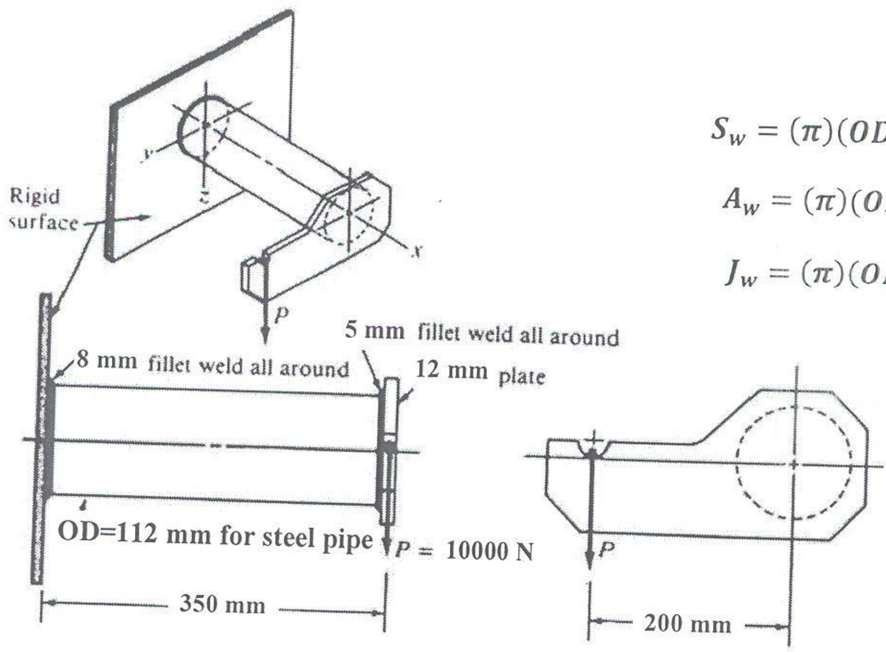

Figure (7)

$$S_w = (\pi)(OD)^2/4$$

$$A_w = (\pi)(OD)$$

$$J_w = (\pi)(OD)^3/4$$

TABLE 20–3 Allowable shear stresses and forces on welds

Base metal ASTM grade	Electrode	Allowable shear stress	Allowable force per mm of leg
Building-type structures:			
A36, A441	E60	93.704 MPa	66.2 N/mm
A36, A441	E70	108.862 MPa	77.2N/mm
Bridge-type structures:			
A36	E60	85.436 MPa	60.7 N/mm
A441, A242	E70	101.283 MPa	71.7 N/mm

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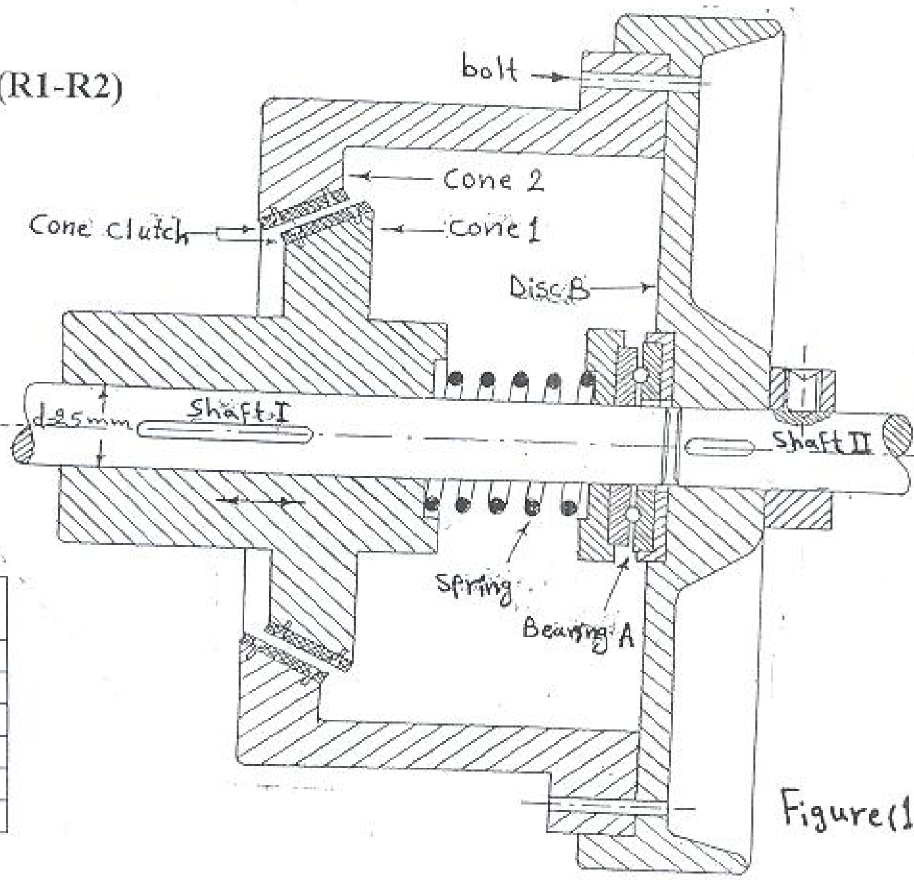
Division: All Branches — Exam Time: 3 Hrs.
Examiners: Dr.JassimAljaaf & Dr.Qasim Abbas — Date: 26 / 5/ 2013

(ANSWER FOUR QUESTIONS ONLY) ملاحظة: افرض القيم التي قد تحتاجها في بعض الاسئلة.

Q1:Figure **(1)** shows **(cone clutch)** system used to transmit the angular motion from input shaft I → cone 1→ cone 2 →disc B → output shaft II .

Diameter of shaft I **(d1=25 mm)**.
Speed of shaft I **(1000 rpm)**.
$\left(\frac{R2}{R1} = 0.8\right)$
for asbestos & cast iron ($\mu = 0.4$ & $P = 0.3\ N/mm^2$)
MAX. FORCE ON SPRING = 1.4 * MIN. FORCE ON SPRING
MIN. FORCE ON SPRING = Fn * sinα
α = 12.5
spring index **(c = 8)**.
number of bolt **(4)**.
Ideal load on thrust ball bearing **(P = X . Pr + Pa)**.
$\tau_{max.}$ of shaft I = **1200 N/cm²**
engagement factor **(β = 1.2)**.
spring force = 2π. P_{max}. . R2 (R1-R2)
wahle factor **(K = 1.184)**.



Figure(1)

Wire Diameter (d) (mm)	Average Service τ_{max} (N/mm²)
Up to 2.125	520
2.125 – 4.625	475
4.625 – 8	415
8 – 13.25	360
13.25 – 24.25	310
24.25 – 38	275

find:

1- Radius of cone clutch (R1 &R2) .....(3 marks)
2- Wire diameter of spring (d). .....(3 marks)
3- Life of bearing (A). .....(2 marks)
4- Bolt diameter (d). .....(2 marks)
5- Draw idea to engaged and separate cone clutch. .....(3 marks)

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Q2: The one speed hoisting winch shown in figure **(2)**.

Liner velocity of wight($V = 0.02$ m/s).
Pulley diameter ($D = 0.4$ m).
Maximum tangential force on handle ($Q = 400$ N).
Spur gear ratio ($i=3$).
Diameter of gear 1 ($D1 = 70$ mm).

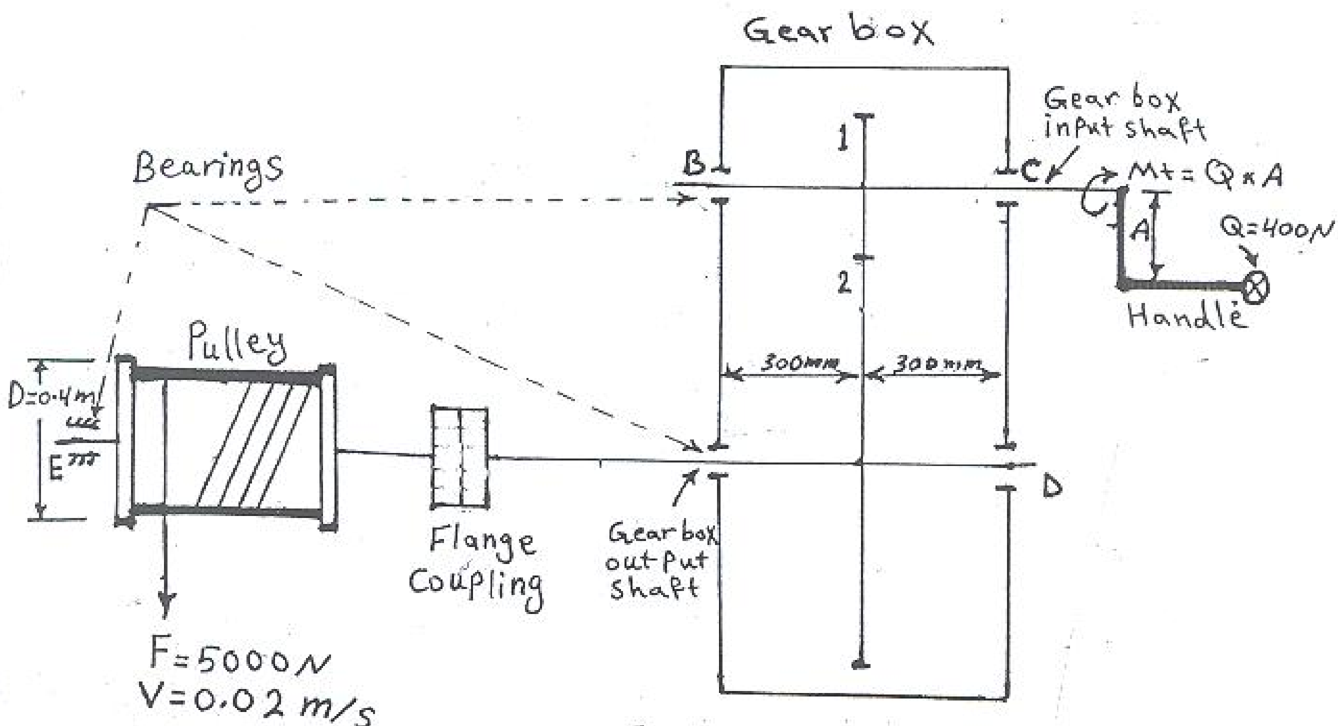

Figure (2)

Find:

1- Dimension (**A**). .....(2 marks)
2- Diameter of shaft (**BC**). .....(4 marks)
3- Life of bearing (**B**). .....(2 marks)
4- Draw all details for shaft (**DE**). .....(5 marks)

University of Technology
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Exam Time: 3 Hrs.
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Q_3:A portable conveyer is to be raised and lowered by means of the **double-screw** arrangement show in figure (3). The two screw are supported by **collars (A)** and are connected by the roller **chain (B)** and rotated by the **bevel gear (C),** operated by the **hand crank** as shown. The movable **frame (E)**is raised and lowered by screws against a load **(W = 8000 N).** use square thread screw.

Assume the following date:
$d_{collars} = d_2$
$\mu_{collars} = \mu_{screw} = 0.122$
lead = pitch = 6 mm
$\alpha = 4.36$
bevel gear ratio (i = 2).
Maximum tangential force on crank = 80 N.

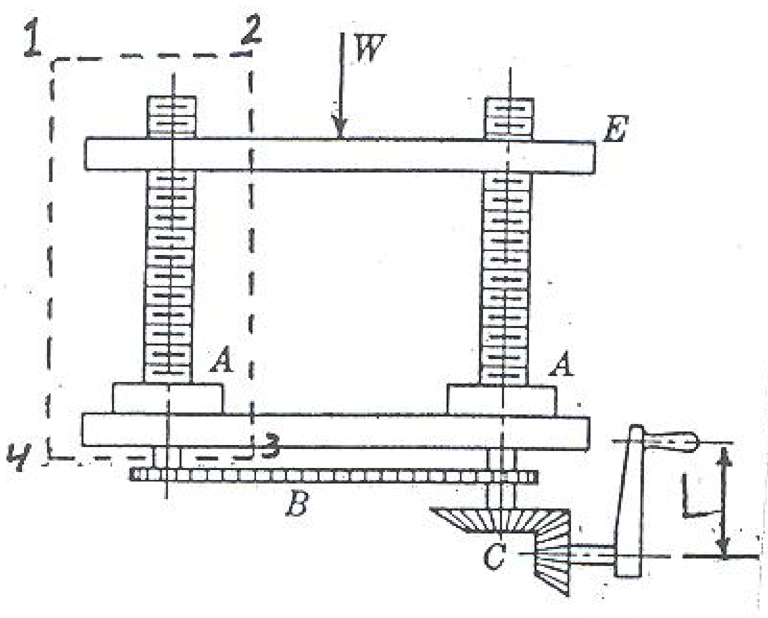


Figure (3)

Find:

1- Size of the screw and nut to be use. .....(4 marks)
2- Length of crank (L). .....(3 marks)
3- Screw efficiency. .....(2 marks)
4- Draw area **(1234)** with **neglected** collar friction. .....(4marks)

Q4: A): Figure below shows a Knuckle joint.

The axial load **F = 100 KN**.

Maximum allowable tensile stress $\sigma_{t)all.}$ = **210 Mpa**, -

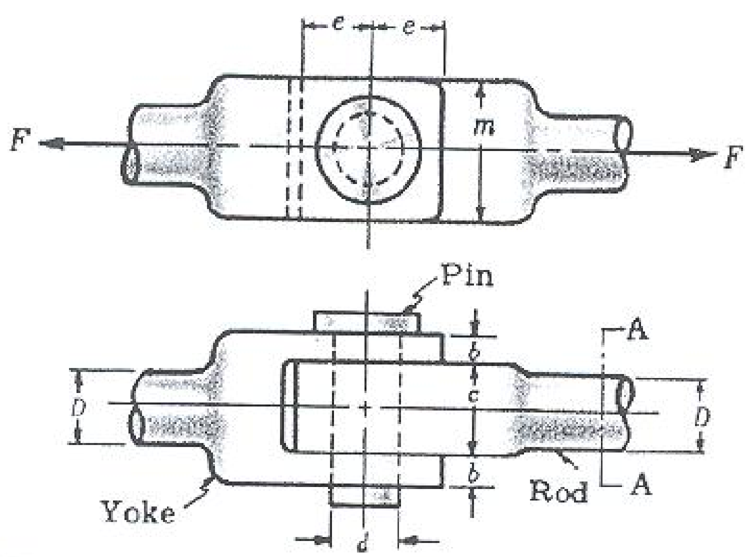
Maximum allowable shear stress $\tau_{max.}$ = **105 Mpa**

Maximum allowable bearing stress $\sigma_{Bearing}$ = **90 Mpa**.

All parts made from steel

Requirement:

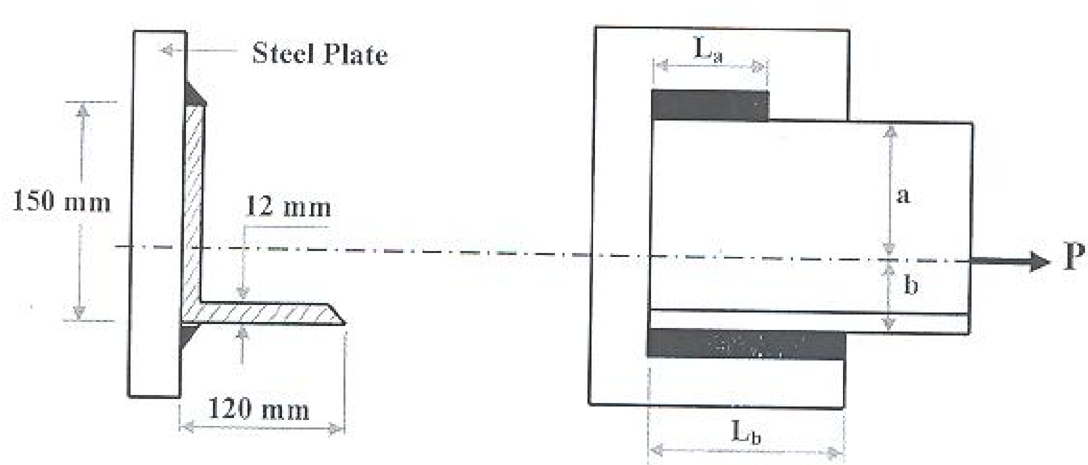
Find dimensions **D, d, c, b, m & e**. **(7.5 marks)**



B): A **150 × 120 × 12 mm** angle is to be welded to a steel plate by fillet welds as shown in Figure below. If the angle is subjected to a static load of **250 kN**, The allowable shear stress for static loading may be taken as **75 MPa**.

Requirements:

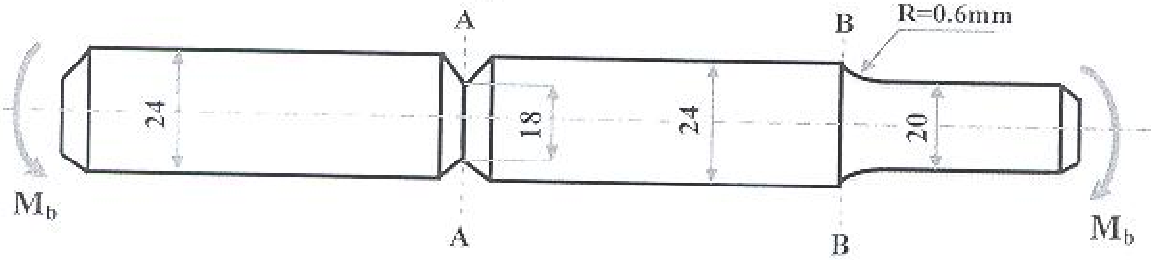
Find the length of weld at the top and bottom. **(5 marks)**



Q5): A): A steel rod as shown in figure below, bending moment M_b applied at each end. Compute the **repeated** Moment by using **Goodman formula** at sections **A-A** and **B-B**.

Where: $\sigma_B = 60\ \frac{Kgf}{mm^2}$ **and** for factor of safety = **1.4** **(8 marks)**

Goodman Formula: $\sigma_{ba} = \frac{\sigma_{bw}}{N}\left[1 - \frac{\sigma_{bm}}{\sigma_B/N}\right]$



B): The figure shows bolt to connect two parts (1&2):

The external load on parts varies from **50 kN to 80 kN**,

The area of parts = **700 mm²**

The cross section area of bolt = **425 mm²**

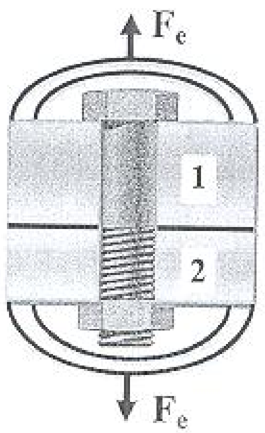
Parts made from Aluminum and bolt from Steel

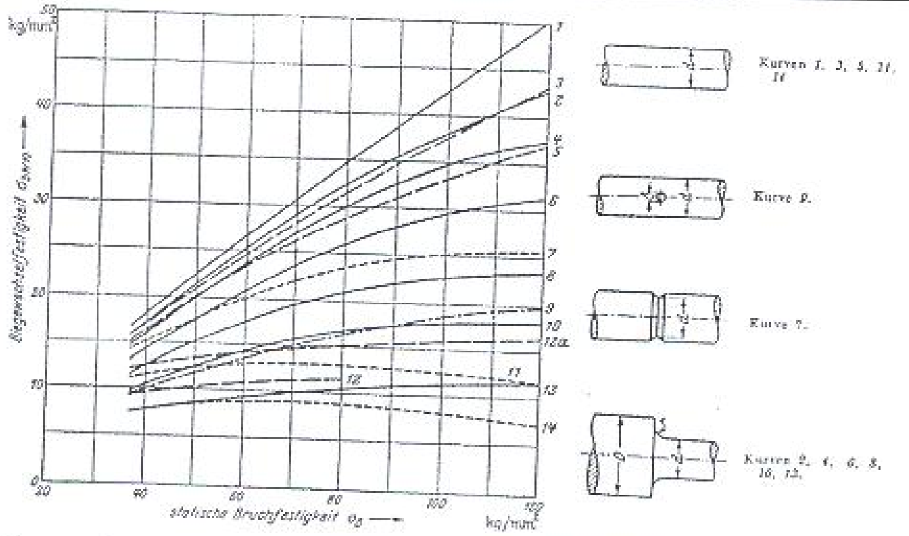
$E_{Al} / E_{ST} = 3$; $L_{Parts} = L_{Bolt}$

σ_B = **500 MPa** & for tension σ_w = **200 MPa**

Requirement:

Find **factor of safety** by using **Goodman formula**. **(4.5 marks)**





D/d	q
1.05	0.13
1.1	0.1
1.2	0.07
1.3	0.052
1.4	0.04
1.5	0.022

d = 10mm	b_o =1
20	0.9
30	0.8
50	0.7
100	0.6
200	0.57
300	0.56

Figure (3/27) Relation between endurance strength for reversed bending of 10 mm diameter. C-steel test pieces and the static ultimate strength σ_B. (a) Smooth shafts: Polished (curve 1); ground fine machined (curve 3); rough machined (curve 5); corroded by ordinary water (curve 11); corroded by salt water (curve 14); (b) with transverse hole: δ=0.175d (curve 9); (c) With sharp notch: 1 mm deep (curve 7); (d) With hub: keyed (curve 12); pressed without key (curve 12a); (e) With step D/d=2: y=r/d=0.5 (curve 2); =0.3(curve 4); =0.2(curve 6); =0.1(curve 8); =0.05(curve 10); =0 (curve 13); (f) For steps with other D/d ratio: Substitute y=r/d+q ; (g) For other diameters d; $\sigma_{bw} \approx \sigma_{bw10} \cdot b_o$ and $\tau_{bw} \approx \tau_{bw10} \cdot b_o$

Q6) A): A spur steel pinion (S_o= **200MN/m^2**) is to drive a spur steel gear (S_o= **140MN/m^2**). The dieameter of the pinion is to be **100 mm** and the center distance **200 mm.** The pinion is to transmit **5 kW** at **900 rev/min**. The teeth are to be **20°** full depth.

Determine the necessary module and width of face to give the greatest number of teeth.

Design for strength only, using the Lewis equation. **(7.5 marks)**

$s = s_o\left(\frac{3}{3+V}\right)$ for V less than **10 m/s**

$s = s_o\left(\frac{6}{6+V}\right)$ for V **10 to 20 m/s**

$s = s_o\left(\frac{5.6}{5.6+\sqrt{V}}\right)$ for V greater than **20 m/s**

Standard Modules

Preferred 1, 1.25, 1.5, 2, 2.5, 3, 4, 5, 6, 8, 10, 12, 16, 20, 25, 32, 40, 50

Second Choice 1.125, 1.375, 1.75, 2.25, 2.75, 3.5, 4.5, 5.5, 7, 9, 11, 14, 18, 22, 28, 36, 45

Table(1) form Factors y – for use in Lewis Strength equation

No. of teeth	12	13	14	15	16	17	18	19	20	21	23	25	27	30	34	38	43	50	60	75	100	150	300	rack
20°full depth	0.078	0.083	0.088	0.092	0.094	0.096	0.098	0.100	0.102	0.104	0.106	0.108	0.111	0.114	0.118	0.122	0.126	0.130	0.134	0.138	0.142	0.146	0.150	0.154

B): For the figure shown below, Given the data for the joint are:

Maximum allowable tensile stress $\sigma_{(t)all.}$ = 260 Mpa,

Maximum allowable shear stress $\tau_{max.}$ = 130 Mpa

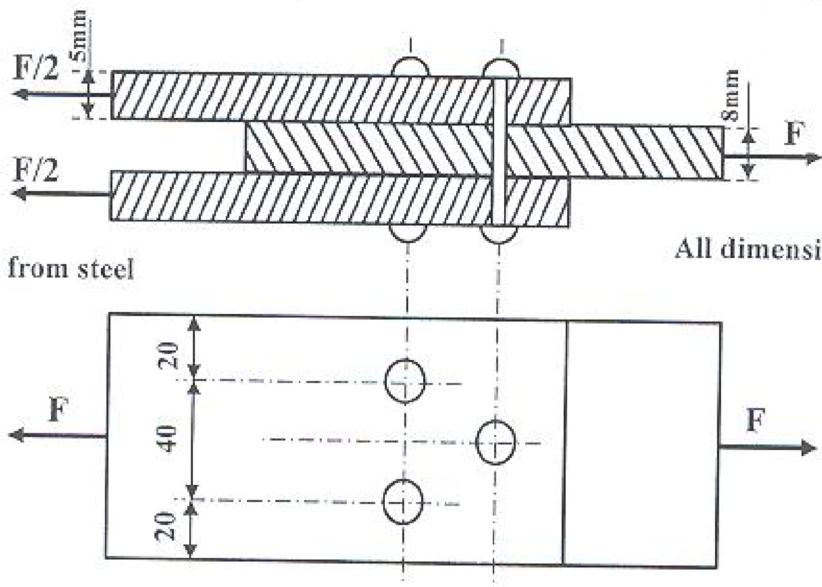
Maximum allowable bearing stress $\sigma_{Bearing}$ = 90 Mpa.

Thickness of main plate is **8 mm** and thickness of cover plate is **5 mm.**

The diameter of rivet is **6 mm.**

Requirement:

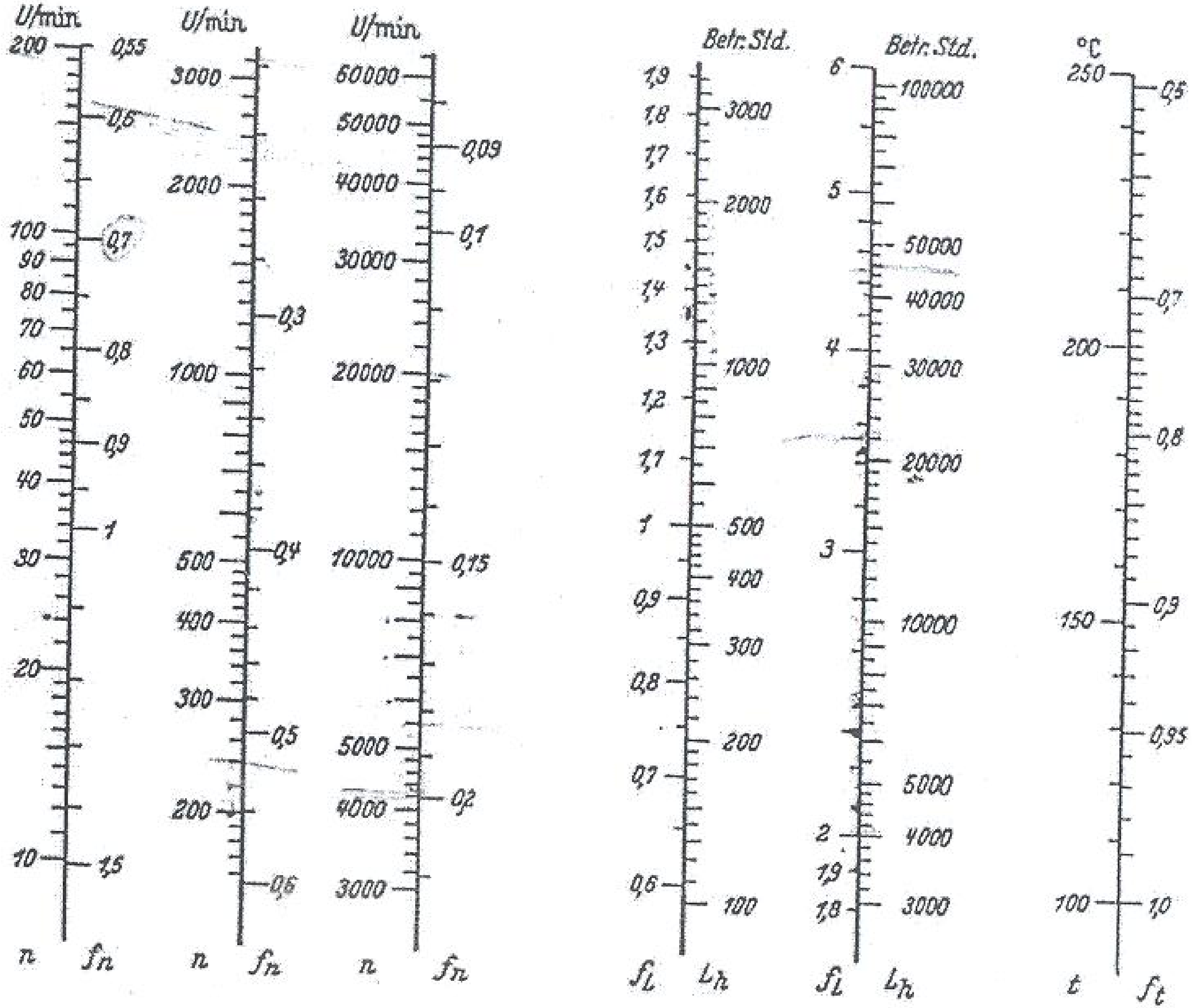
Find the safe loading capacity of this joint **F**. **(5 marks)**



All parts made from steel

All dimensions in mm

Chart of Life Factor of Bearing



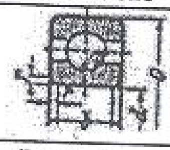
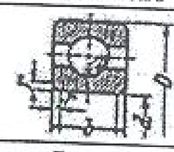
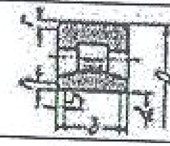
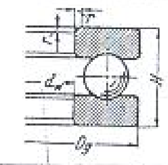
All dimensions are in mm. C= basic load rating			Deep groove ball bearing DIN 625			Angular contact ball b. DIN 628			Cylindrical ball bearing DIN 5412		
											
			$P = x.P_r + y.P_a$			$P = x.P_r + y.P_a$			$P = x.P_r$		
			$x = 1$ / $x = 1.4$			$x=0.5$ $x=0.7$ $y=0.7$			$x=1$ $x=1.4$		
			$C:P_a$: 5, 10, 20, 30								
			y: 1.4, 1.6, 1.8, 2.0								
d	D	r	Symbol	b	C Kgf	Symbol	b	C Kgf	Symbol	b	C Kgf
4	16	0.5	R4	5	140	------	------	------	------	------	------
5	19	0.5	R5	6	216	------	------	------	------	------	------
7	22	0.5	R7	7	240	------	------	------	------	------	------
9	26	1	R9	8	340	------	------	------	------	------	------
10	30	1	6200	9	340	------	------	------	------	------	------
12	32	1	01	10	530	QA 10	9	430	------	------	------
15	35	1	02	11	585	12	10	465	------	------	------
17	40	1.5	03	12	720	15	11	540	------	------	------
20	47	1.5	04	14	980	17	12	735	------	------	------
25	52	1.5	05	15	1040	20	14	1120	NUL 20	14	980
30	62	1.5	06	16	1460	25	15	1270	25	15	1100
35	72	7	07	17	1960	30	16	1560	30	16	1460
40	80	2	08	18	2240	35	17	1900	35	17	2120
45	85	2	09	19	2500	40	18	2280	40	18	2750
50	90	2	6210	20	2700	45	19	2360	45	19	2900
55	100	2.5	11	21	3250	50	20	2450	50	20	3050
60	110	2.5	12	22	4000	55	21	3150	55	21	3650
65	120	2.5	13	23	4400	60	22	4000	60	22	4400
70	125	2.5	14	24	4650	65	23	4550	65	23	5100
75	130	2.5	15	25	5000	70	24	4750	70	24	5300
80	140	3	16	26	5500	75	25	5000	75	25	6200
85	150	3	17	28	6300	QA 80	26	5850	NUL 80	26	7100
90	160	3	18	30	7100	85	28	6550	85	28	8150
95	170	3.5	19	32	8000	90	30	7350	90	30	9800
100	180	3.5	20	34	9000	95	32	8500	95	32	11400
						100	34	9500	100	34	12700

Table 14/12. Ball thrust bearing, dimension group 1 (very light series)

DIN 711 (Aug. 1942)



d_w	D_g	H	r	Symbol	C kgf
10	24	9	0,5	51100	570
12	26	9		01	610
15	28	9		02	655
17	30	9		03	720
20	35	10		04	965
25	42	11	1	05	1 220
30	47	11		06	1 320
35	53	12		07	1 460
40	60	13		08	1 960
45	65	14		09	2 080
50	70	14		10	2 240
55	78	16		11	2 700
60	85	17	1,5	12	3 200
65	90	18		13	3 350
70	95	18		14	3 450
75	100	19		15	3 650
80	105	19		16	3 750
85	110	19		17	3 900
90	120	22		18	5 000
100	135	25		20	6 950
110	145	25		22	7 350
120	155	25		24	7 650
130	170	30		26	8 800
140	180	31		28	9 150
150	190	31		30	9 650
160	200	31		32	10 000
170	215	34	2	34	11 800
180	225	34		36	12 000
190	240	37		38	14 600
200	250	37		40	15 000
220	270	37		44	16 000
240	300	45	2,5	48	20 800

Subject: Machine Design I
Division: All Branches
Examiner(s): Dr. Jassim Aljaaf & Dr. Qasim Abbas

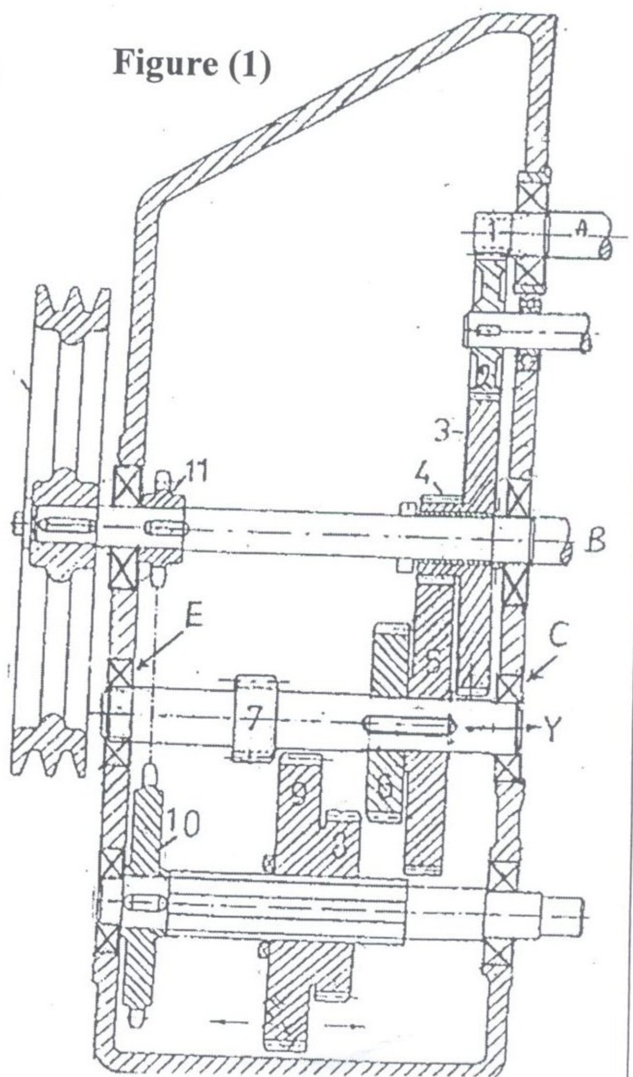
Year: 3rd Class
Exam Time: 1.5 Hrs.
Date: 13 / 01 / 2013

Q1: Figure **(1)** shows the gear box used to reduce speed. Angular motion transmit from shaft **(A)** to gear **(1)** then to gears **(2,3,4,5,6 and 7).** Gears **(3&4)** and **(8&9)** are combined, when gears **(8,9)** move to right side engaged it with gear **(6)**, but they engage with gear **(7)** when they move to left side, finally the angular motion transmitted from sprockets **(10,11)** to pulley **(12)**. Torque in shaft **(A) = 150 N.m** and speed of shaft **(A) = 1000 rpm**.
The shaft material has the maximum shear stress τ_{max}**=130 N/mm²** **(7 marks)**

Requirements:

1) Diameter of shaft **(Y)**, only when gear **(9)** move to left side to engaged with gear **(7)**.
2) Draw the shaft **(Y)** showing all details especially how you fixing the outer and inner races of the bearings and gears.
3) Life of bearings **(C & E)**.

Figure (1)



Note: All gears are spur type except gears **(4,5)** are helical gears.

$i_{12}=3$; $i_{23}=2$; $i_{45}=3$

Helix angle $\beta = 15^o$

Diameter of gear 5 (d_5) = **150 mm**

Diameter of gear 7 (d_7) = **80 mm**

Reactions on bearing C:

R_{CV} = **3998 N** ; R_{CH} = **7676 N**

Reaction on bearing E:

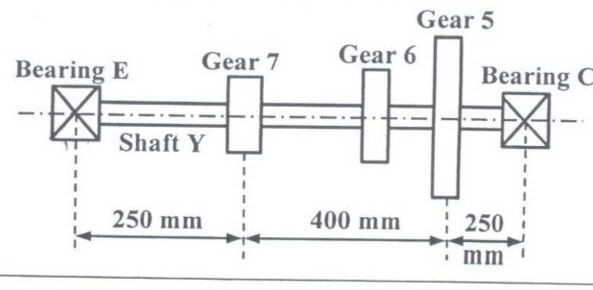
R_{EV} = **15001** N ; R_{EH} = **39176 N**

Forces on Gear (5) :

F_R = **13565 N** ; F_T = **36000 N** ; F_A = **9646 N**

Forces on Gear (7) :

F_R = **24568 N** ; F_T = **6700 N**



Q2: Answer **A** or **B** only: **(3 marks)**

A) The knuckle joint shown in figure(2) carrying a tensile load **F = 240 N;**

Allowable bearing stress (between any two parts you are choosing) = **20 N/mm^2.**

Allowable shear stress = **12 N/mm^2,**

Allowable tensile stress = **24 N/mm^2**

Requirements:

Find the dimensions **a,b,d,e &f.**

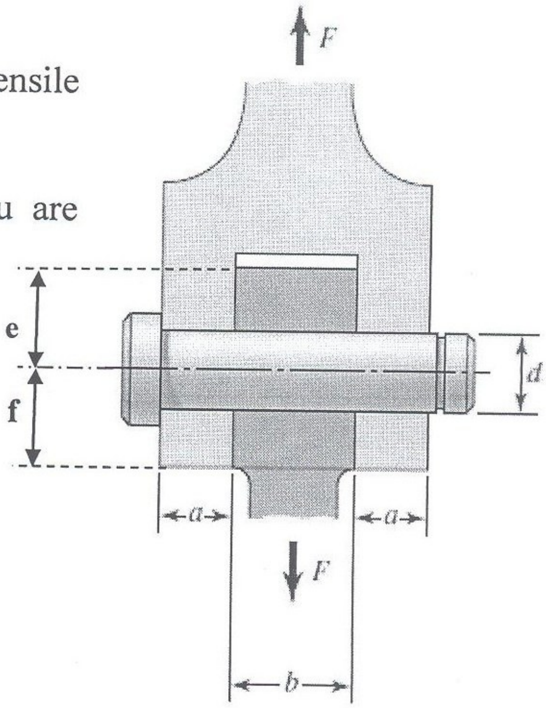


Figure (2)

B) The layout and dimensions of a double shoe brake is shown in Figure (3). The diameter of the brake drum is **300 mm** and the contact angle **(2θ)** for each shoe is **90°.** The coefficient of friction **(μ)** for the brake lining and the drum is **0.4**

Requirements:

1) Find the force necessary to transmit a torque of **30 N.m.**

2) Determine the width of the brake shoes, if the bearing pressure on the lining material is not to exceed **0.28 N/mm^2.**

Note: $\bar{\mu} = \dfrac{4\mu.\sin\theta}{2\theta+\sin 2\theta}$

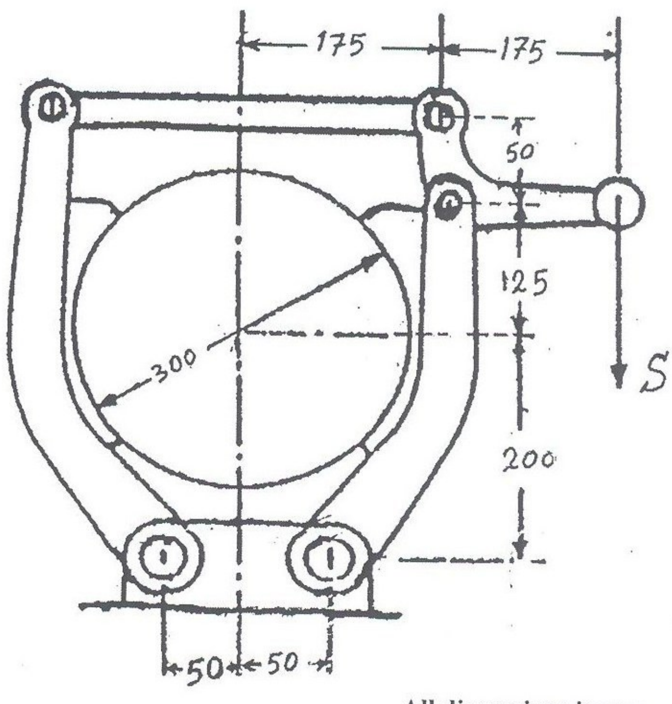
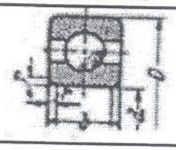
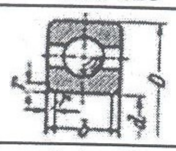
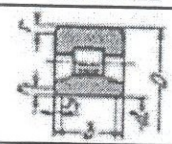


Figure (3) **All dimensions in mm**

With best wishes in succeed
Dr. Qasim Abbas & Dr. Jassim Aljaaf

All dimensions are in mm.

C= basic load rating

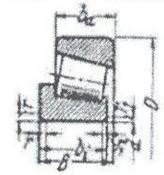
			Deep groove ball bearing DIN 625			Angular contact ball b. DIN 628			Cylindrical ball bearing DIN 5412		
											
			$P = x.P_r + y.P_a$			$P = x.P_r + y.P_a$			$P = x.P_r$		
			$x = 1$ $x = 1.4$			$x=0.5$					
			$C:P_a$ 5 / 10 / 20 / 30			$x=0.7$			$x=1$		
			y 1.4 / 1.6 / 1.8 / 2.0			$y=0.7$			$x=1.4$		
d	D	r	Symbol	b	C Kgf	Symbol	b	C Kgf	Symbol	b	C Kgf
4	16	0.5	R4	5	140	------	-----	------	------	------	------
5	19	0.5	R5	6	216	------	-----	------	------	------	------
7	22	0.5	R7	7	240	------	-----	------	------	------	------
9	26	1	R9	8	340	------	-----	------	------	------	------
10	30	1	6200	9	340	QA 10	9	430	------	------	------
12	32	1	01	10	530	12	10	465	------	------	------
15	35	1	02	11	585	15	11	540	------	------	------
17	40	1.5	03	12	720	17	12	735	------	------	------
20	47	1.5	04	14	980	20	14	1120	NUL 20	14	980
25	52	1.5	05	15	1040	25	15	1270	25	15	1100
30	62	1.5	06	16	1460	30	16	1560	30	16	1460
35	72	7	07	17	1960	35	17	1900	35	17	2120
40	80	2	08	18	2240	40	18	2280	40	18	2750
45	85	2	09	19	2500	45	19	2360	45	19	2900
50	90	2	6210	20	2700	50	20	2450	50	20	3050
55	100	2.5	11	21	3250	55	21	3150	55	21	3650
60	110	2.5	12	22	4000	60	22	4000	60	22	4400
65	120	2.5	13	23	4400	65	23	4550	65	23	5100
70	125	2.5	14	24	4650	70	24	4750	70	24	5300
75	130	2.5	15	25	5000	75	25	5000	75	25	6200
80	140	3	16	26	5500	QA 80	26	5850	NUL 80	26	7100
85	150	3	17	28	6300	85	28	6550	85	28	8150
90	160	3	18	30	7100	90	30	7350	90	30	9800
95	170	3.5	19	32	8000	95	32	8500	95	32	11400
100	180	3.5	20	34	9000	100	34	9500	100	34	12700

All dimensions are in mm

C= basic load rating

Taper roller bearing

DIN 720 (Aug 1942)

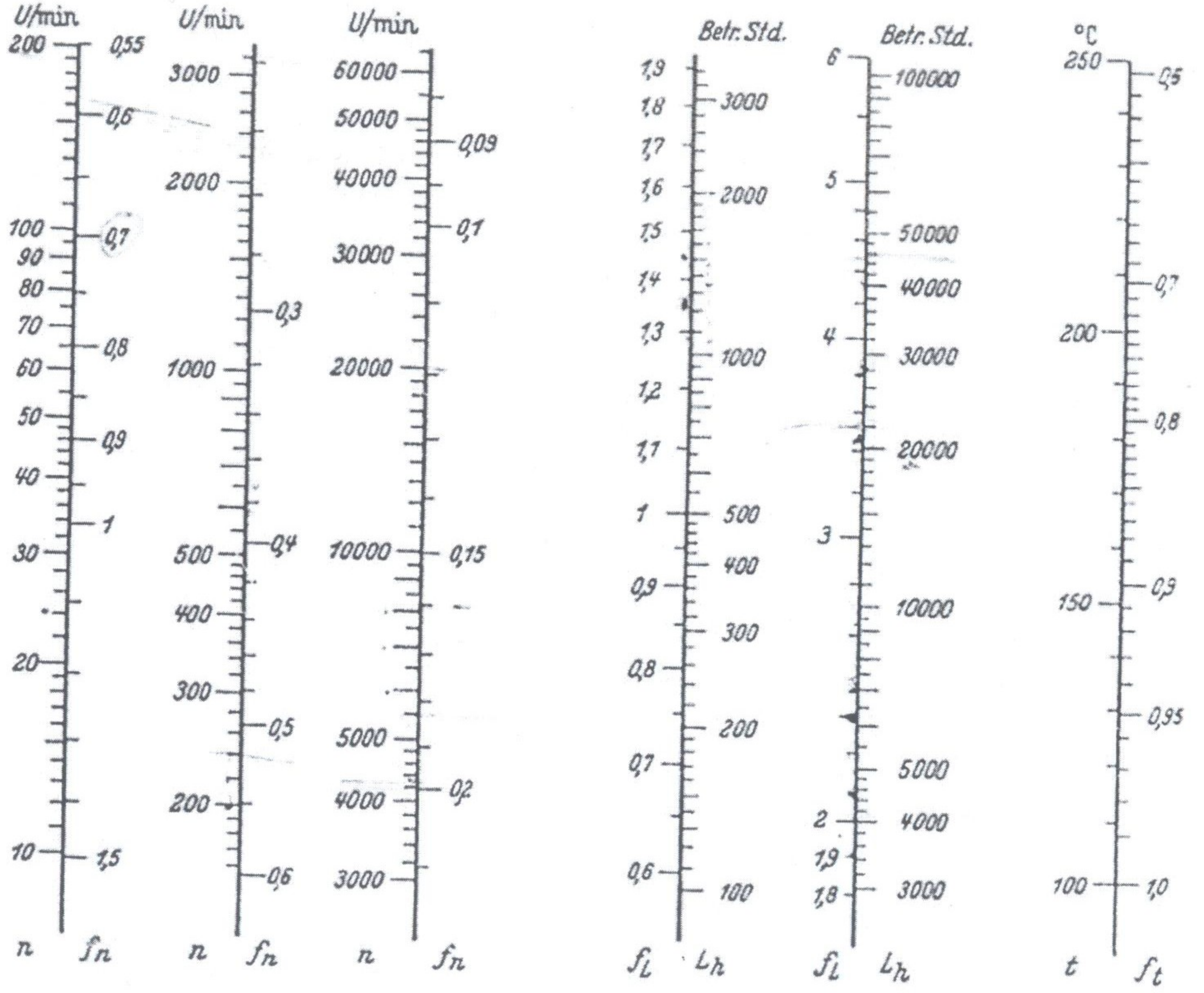


$P = x \cdot P_r + y \cdot P_a$

		Bearing no.	y
$P > P_r$	$x = 0{,}5$ [1]		
$P \leq P_r$	$x = 1$ [1]	30203/04	1,8
$P > 1{,}4\ P_r$	$x = 0{,}7$ [2]	30205/22	1,6
$P \leq 1{,}4\ P_r$	$x = 1{,}4$ [2]	30224/30	1,4

d	D	r	r_1	Symbol	b_i	b_a	B max	B min	C kgf
15	—	—	—	—	—	—	—	—	—
17	40	1,5	0,5	30203	12	11	13,5	13	1 040
20	47			04	14	12	15,5	15	1 600
25	52			05	15	13	16,5	16	1 760
30	62			06	16	14	17,5	17	2 400
35	72	2	0,8	07	17	15	18,5	18	3 100
40	80			08	18	16	20	19,5	3 600
45	85			09	19	16	21	20,5	4 150
50	90			10	20	17	22	21,5	4 550
55	100	2,5		11	21	18	23	22,5	5 600
60	110			12	22	19	24	23,5	6 100
65	120			13	23	20	25	24,5	7 200
70	125			14	24	21	26,5	26	7 800
75	130			15	25	22	27,5	27	8 650
80	140	3	1	16	26	22	28,5	28	9 650
85	150			17	28	24	31	30	11 400
90	160			18	30	26	33	32	12 700
95	170	3,5	1,2	19	32	27	35	34	14 000
100	180			20	34	29	37,5	36,5	16 300
105	190			21	36	30	39,5	38,5	18 300
110	200			22	38	32	41,5	40,5	20 400
120	215			24	40	34	44	43	22 800
130	230	4	1,5	26	40	34	44,5	43	24 500
140	250			28	42	36	46,5	45	28 500
150	270			30	45	38	50	48	32 500

Chart of Life Factor of Bearing



University of Technology
Department of Machines and Equipments Engineering
Final Examination 2011/2012

Subject: Machine Design I — Class: 3rd year
Branch: All — Time: 3Hours
Examiner: Design Group — Date: 21/05/2012

Answer Four Questions Only

Q1: A cargo winch (رافعة حمولة) as shown in **fig.(1)** is driven by a **5 KW** at **200 rpm.** motor through a single reduction spur gearing so that the speed of drum is **80 rpm.**

Assume the following data:

Teeth: AGMA **20°** full depth, Pinion: S_o =**80 MN/m²**, Gear: S_o =**80 MN/m²**&N_p =**20.**

Requirements:

A) What standard module and width of face will satisfy the condition with minimum center distance? Use the Lewis equation. **(10 marks)**

B) If the dynamic load for this pair is computed to be **3.8 KN**, determine whether or not the design is safe from the standpoint of strength. **(4 marks)**

C) Check the design for wear or surface fatigue if the fatigue constant **K =1350. (5 marks)**

D) Draw in detail the dotted area? **(6 marks)**

Q2: Using the data in Question**(1)** and **figure (1)**:

Requirements:

A) Shaft diameter, assuming the following data: **(12 marks)**

Allowable stress for shaft = **240 MPa**

Neglect the radial force on spur gear and only the tangential load on gear for both shaft and bearing.

Assume $F_t = 0.8\ F_{drum}$.

Drum diameter = **200 mm**?

B) Select suitable bearing on shaft and find its life? **(6 marks)**

C) Draw in detail section X-X? **(7 marks)**

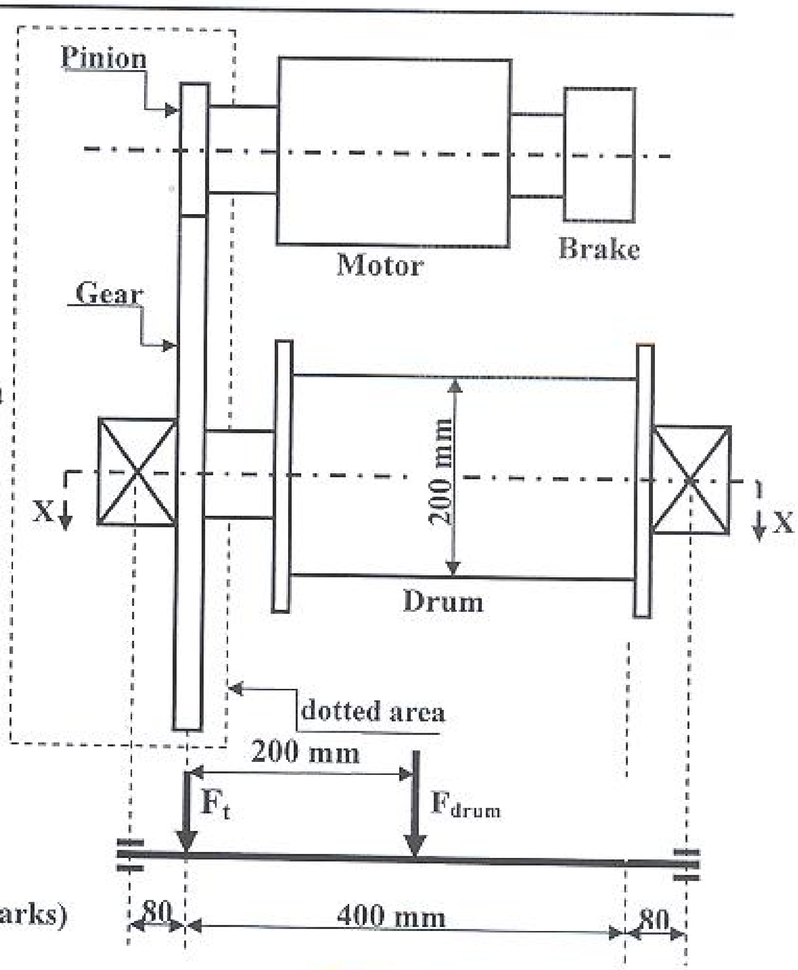


Figure (1)

Q3: The large diameter and face of the disks of **a multiple-disk** clutch are **250 mm** and **25 mm** respectively. The helical compression spring used to engage the clutch has **9.5** effective coils of **10 mm** steel wire, the outer diameter of coils being **80 mm**. The free length of the springs is **180 mm** and when in place with the clutch engaged, its length is **130 mm**. Assuming that there are **10 pairs** of friction surfaces in contact, that the motor run at **1200 rpm**, and the coefficient of friction is **0.15**, **G = 80 KN/m^2**.

Requirements:

A) The axial force produced by the spring? **(12 marks)**

B) The power that the clutch will transmit? **(7 marks)**

C) Draw a section showing how the torque will be transmitted from the input shaft to contact friction surfaces then to the output driven part. (draw free hand sketch showing all details)? **(6 marks)**

Q4: A hydraulic control for a straight-line motion utilizes a spherical pressure tank **A** that is connected to work cylinder **B**, as shown in figure **(2)**. A pump maintains pressure in the tank equal to **3 N/mm^2**.

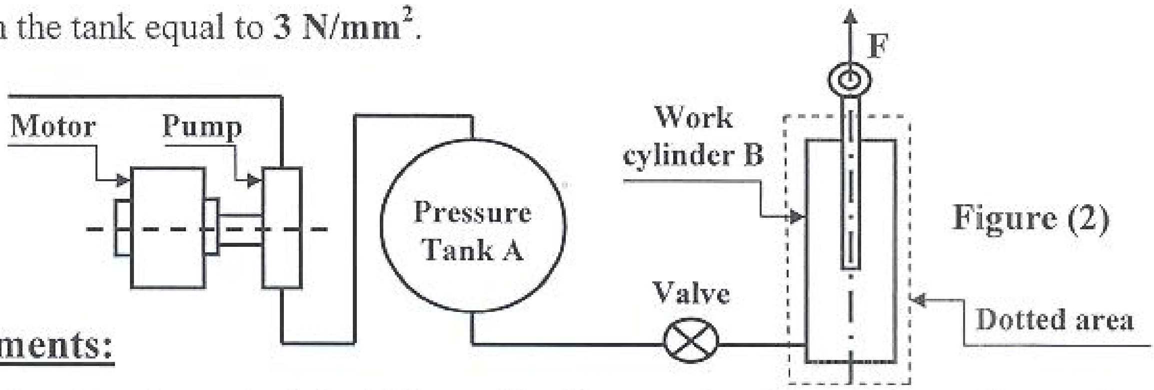


Figure (2)

Requirements:

A) Assuming that the tank **A** is **800 mm** in diameter, having an allowable tensile strength of **50 N/mm^2**, determine the thickness of the plate required for the tank. **(5 marks)**

B) Assuming a pressure drop of **0.25 N/mm^2** between the tank and the cylinder, determine the diameter of piston required to produce an operating force **F** of **22.5 kN**. Assume an allowable for friction in the cylinder and packing equal **10 %** of **F**. **(5 marks)**

C) Determine the thickness of the cylinder wall, assuming that is made of cast iron having an allowable tensile stress of **28 N/mm^2**. **(5 marks)**

D) Determine the power output of the cylinder during a working stroke, assuming the piston stroke is **450 mm** and that **5 second** is required for a work stroke. **(4 marks)**

E) Draw a complete construction of dotted area (draw sectional view in details). **(6 marks)**

Q5: Figure (3) shows the arrangement for a type of linear actuator for landing gear. The screw for such an actuator is to be designed and the motor.

Data:

Maximum force on screw = **11250 N.**

Extension of actuator = **125 mm.**

Time of extension = **6 second.**

Motor speed = **7200 rpm.**

Requirements:

A) Determine the root area of the screw, allowable stress for screw equal to **70 N/mm^2.**

if trapezoidal thread used with $2\Phi = 30^\circ$.

Using a coefficient of thread friction of **0.08** and neglecting collar friction since a ball thrust bearing is used. **(11 marks)**

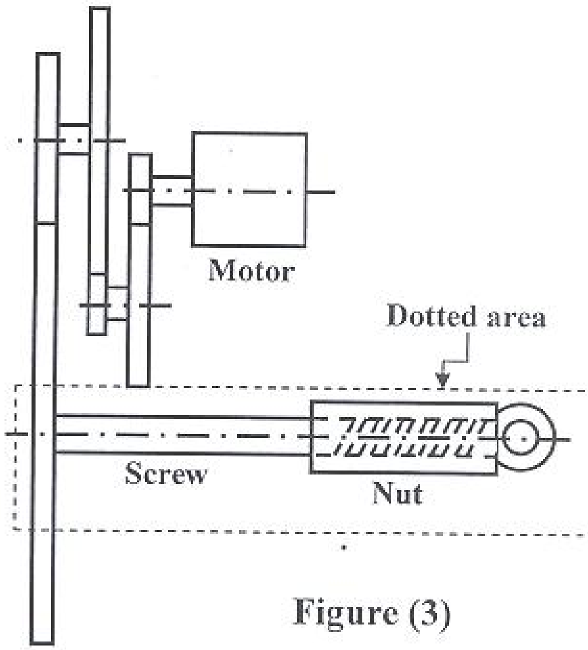


Figure (3)

B) Assuming an overall efficiency for the triple reduction gear between motor and screw such as **94 %**, determine the power of motor required. **(5 marks)**

C) Determine the overall gear ratio from the motor to the screw. **(3 marks)**

D) Draw in detail the sectional view of dotted area (showing screw, nut and part of the larger gear). **(6 marks)**

Assume missing data, Give your opinion about results

Charts, Tables, Figures and necessary laws:

Gear: Lewis Equation $= sbP_c y$, $s = s_o\left(\frac{3}{3+V}\right)$ for V less than 10 m/s

$s = s_o\left(\frac{6}{6+V}\right)$ for V 10 to 20 m/s, $s = s_o\left(\frac{5.6}{5.6+\sqrt{V}}\right)$ for V greater than 20 m/s.

$F_w = d_P \cdot b \cdot k \cdot Q$, $Q = \frac{2N_g}{N_g + N_P}$

Standard modules are: 1, 2, 3, 3.5, 4, 4.5, 5, 5.5, 6, 7, 8, 9, 10.

Table: Form factor **(y)** for use in Lewis strength equation.

Number of Teeth	15	16	17	18	19	20	21	23	25	27	30	34	38	43	50	60	75	100
20°Full depth	0.092	0.094	0.096	0.98	0.100	0.102	0.104	0.106	0.108	0.111	0.114	0.118	0.122	0.126	0.130	0.134	0.138	0.142

Clutch: $T = \mu . F_n . r$

Uniform pressure, $r = \frac{2}{3} \cdot \frac{R_1^3 - R_2^3}{R_1^2 - R_2^2}$, uniform wear, $r = \frac{R_1 + R_2}{2}$

Thin cylinder: $t = \frac{p_i . d_i}{2\sigma_h}$, $t = \frac{p_i . d_i}{4\sigma_L}$

Thick cylinder: Lamie's Equation:

Brittle material , $t = \frac{d_i}{2}\left[\sqrt{\frac{[\sigma]+p_i}{[\sigma]-p_i}} - 1\right]$, Ductile material , $t = \frac{d_i}{2}\left[\sqrt{\frac{[\sigma]}{[\sigma]-2p_i}} - 1\right]$

Table: Trapezoidal threads.

d	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
d_1	6.5	8.5	9.5	11.5	13.5	15.5	16.5	18.5	20.5	22.5	23.5	25.5	27.5	29.5	30.5	32.5	34.5
d_2	8.5	10.5	12	14	16	18	19.5	21.5	23.5	25.5	27	29	31	33	34.5	36.5	38.5
h	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7
d	44	46	48	50	52	55	58	60	62	66	68	70	72	75	78	80	82
d_1	36.5	37.5	39.5	41.5	43.5	45.5	48.5	50.5	52.5	54.5	57.5	59.5	61.5	64.5	67.5	69.5	71.5
d_2	40.5	42	44	46	48	50.5	53.5	55.5	57.5	60	63	65	67	70	73	75	77
h	7	8	8	8	8	9	9	9	9	10	10	10	10	10	10	10	10

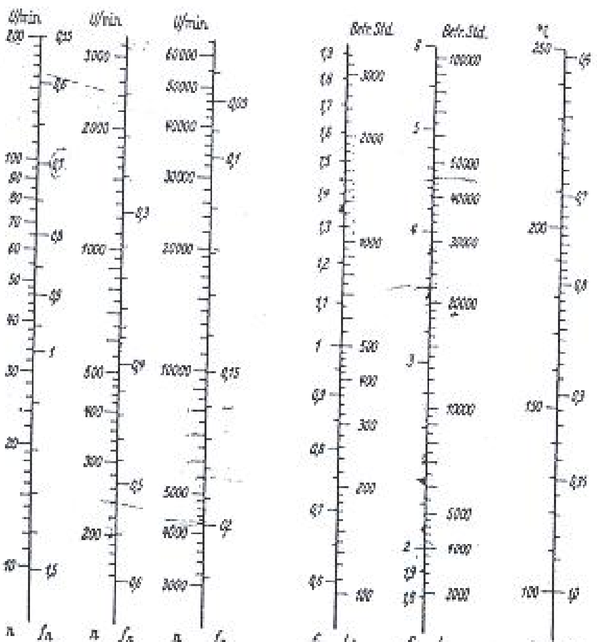
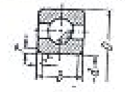


Fig. 14/7. Nomograms for coefficients for f_n, f_L, f_t as a function of speed of rotation n (rpm), of life L_h in service hours and of bearing temperature t (°C). For $t \leq 100$ °C, $f_t = 1$.
U/min = rpm; Betr. Std. = operational hours.

All dimensions are in mm

C = basic load rating

DIN 625 (Aug. 1942)

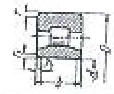


$P = x \cdot P_r + y \cdot P_a$

$x = 1$ $x = 1,4$

$C : P_a$	5	10	20	40
y	1,4	1,6	1,8	2,0

* DIN 5412 (Aug. 1942)



$P = x \cdot P_r$

$x = 1$
$r = 1,4$
$y = 0$

d	D	r	Symbol	b	C kgf	Symbol	b	r_1	C kgf
3	10	0,5	EL 3	4	40	—	—	—	—
4	13		4	5	80	—	—	—	—
5	16		5	5	140	—	—	—	—
6	19		6	6	216	—	—	—	—
7	19		7	6	156	—	—	—	—
8	22		8	7	240	—	—	—	—
9	24		9	7	260	—	—	—	—
10	26		6000x	8	340	—	—	—	—
12	28		01x	8	375	—	—	—	—
15	32		02x	9	405	—	—	—	—
17	35		03x	10	430	—	—	—	—
20	42	1	04x	12	695	—	—	—	—
25	47		05x	12	750	NUE 25	12	0,5	830
30	55	1,5	06x	13	1 000	30	13	0,8	1 100
35	62		07x	14	1 200	35	14		1 340
40	68		08x	15	1 270	40	15	1	1 560
45	75		09x	16	1 630	45	16		1 800
50	80		10x	16	1 700	50	16		2 000
55	90	2	11x	18	2 200	55	18	1,5	2 280
60	95		12x	18	2 280	60	18		2 360
65	100	2	13x	18	2 400	65	18	1,5	2 450
70	110		14x	20	3 000	70	20		3 550
75	115		15x	20	3 150	75	20		3 650
80	125		16x	22	3 750	80	22		4 600
85	130		17x	22	3 900	85	22		4 900
90	140	2,5	18x	24	4 550	90	24	2	5 500
95	145		19x	24	4 800	95	24		5 600
100	150		20x	24	4 800	100	24		5 850
105	160	3	21x	26	5 700	105	26		6 800
110	170		22x	28	6 400	110	28		8 500
120	180		24x	28	6 700	120	28		9 150
130	200		26x	33	8 300	130	33		11 200
140	210		28x	33	8 650	140	33		12 000
150	225	3,5	30x	35	9 800	150	35	2,5	13 400
160	240		32x	38	11 000	160	38		16 300
170	260		34x	42	12 900	170	42	3,5	19 600
180	280		36x	46	14 600	180	46		24 500
190	290		38x	46	15 600	190	46		25 500
200	310		40x	51	17 600	200	51		28 000
220	340	4	44x	56	20 000	220	56	4	36 500
240	360		48x	56	21 200	240	56		39 400
260	400	5	52x	65	24 500	260	65	5	48 000
280	420		56x	65	25 500	280	65		51 000
300	460		60x	74	30 500	300	74		67 000
320	480		64x	74	32 000	320	74		68 000
340	520	6	68x	82	38 000	340	82	6	83 000
360	540		72x	82	40 000	360	82		86 500
380	560		76x	82	40 000	380	82		88 000
400	600		80x	90	45 000	400	90		110 000

Answer **Three** Questions Only

Assume missing data, Give your opinion about results

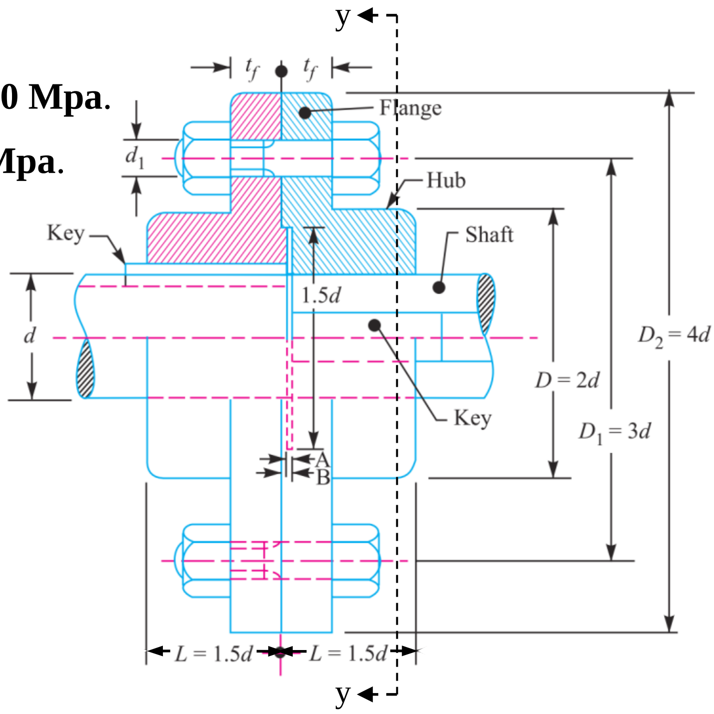
Q1: The figure shows a flange coupling to transmit torque from one shaft to another.

Data:

Shear stress for shaft, bolt, key& Flange = **40 Mpa**.

Bearing stress between any two parts = **80 Mpa**.

The torque transmitted = **250 N.m**.



Requirements:

1) Find shaft diameter **(d)**.
2) Find bolt diameter **(d_1)**.
3) Find thickness of flange **(t_f)**.
4) Find Dimensions of the **key**.
5) Draw section **y-y** showing all details.

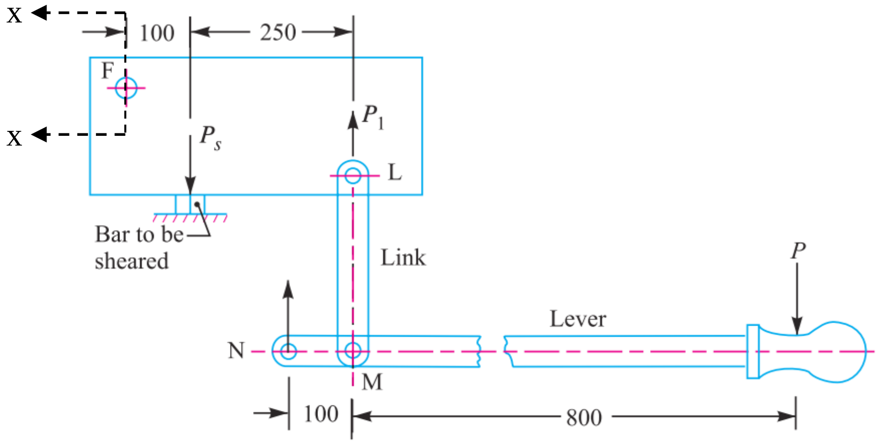
Note:

Size of diameter (d)	**up to 40 mm**	**up to 100 mm**	**up to 180 mm**
Number of bolts	**3**	**4**	**6**

Q2: A bench shearing machine as shown in figure is used to shear a mild steel bars of **(5 mm x 3 mm)**. **The ultimate shearing strength** of the mild steel is **400 Mpa**. The permissible tensile stress for pins, links and lever is **80 Mpa**. The allowable bearing pressure between any two parts may be taken as **20 N/mm^2**.

Requirements: Design the pins at (**L, M and N**) and draw section **(x-x).**

Note: Neglect the horizontal forces on each part in the system.



All dimensions in mm.

Q3: Join the two main plate shown in figure below: (**answer both branches**)

A) By using the welding, find the width **(b)** if you weld:

i) The main plates directly **(butt join)**.

ii) The main plates with two cover plates **(fillet join)**.

Draw the section of front view to see the weld connection in the two cases.

B) By using rivets:

Find the suitable number of rivets by using shearing or bearing stresses if the **dia. of rivet = 25mm**. Then use the number of rivets you found to find the suitable width of plates **(b)**, and draw the top view to show the orientation of the rivets.

Note: put the rivets onto the plates as you seen it advisable.

Data: $\upsilon = 1$

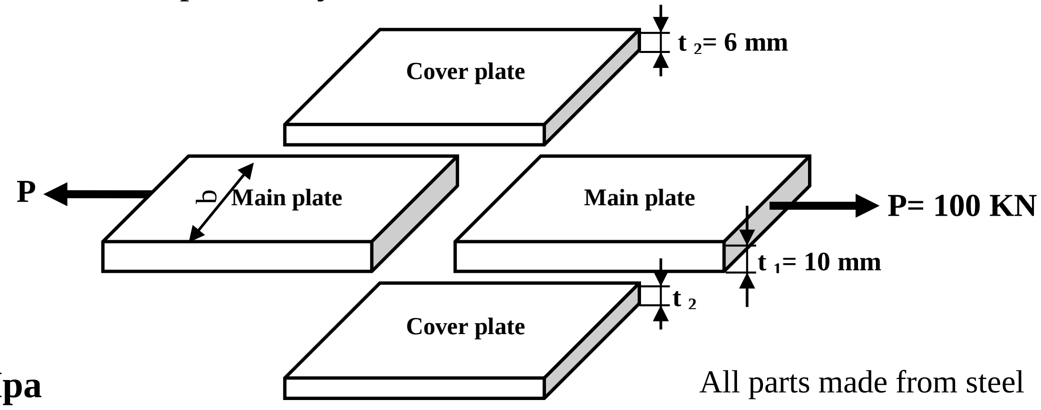
$\upsilon_{2)fillet} = 0.65$

$\upsilon_{2)butt} = 0.75$

$\tau_{all} = 34$ **Mpa**

$\sigma_{all} = 68$ **Mpa**

$\sigma_{bearing} = 80$ **Mpa**



Q4: The figure below shows run wheel on a rope to transport material from mountain stations. The run wheel supported by two tapered roller bearings, at point **A & B**; which are supported between **axle** and **run wheel**.

Data:

Distance between the two tapered roller bearings = **95 mm**.

Diameter of the run wheel = **250 mm**.

Radial load on the run wheel (P_r) = **8000 N**.

Axial load on the run wheel (P_a) = **1600 N**.

Speed of run wheel = **270 rpm**.

Requirements:

1) Find R_A and R_B.

2) Find life of taper **bearing A** and **B**.

3) Draw the dotted area showing all details a specially how you fixing the outer and inner races of the taper bearings.

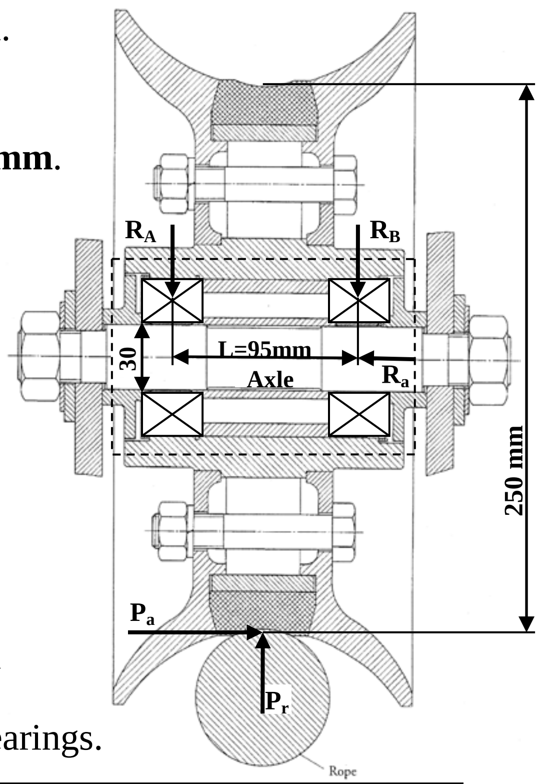
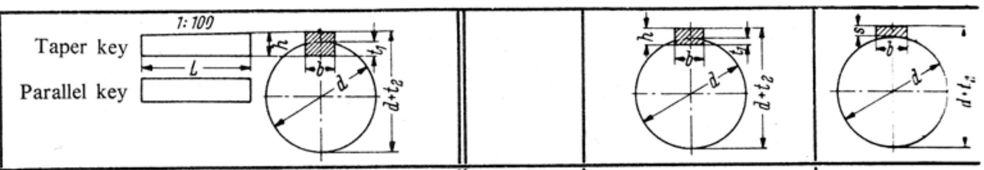


Table of Keys

Table 18/6. Dimensions of parallel and taper keys and key ways (mm) according to DIN



Shaft d from	Shaft d to	For parallel keys according to DIN 6885 (Feb 1956) and taper keys according to DIN 6886 (Feb. 1956) b	h*		t_2*		t_1*		Shaft d from	Shaft d to	For flat keys according to DIN 6883 (Feb. 1956) $b \cdot h$	t_1	t_2	For saddle keys according to DIN 6881 (Feb. 1956) $b \cdot s$	t_1
10	12	4	4	4	1,7	1,7	2,4	2,4							
12	17	5	5	3	2,2	1,2	2,9	1,9							
17	22	6	6	4	2,6	1,6	3,5	2,5							
22	30	8	7	5	3,0	2,0	4,1	3,1	22	30	8 · 5	1,3	3,2	8 · 3,5	3,2
30	38	10	8	6	3,4	2,4	4,7	3,7	30	38	10 · 6	1,8	3,7	10 · 4,0	3,7
38	44	12	8	6	3,2	2,2	4,9	3,9	38	44	12 · 6	1,8	3,7	12 · 4,0	3,7
44	50	14	9	6	3,6	2,1	5,5	4,0	44	50	14 · 6	1,4	4,0	14 · 4,5	4,0
50	58	16	10	7	3,9	2,4	6,2	4,7	50	58	16 · 7	1,9	4,5	16 · 5,0	4,5
58	65	18	11	7	4,3	2,3	6,8	4,8	58	65	18 · 7	1,9	4,5	18 · 5,0	4,5
65	75	20	12	8	4,7	2,7	7,4	5,4	65	75	20 · 8	1,9	5,5	20 · 6,0	5,5
75	85	22	14	9	5,6	3,1	8,5	6,0	75	85	22 · 9	1,8	6,5	22 · 7,0	6,5
85	95	25	14	9	5,4	2,9	8,7	6,2	85	95	25 · 9	1,9	6,4	25 · 7,0	6,4
95	110	28	16	10	6,2	3,2	9,9	6,9	95	110	28 · 10	2,4	6,9	28 · 7,5	6,9
110	130	32	18	11	7,1	3,5	11,1	7,6	110	130	32 · 11	2,3	7,9	32 · 8,5	7,9
130	150	36	20	12	7,9	3,8	12,3	8,3	130	150	36 · 12	2,8	8,4	36 · 9,0	8,4
150	170	40	22	14	8,7	4,6	13,5	9,5	150	170	40 · 14	4,0	9,1	—	—
170	200	45	25	16	9,9	5,3	15,3	10,8	170	200	45 · 16	4,7	10,4	—	—

*The first column of h, t_1 and t_2 is for taper keys and parallel keys.
The second column of h, t_1 and t_2 is for weaker parallel keys.

Chart of Life Factor of Bearing

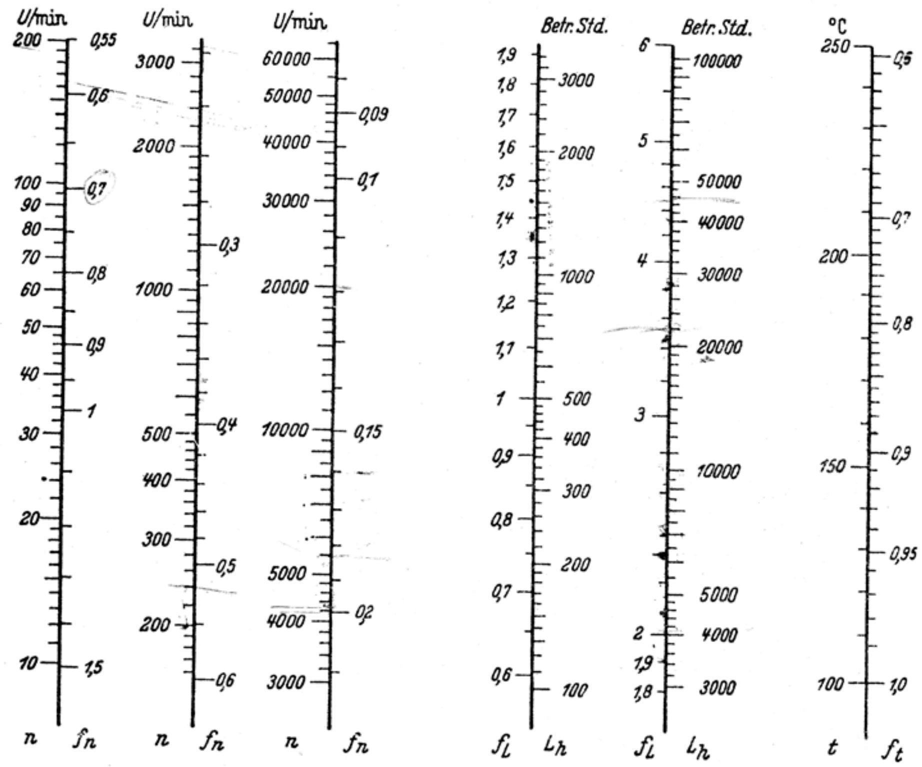
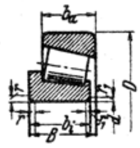
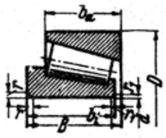


Fig. 14/7. Nomograms for coefficients for f_n, f_L, f_t as a function of speed of rotation n (rpm), of life L_h in service hours and of bearing temperature t (°C). For $t \leq 100$ °C, $f_t = 1$.
U/min = rpm; Betr. Std. = operational hours.

Turn the page

Table of Taper Roller Bearings

Dimension group 2 (light series)

All dimensions are in mm C = basic load rating	Taper roller bearing DIN 720 (Aug 1942)	Taper roller bearing DIN 720 (Aug. 1942)
		
	$P = x \cdot P_r + y \cdot P_a$	$P = x \cdot P_r + y \cdot P_a$

		Bearing no.	y
$P > P_r$	$x = 0{,}5$ [1]		
$P \leq P_r$	$x = 1$ [1]	30203/04	1,8
$P > 1{,}4\, P_r$	$x = 0{,}7$ [2]	30205/22	1,6
$P \leq 1{,}4\, P_r$	$x = 1{,}4$ [2]	30224/30	1,4

$P > P_r$	$x = 0{,}5$ [1]	$y = 1{,}6$
$P \leq P_r$	$x = 1$ [1]	
$P > 1{,}4\, P_r$	$x = 0{,}7$ [2]	
$P \leq 1{,}4\, P_r$	$x = 1{,}4$ [2]	

d	D	r	r_1	Symbol	b_i	b_a	B max	B min	C kgf	Symbol	b_i	b_a	B max	B min	C kgf
15	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
17	40	1,5	0,5	30203	12	11	13,5	13	1 040	—	—	—	—	—	—
20	47			04	14	12	15,5	15	1 600	—	—	—	—	—	—
25	52			05	15	13	16,5	16	1 760	—	—	—	—	—	—
30	62			06	16	14	17,5	17	2 400	32206	20	17	21,5	21	3 250
35	72	2	0,8	07	17	15	18,5	18	3 100	07	23	19	24,5	24	4 300
40	80			08	18	16	20	19,5	3 600	08	23	19	25	24,5	4 800
45	85			09	19	16	21	20,5	4 150	09	23	19	25	24,5	5 200
50	90			10	20	17	22	21,5	4 550	10	23	19	25	24,5	5 300
55	100	2,5		11	21	18	23	22,5	5 600	11	25	21	27	26,5	6 950
60	110			12	22	19	24	23,5	6 100	12	28	24	30	29,5	8 300
65	120			13	23	20	25	24,5	7 200	13	31	27	33	32,5	10 000
70	125			14	24	21	26,5	26	7 800	14	31	27	33,5	33	10 200
75	130			15	25	22	27,5	27	8 650	15	31	27	33,5	33	10 800
80	140	3	1	16	26	22	28,5	28	9 650	16	33	28	35,5	35	12 500
85	150			17	28	24	31	30	11 400	17	36	30	39	38	14 300
90	160			18	30	26	33	32	12 700	18	40	34	43	42	17 300
95	170	3,5	1,2	19	32	27	35	34	14 000	19	43	37	46	45	19 600
100	180			20	34	29	37,5	36,5	16 300	20	46	39	49,5	48,5	22 000
105	190			21	36	30	39,5	38,5	18 300	21	50	43	53,5	52,5	25 500
110	200			22	38	32	41,5	40,5	20 400	22	53	46	56,5	55,5	28 500
120	215			24	40	34	44	43	22 800	24	58	50	62	61	34 000
130	230	4	1,5	26	40	34	44,5	43	24 500	—	—	—	—	—	—
140	250			28	42	36	46,5	45	28 500	—	—	—	—	—	—
150	270			30	45	38	50	48	32 500	—	—	—	—	—	—

[1] Is applicable for peripheral load for the inner race. If hereby with $x = 0.5$, $P < P_r$, then instead of $x = 0.5$ the value $x = 1$, $y = 0$ should be used.

[2] Is applicable for the point load for inner race. If hereby $x = 0.7$, $P < 1.4\, P_r$, then instead of $x = 0.7$ the value $x = 1.4$ and $y = 0$ should be used.

With best wishes in success^^^^^^^Design Group

Answer **Three** Questions Only

Q1: Figure (1) shows how the torque transmitted from spur gears to the chain. Torque transmitted through pinion **(F) = 100 N.m**, Rotational speed of pinion **(F) = 950 rpm**. Maximum torsional stress for shaft **(EG)**, τ_{max} **= 30 Mpa**, **Φ** = pressure angle **20°** full depth, S_o for pinion **(F) = 140 MN/m²**, S_o for gear **(C) = 55 MN/m²**.

Assume capacity of bearing **(E)** and **(G), C = 10000 N**, $f_n = f_t = x = 1$.

A) Choose **One** branch only:

1) Find the diameter of shaft **(EG)** and find the life factor for bearing **(E)** or **(G)?** **(12 marks)**

2) Find proper **module**, proper **number of teeth** and **face width** of spur gears for strength only (Note: no less than **15 teeth** are to be used on either gears)? **(12 marks)**

B) Draw **section** for shaft **EG**, spur gear **F** and **bearings** showing how you are **fixing** all parts in detail. **(5 marks)**

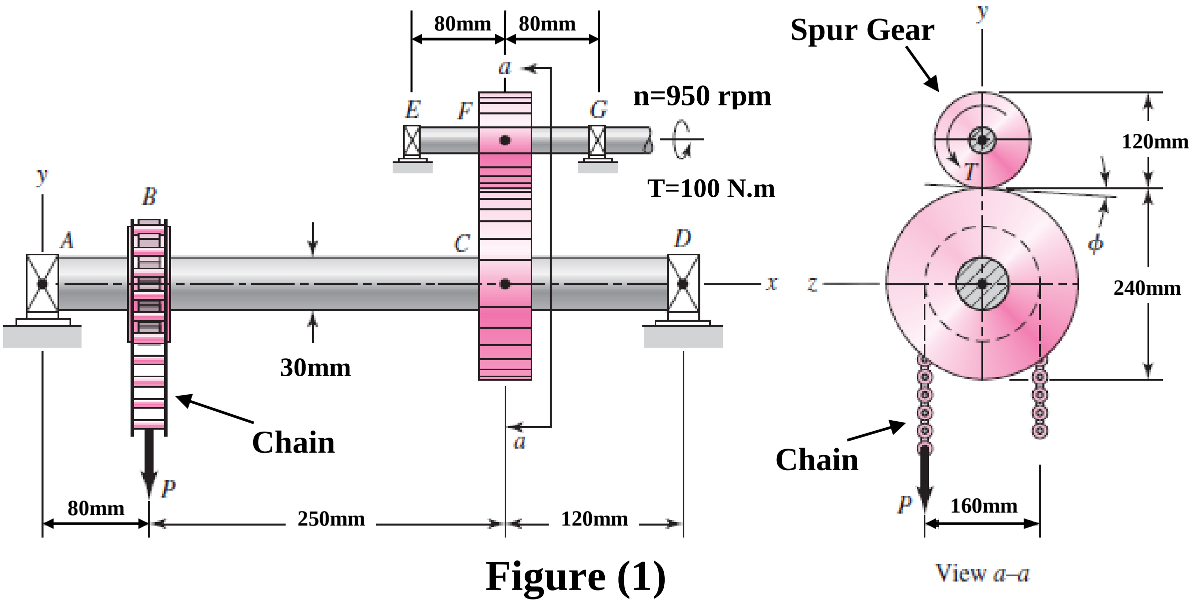


Figure (1)

Standard modules are: 1,2,3,3.5,4,4.5,5,5.5,6,7,8,9,10.

Number of Teeth	15	16	17	18	19	20	21	23	25	27	30	34	38	43	50	60	75	100
20°Full depth	0.092	0.094	0.096	0.98	0.100	0.102	0.104	0.106	0.108	0.111	0.114	0.118	0.122	0.126	0.130	0.134	0.138	0.142

<u>Q2:</u> Figure (2) shows flexible coupling and **Figure (3)** shows the driving and driven discs.

Number of driving discs **= 3**, Number of driven discs **= 2**

Power transmitted = **35 KW**, Speed = **1000 rpm**

Outer rad. of disc plate **= 260 mm**, Inner rad. of disc plate **= 150 mm**

Number of springs **= 6** , Spring index **C = 6**

Permissible uniform pressure on lining material = **0.07 N/mm^2**

Coefficient of friction of lining material **= 0.15**

Stress concentration factor in spring = $\frac{4C-1}{4C-4} + \frac{0.615}{C}$

Permissible stress in spring steel **= 420 Mpa**

Modulus of rigidity of spring steel **= 84 KN/mm^2**

Compression of spring to keep it engaged **= 12.5 mm**

Requirements:

1. Find spring Diameter? **(9 marks)**
2. Find number of active coils? **(3 marks)**
3. Draw section x-x? **(5 marks)**

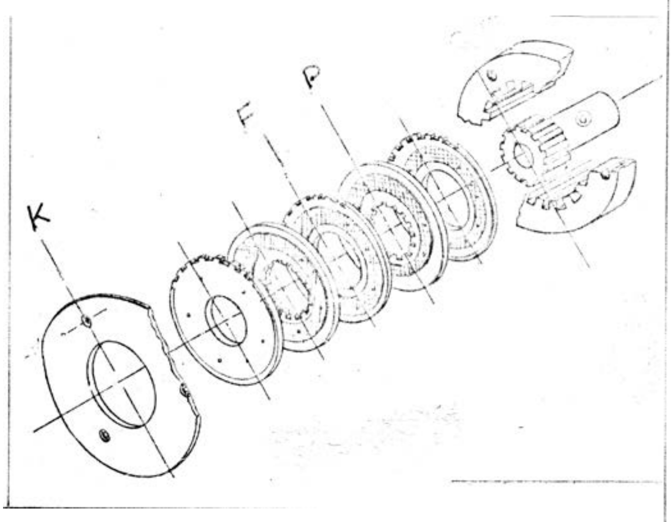


Figure (3)

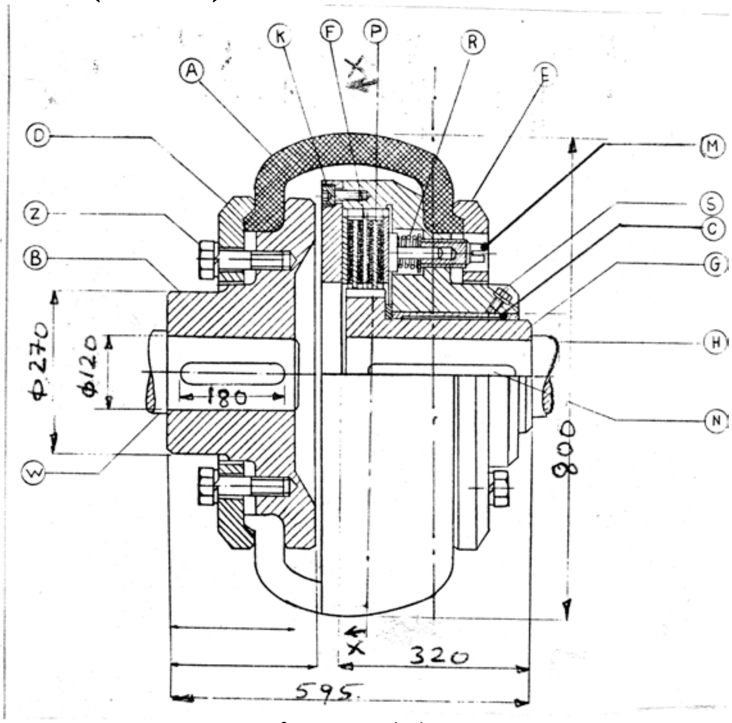


Figure (2)

<u>Q3:</u> A vertical **square** threads screw of a **70 mm** mean diameter and **10 mm** pitch supports a vertical load of **50 kN**. It passes through the boss of a spur gear wheel of **70 teeth** which acts as a nut. In order to raise the load, the spur gear wheel is turned by means of a pinion having **20 teeth**. The mechanical efficiency of pinion and gear wheel drive is **90%**. The axial thrust on the screw is taken up by a collar bearing having a mean radius of **100 mm**. the coefficient of friction for the screw and nut is **0.15** and that for collar bearing is **0.12**.

Requirements:

1) Torque to be applied to the pinion shafts? **(6 marks)**
2) Maximum shear stress in the screw? **(3 marks)**
3) Height of nut, if bearing pressure is limited to **12 N/mm^2**? **(3 marks)**
4) Draw a complete construction of whole system? **(5 marks)**

<u>Q4:</u> A steam engine of effective diameter **300 mm** is subjected to a steam pressure of **1.5 N/mm^2**. The cylinder head is connected by **8 bolts** having a yield point **330 Mpa** and endurance limit at **240 Mpa**. The bolts are tightened with an initial load of **1.5 times** the steam load. A soft copper gasket is used between cover and cylinder. Assuming factor of safety is **2** and equivalent stiffness **K = 0.5**.

Requirements:

1) Find the size of bolt? **(9 marks)**
2) Find the thickness of cylinder. **(3 marks)**
3) Draw a section of the whole system, showing all parts, i.e. cylinder, cover, bolts, and static seals? **(5 marks)**

Gear: Lewis Equation = $sbP_c y$

$s = s_o\left(\frac{3}{3+V}\right)$ for **V** less than **10 m/s**

$s = s_o\left(\frac{6}{6+V}\right)$ for **V 10 to 20 m/s**

$s = s_o\left(\frac{5.6}{5.6+\sqrt{V}}\right)$ for **V** greater than **20 m/s**

Clutch: $T = \mu.F_n.r$

Uniform pressure, $r = \frac{2}{3}.\frac{R_1^3-R_2^3}{R_1^2-R_2^2}$, uniform wear, $r = \frac{R_1+R_2}{2}$

Thin cylinder: $t = \frac{p_i.d_i}{2\sigma_h}$, $t = \frac{p_i.d_i}{4\sigma_L}$

Thick cylinder: Lamie's Equation:

Brittle material , $t = \frac{d_i}{2}\left[\sqrt{\frac{[\sigma]+p_i}{[\sigma]-p_i}} - 1\right]$,

Ductile material , $t = \frac{d_i}{2}\left[\sqrt{\frac{[\sigma]}{[\sigma]-2p_i}} - 1\right]$

Spring: Stiffness of spring = $\frac{G.d}{8.C^3.Z}$, shear stress of spring = $K.\frac{8.P.C}{\pi.d^2}$

Soderberg and Goodman equations:

$\sigma_a = \frac{\sigma_\omega}{n}\left[1 - \frac{\sigma_m}{\sigma_F/n}\right]$, $\sigma_a = \frac{\sigma_\omega}{N}\left[1 - \frac{\sigma_m}{\sigma_B/N}\right]$

Assume missing data, Give your opinion about results

With best wishes in success

Design Group

Answer **Three** Questions Only

Q1: A flange type coupling required to transmit 50 KW at 2000 rpm. Find:

a) Shaft diameter if the driving shaft is hollow with (d_1/d_o= 0.6), and driven shaft is solid. Take τ= 100 Mpa.

b) Diameter of bolts, if the coupling uses four bolts. Assume pitch circle diameter as about 3 times the outside diameter of the hollow shaft.
Take $\sigma_t = \sigma_c$ = 70 Mpa. And τ= 25 Mpa.

c) Thickness of the flange and diameter of the hub.

d) Make a neat free hand sketch of the section of assembled coupling

---

Q2: A portable conveyor is to be raised and lowered by means of the double-screw arrangement shown in figure (1), the two screws rotates by using chain and bevel gears. And the frame E moved and down against a load of 8000 N.

Data: Load W = 8000 N, σ_{all} = 50 N/mm^2 , $\sigma_{bearing}$ = 10 N/mm^2.

Mean diameter of collar = outside diameter of power screw.

Coefficient of friction between any two contact parts = 0.15

Gear ratio for bevel gear = 2

Load on lever that rotate the bevel gear = 80 N

Type of thread = trapezoidal thread

Requirements:

1) Diameter of power screw.

2) Length L.

3) Draw in detail the dotted area.

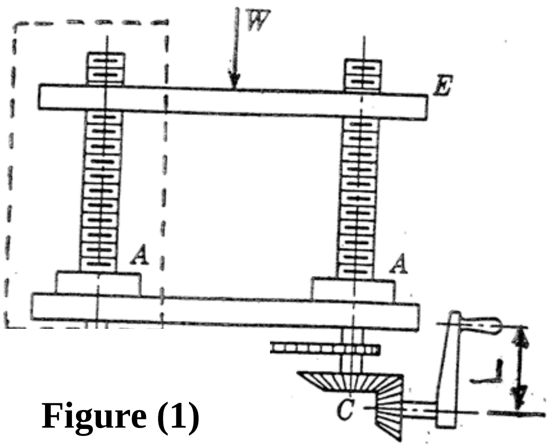


Figure (1)

d	10	12	14	16	18	20	22	24	26	28	30	32	34	36	38	40	42
d_1	6.5	8.5	9.5	11.5	13.5	15.5	16.5	18.5	20.5	22.5	23.5	25.5	27.5	29.5	30.5	32.5	34.5
d_2	8.5	10.5	12	14	16	18	19.5	21.5	23.5	25.5	27	29	31	33	34.5	36.5	38.5
h	3	3	4	4	4	4	5	5	5	5	6	6	6	6	7	7	7
d	44	46	48	50	52	55	58	60	62	66	68	70	72	75	78	80	82
d_1	36.5	37.5	39.5	41.5	43.5	45.5	48.5	50.5	52.5	54.5	57.5	59.5	61.5	64.5	67.5	69.5	71.5
d_2	40.5	42	44	46	48	50.5	53.5	55.5	57.5	60	63	65	67	70	73	75	77
h	7	8	8	8	8	9	9	9	9	10	10	10	10	10	10	10	10

Q3: The figure (2) below shows the layout of gear box with double reduction spur gear, the free body diagram for the forces on gears and bearings are shown below:

Data:

Shaft AB rotates at 1200 rpm.

Shaft CD rotates at 240 rpm.

Shaft of EF rotates at 80 rpm.

Modulus for gear 1 and 2 equal 6.25 mm.

Modulus for gear 4 and 4 equal 10 mm.

Permissible shear stress for shaft and key material = 33 Mpa.

Permissible bearing stress between gear and key = 60 Mpa.

Requirements:

1) Find diameter of shaft AB.
2) Choose suitable bearing and find life of bearing B.
3) Make a neat free hand sketch of shaft AB showing fixation of bearing on shaft and how you fixed the gear 1 on the shaft AB.

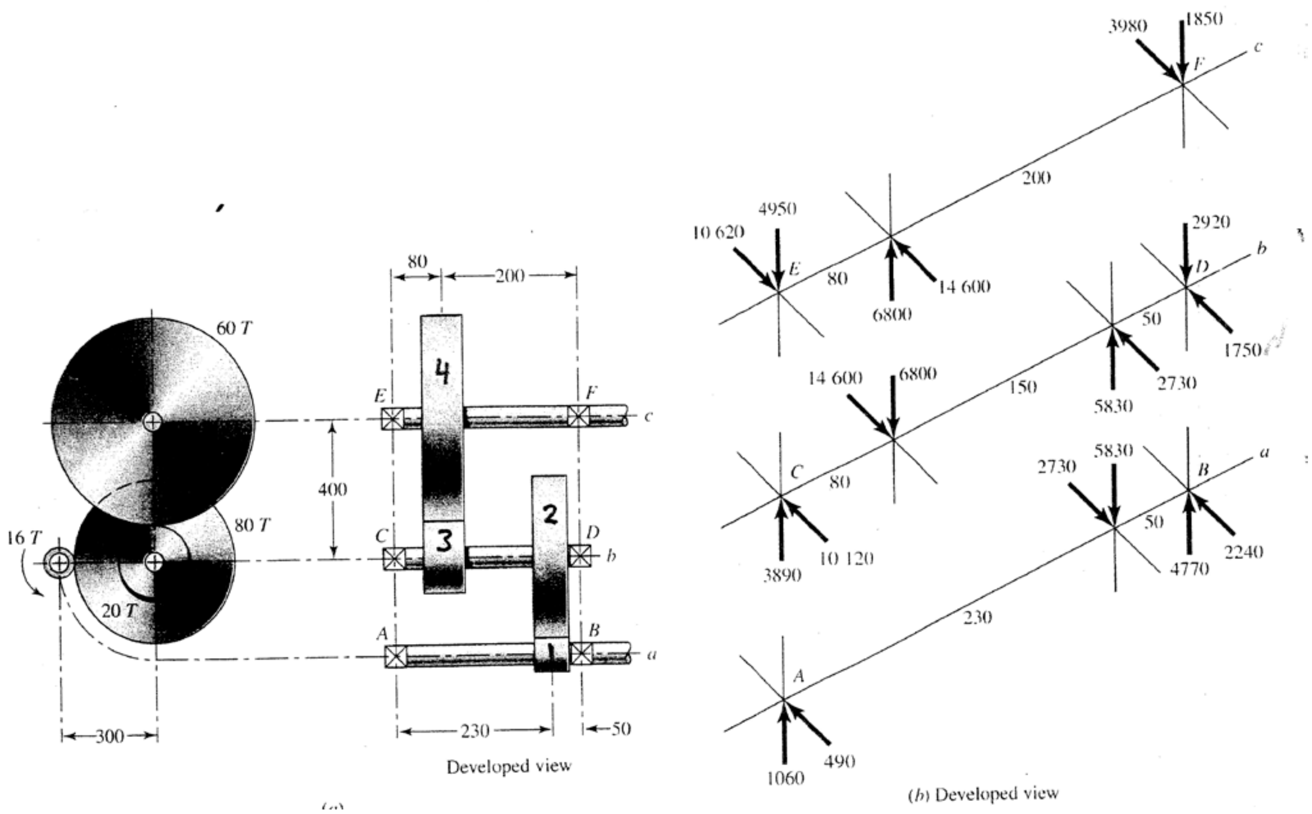


Figure (2)

Q4: The figure (3) shows a hydraulic cylinder with following data:

Data:

Material of cylinder (body no.1) and cover (no.17) = GG14

σ_b for cylinder = 140 N/mm^2.

The load on the piston (plunger or ram no.2) varies from (0 to 100 kN).

Endurance strength σ_w for piston rod and bolts = 85 N/mm^2.

Material for piston rod and bolts = 37.11 of σ_F = 210 N/mm^2.

No. of bolts (part no.4) = 6 with root area 31.9 mm^2.

Initial tension on bolt = external load on parts.

Stiffness of bolt = 3 times of stiffness parts.

Requirements:

1) Find the pressure inside cylinder.
2) Find the safety factor of piston rod using Soderbery line.
3) Find the safety factor of bolt no.4 and show the location of this point on Goodman line. Give your opinion of this factor.
4) Draw section X_X

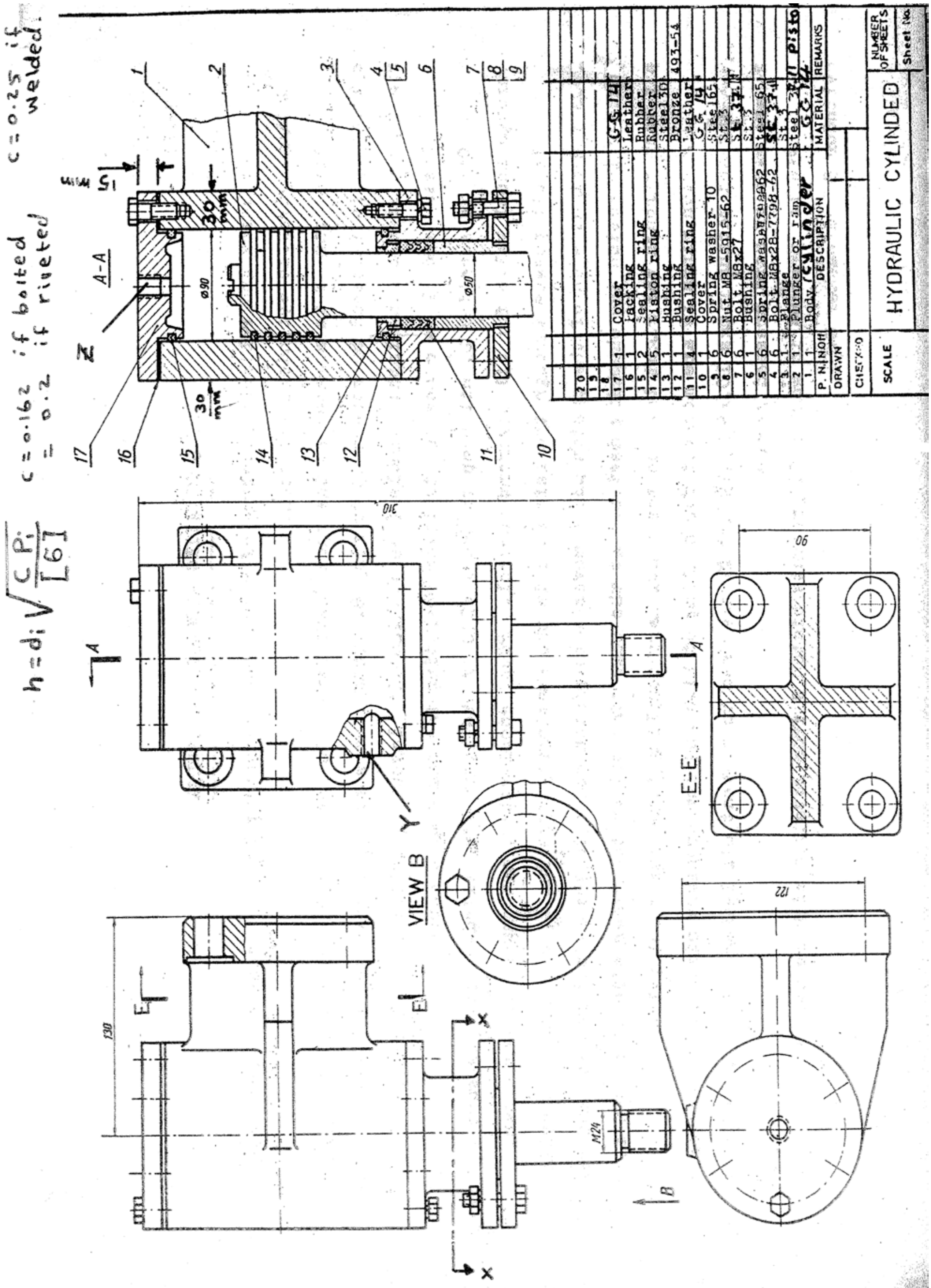
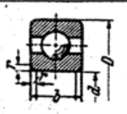
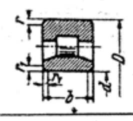
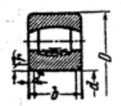
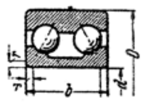

HYDRAULIC CYLINDED
VIEW B
E-E
A-A
c = 0.25 if welded.
c = 0.162 if bolted
= 0.2 if riveted

Figure (3)

Table 14/5. Radial bearings. Dimension group 0 (very light series)

All dimensions are in mm			Deep-groove ball bearing DIN 625 (Aug. 1942)			Cylindrical roller bearing DIN 5412 (Aug. 1942)			
									
C = basic load rating			$P=(x\cdot P_r+y\cdot P_a)K_S$			$P=x\cdot P_r$			
			$x=1$ $x=1,4$[1]			$x=1$[1] $x=1,4$ $y=0$			
			$C:P_a$ 5 / 10 / 20 / 40						
			y 1,4 / 1,6 / 1,8 / 2,0						
d	D	r	Symbol	b	C kgf	Symbol	b	r_1	C kgf
3	10	0,5	EL 3	4	40	—	—	—	—
4	13		4 [2]	5	80	—	—	—	—
5	16		5	5	140	—	—	—	—
6	19		6	6	216	—	—	—	—
7	19		7	6	156	—	—	—	—
8	22		8	7	240	—	—	—	—
9	24		9	7	260	—	—	—	—
10	26		6000x	8	340	—	—	—	—
12	28		01x	8	375	—	—	—	—
15	32		02x	9	405	—	—	—	—
17	35		03x	10	430	—	—	—	—
20	42	1	04x	12	695	—	—	—	—
25	47		05x	12	750	NUE 25	12	0,5	830
30	55	1,5	06x	13	1 000	30	13	0,8	1 100
35	62		07x	14	1 200	35	14		1 340
40	68		08x	15	1 270	40	15	1	1 560
45	75		09x	16	1 630	45	16		1 860
50	80		10x	16	1 700	50	16		2 000
55	90	2	11x	18	2 200	55	18	1,5	2 280
60	95		12x	18	2 280	60	18		2 360
65	100	2	13x	18	2 400	65	18	1,5	2 450
70	110		14x	20	3 000	70	20		3 550

	Self-aligning bearing DIN 635 (Aug. 1942)			Angular-contact bearing DIN 628 (Aug. 1942)		
						
	$P=(x\cdot P_r+y\cdot P_a)K_S$			$P=(x\cdot P_r+y\cdot P_a)K_S$		
	$x=1$[1] $x=1,4$ $y=9,5$			$x=1$[1] $x=1,4$ $y=1,3$		
d	Symbol	b	C kgf	Symbol	b	C kgf
—	—	—	—	—	—	—
—	—	—	—	—	—	—
—	—	—	—	3302x	19,0	1 370
—	—	—	—	03x	22,2	1 860
20	20304	15	1 600	04x	22,2	1 860
25	05	17	2 160	05x	25,4	2 600
30	06	19	3 000	06x	30,2	3 450
35	07	21	3 650	07x	34,9	4 300
40	08	23	5 000	08x	36,5	5 500
45	09	25	5 600	09x	39,7	6 550
50	10	27	7 100	10x	44,4	8 000
55	11	29	8 150	11x	49,2	8 650
60	12	31	10 000	12x	54,0	10 000
65	13	33	11 600	13x	58,7	11 400
70	14	35	12 900	14x	63,5	13 200

If d > 70
take d = 70

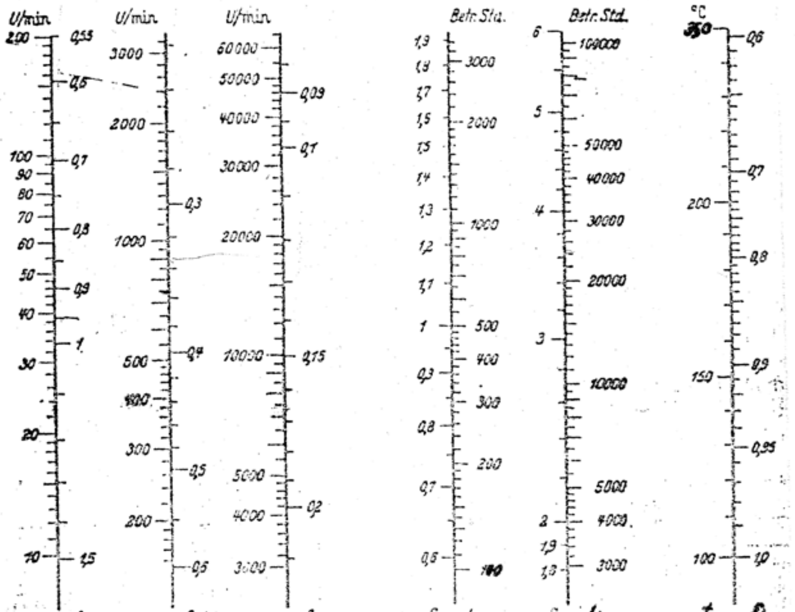


Fig. (1-2) Nomograms for coefficients for f_n, f_L, f_t as a function of speed of rotation n (rpm), of life L_h in service hours and of bearing temperature t (°C). For $t \leq 100$ °C, $f_t = 1$.
U/min = rpm; Betr. Std. = operational hours.

$$f_L = f_n \, f_t \, \frac{C}{P}$$

University of Technology
Department of Machines and Equipments
All Branches
Third Class

Subject: Design I
Date: Tuesday 6/9/2011
Time: 3 hours
Final Exam/2nd Attempt

Answer **Three** Questions Only

Assume missing data, Give your opinion about results

Q1: The knuckle joint shown in figure **(1a)** carrying a tensile load **F**;

Data:

a = 12 mm; **b = 18 mm**; **d = 10 mm**; **e = 14 mm**; **f = 16 mm**.

Allowable shear stress (for any part you are choosing) = **5 N/mm^2**.

Allowable tensile stress (for any part you are choosing) **= 10 N/mm^2.**

Allowable bearing stress (between any two parts you are choosing) = **20 N/mm^2.**

Requirements:

1) Find the safe load F to satisfy the five given dimensions. (10 marks)

2) The usual designer's assumption of loading shown in **figure (1c)**, find the maximum bending stress on pin due to safe load you found before. (4 marks)

3) Draw section **x-x.** (3 marks)

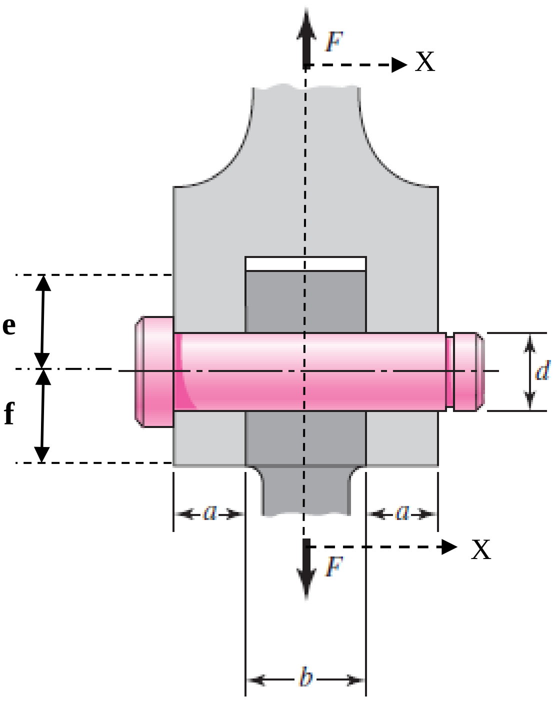


Figure (1a)

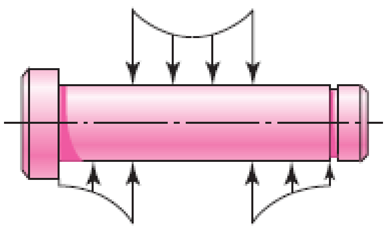


Figure (1b)

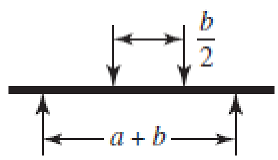


Figure (1c)

Q2: A horizontal shaft **AD** supported in bearings at **A&D** and carrying pulleys at **B&C**, is to transmit a power (**P**) at **500** rpm from drive pulley **B** to off-take pulley **C** as shown in figure (2).

Data:

Diameter of pulley B **= 100 mm**, Diameter of pulley C **= 200 mm**.

τ allowable for shaft and key **= 45 Mpa**, **σ** bearing allowable for key **= 90 Mpa.**

Requirements:

1) Find the shaft diameter**.** (4 marks)
2) Find the capacity of the bearing D.

Assuming the speed factor **= 0.41**, temperature factor **= 1**, radial factor (x) **= 1,** Life factor = **1.** (3 marks)

3) Find the length of key between pulley **B** and shaft if the cross section of the key is **square**, and width of key = **1/4** length of key. (4 marks)
4) Find the power **(P).** (1 marks)
5) Draw complete construction showing all details (note: chose suitable bearing you seen advisable). (5 marks)

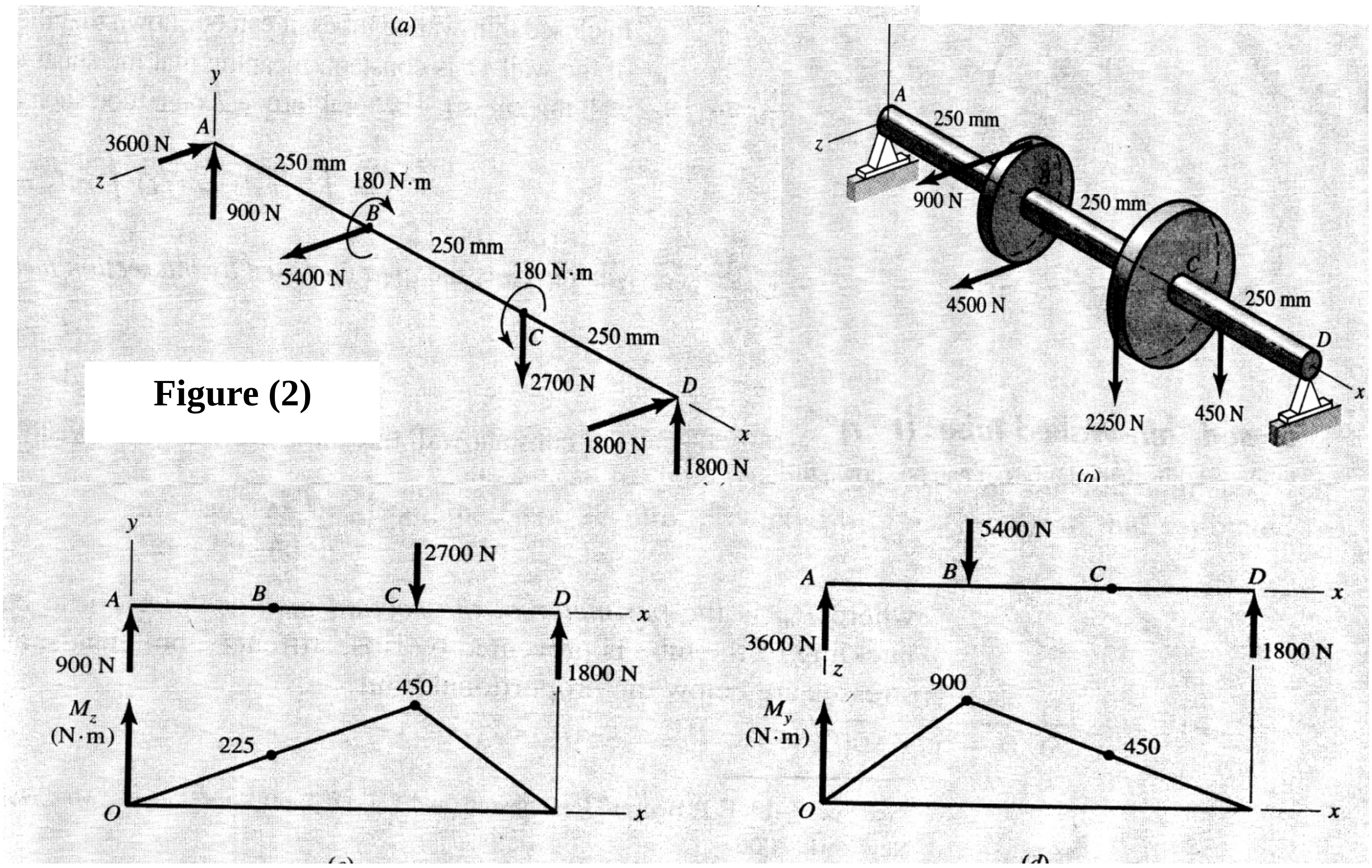


Figure (2)

Q3: **A):** An engine developing a power **(P)** at **1000 rpm** is fitted with a cone clutch having the face width of the clutch **= 106 mm**. The cone has a face angle of **12°**. If the mean normal pressure on the clutch face is not exceed **0.07 N/mm²** and the coefficient of friction is **0.2**, the axial spring force necessary to engage the clutch is **1796 N**, determine:

1) The mean diameter of cone clutch. (3 marks)

2) The developing power (P). (3 marks)

3) Complete constructional drawing showing all detail. (3 marks)

B) A circular cam **(300 mm)** rotates off center with an eccentricity of **24 mm** and operates with roller follower that is carried by the arm as shown in **figure (3).**

The roller follower is held against the cam by means of an extension spring. Assuming that:

Spring diameter = **7.8 mm**, No. of turns of spring **= 10**, Spring index **C = 7**,

Stress concentration factor in spring = $\frac{4C-1}{4C-4}+\frac{0.615}{C}$

Permissible stress in spring steel **= 420 Mpa**

Modulus of rigidity of spring steel **= 84 KN/mm²**

Requirements:

1) Find the force between the follower and cam at **lowest** position. (4 marks)
2) Find the force between the follower and cam at **highest** position. (4 marks)

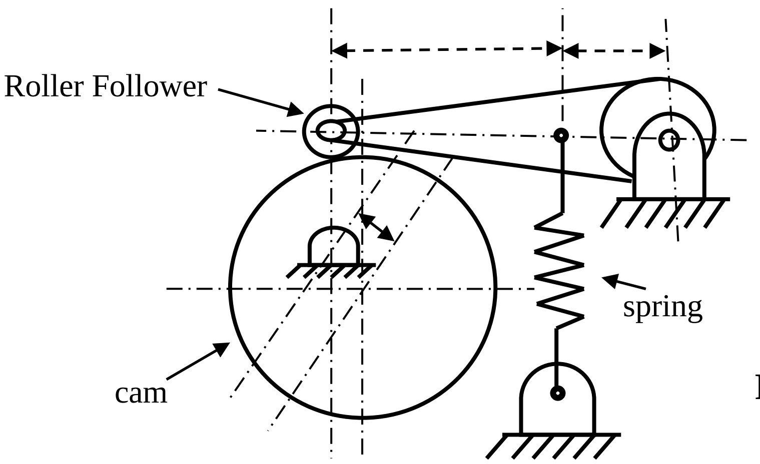


Figure (3)

Clutch: $T=\mu.F_n.r$, uniform wear $r=\frac{R_1+R_2}{2}$, $F_{spring}=2\pi P_{max}R_2(R_1-R_2)$

Spring: Stiffness of spring = $\frac{G.d}{8.C^3.Z}$, shear stress of spring = $K.\frac{8.P.C}{\pi.d^2}$

<u>Q4:</u> <u>A):</u> A single start square threaded screw is to be designed for a C-clamp. The axial load on the screw may be assumed to be **10 kN**. A thrust pad is attached at the end of the screw whose mean diameter may be taken as **30 mm**. the coefficient of friction for the screw threads and for the thrust pads is **0.12 and 0.08** respectively. The allowable tensile strength of the screw is **60 Mpa** and the allowable bearing pressure is **12 N/mm^2**. The square thread as under:

Nominal diameter, mm	16	18	20	22
Core diameter, mm	**13**	**15**	**17**	**19**
Pitch, mm	**3**	**3**	**3**	**3**

Requirements:

1) Which dimension is suitable for screw out of the four values that given in table. (4 marks)

2) If the force of person on handle = **100 N**, find the length of lever and diameter of lever if the allowable bending stress of the lever = **40 Mpa**. (3 marks)

3) Draw a sectional front view of the system. (5 marks)

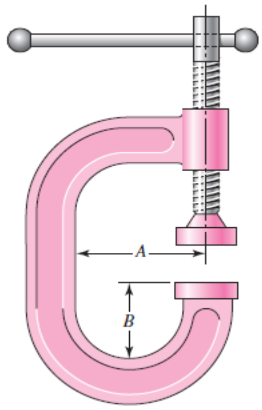


Figure (4)

<u>B)</u> The following data for the pressure vessel:

Inside diameter = **10 cm**, Thickness of vessel = **1.1 cm**,

The pressure inside the pressure vessel varies from **0 to 10 N/mm^2**.

$\boldsymbol{\sigma_w = \sigma_{endurance} = 130\ N/mm^2,\ \sigma_{yield} = 230\ N/mm^2,\ \sigma_{ultimate} = 420\ N/mm^2}$.

Requirements:

Draw soderberg line and find the safety factor for the pressure vessel. (5 marks)

<u>Thin cylinder:</u> $t = \frac{p_i . d_i}{2\sigma_h}$, $t = \frac{p_i . d_i}{4\sigma_L}$

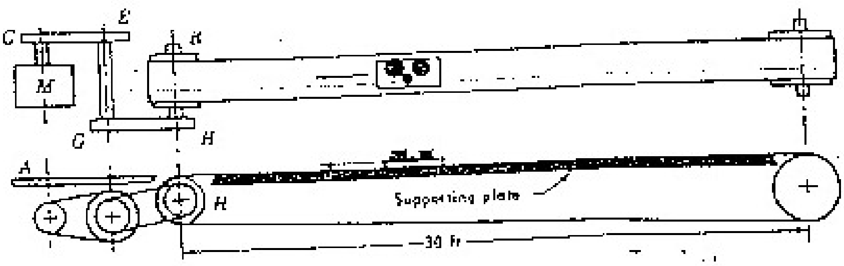
<u>Thick cylinder:</u> Lamie's Equation:

Brittle material , $t = \frac{d_i}{2}\left[\sqrt{\frac{[\sigma]+p_i}{[\sigma]-p_i}} - 1\right]$, Ductile material , $t = \frac{d_i}{2}\left[\sqrt{\frac{[\sigma]}{[\sigma]-2p_i}} - 1\right]$

With best wishes in success^^^^^^^Design Group

الجامعة التكنولوجية قسم هندسة المكائن والمعدات الصف الثالث تكيف الموضوع : تصميم المكائن I	امتحان الفصل الاول 2005___2004 مدرس المادة : جاسم الجاف	ملاحظات : 1- يسمح باستخدام الكتب والمحاضرات . 2- افرض القيم التي تراها مناسبة.

س1/ الشكل يمثل حزام لنقل أطباق توضع عليها أواني الطعام ؛ وتتألف الآلية من محرك (M) وحزام على شكل (V) (V-belt) (CE) . وحزام مسطح (flat belt) (GH). وبعدها تنتقل الحركة إلى اسطوانة حزام نقل الحركة التي توضع علية الإطباق .



المعلومات:

السرعة الخطية للزام الناقل = (0.333 m/s)

السرعة الدورانية للمحرك =(870 rpm)

وزن الطبق وهو محمل = (120 N)

عدد الأطباق الكلية الموضوعة على الحزام =(25 طبق)

معامل الاحتكاك بين الحزام والصفيحة الساندة للحزام(supporting plat) =(0.3)

نسبة التخفيض للحزام(CE)= نسبة التخفيض للحزام (GH) =(3)

قطر البكرة E (dE=12cm)

قطر البكرة G (dG=8cm)

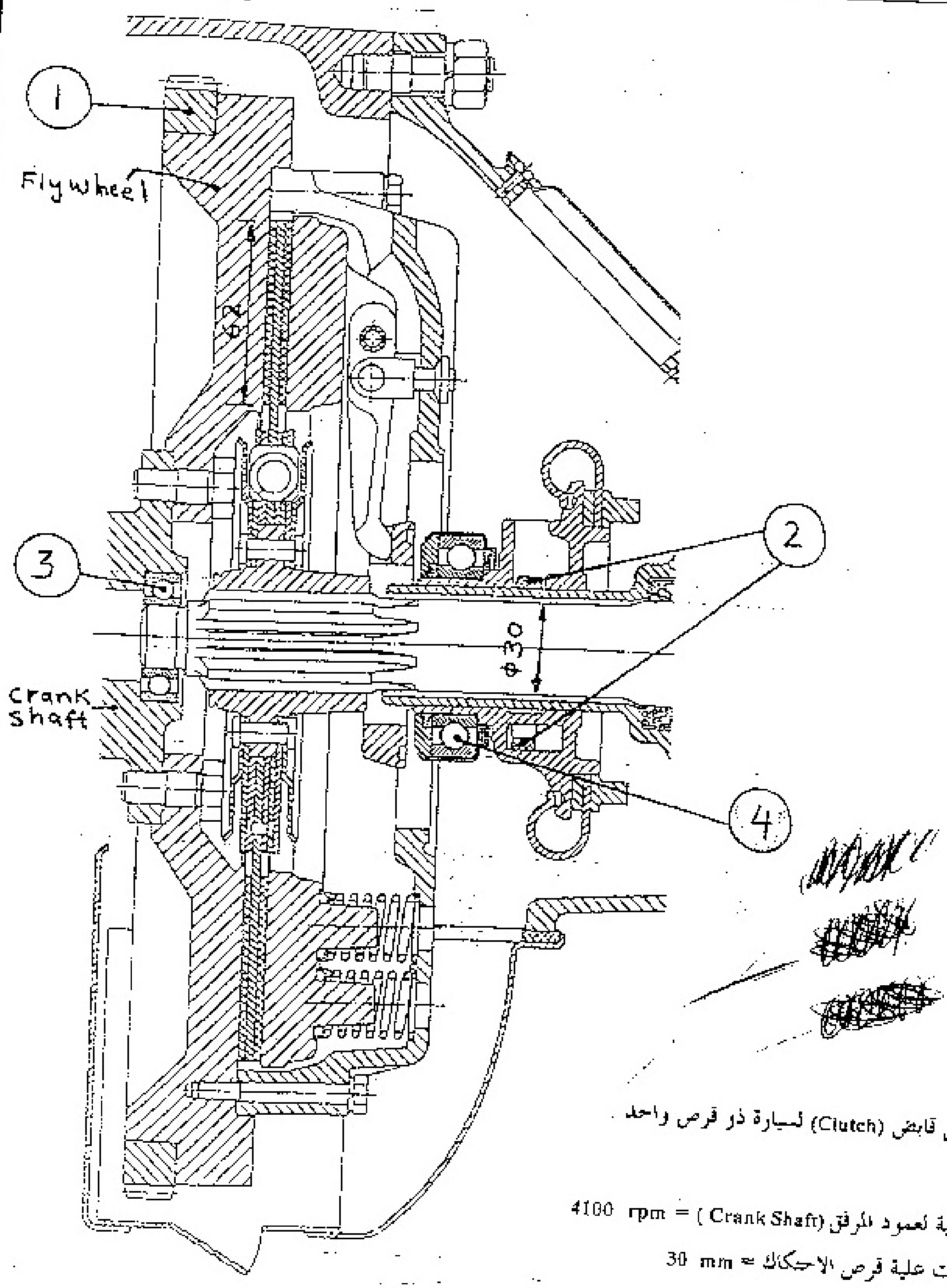
المطلوب:

أ-أوجد القدرة اللازمة للمحرك .... 15 درجة.

ب-أوجد قطر العمود EG .... 20 درجة.

ج-ارسم مقطع يوضح كيفية تثبيت العمود EG مع الأطواق الداخلية (Inner Races) للركائز المناسبة التي تختارها وتثبيت الأطواق الخارجية (Outer Races) للركائز مع البدن وكيفية تثبيت البكرتين G &E على العمود .... 25 درجة.

-ملاحظة مهمة:- لتسهيل الحل افرض آن البكرات والأحزمة بوضع أفقي ونسبة الشد بالأحزمة (T1 / T2=3)



س1/ الشكل يمثل قابض (Clutch) لسيارة ذو قرص واحد .

المعلومات:-

السرعة الدورانية لعمود المرفق (Crank Shaft) = 4100 rpm

قطر العمود المثبت عليه قرص الاحتكاك = 30 mm

القطر الخارجي للنابض = Do= 20 mm

القطر الداخلي للنابض = D= 18 mm

اكبر قوة على النابض = 1.2 * اقل قوة على النابض

المطلوب:-

أ-أوجد عدد النوابض المفروض استخدامها على محيط القابض ....25 درجة .

ب-أوجد عمر الركيزة (رقم 4). خذ كافة الأبعاد التي تساعدك في استخراج عمر الركيزة من الرسم ......25 درجة .

الجامعة التكنولوجية

قسم هندسة المكائن والمعدات

الصف : الثالث (عام+ تكيف)

الموضوع : تصميم مكائن I

امتحان الفصل الثاني

2005-2004

مدرسو المادة : السيد عبد الكريم سلمان

السيدة سهاد عبد الحميد

السيد جاسم الجاف

الملاحظات : اجب عن س

اذكر رأيك

الزمن ساعة

س1/ رافعة تقوم برفع حمل مقداره (8000 N) عن طريق اسطوانة قطرها (250 mm) . تم ربط عمود اسطوانة على موقف مواصفاته كما موضحة في الشكل رقم (1) . مقدار معامل الاحتكاك والضغط بين الاسبستوس وحديد = 0.3 و $0.34\ N/mm^2$ على التوالي .

المطلوب :

- مقدار القوة (F) .
- عرض البطانة للموقف .
- ارسم المقطع (X-X) .

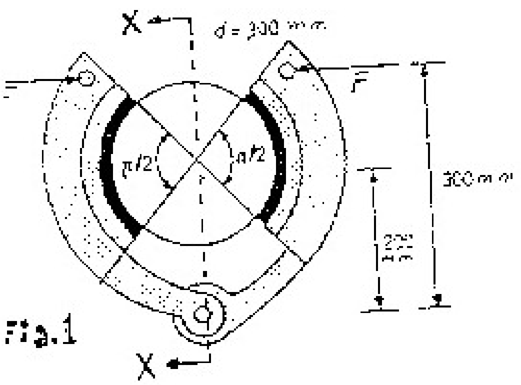


Fig.1

س2/ في الشكل رقم (2) الحمل يتغير من (F – إلى 2F) معامل الأمان في المقطع (A-A) = 1.34

المعدن المستخدم (St.34 :11)

المطلوب :

مقدار القوة F باستخدام مخطط (σ A) .

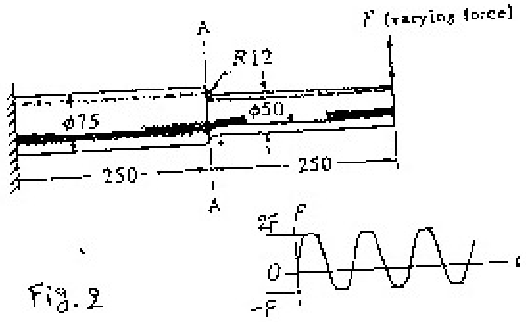


Fig. 2

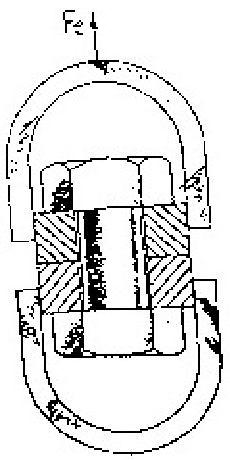
س3/ القوة الخارجية على الأجزاء تتغير من (صفر إلى 72 kN) نسبة معامل الصلابة المكافئة (k= 0.75)

المعدن المستخدم للبرغي (St.34 :11)

مساحة جذر السن للبرغي = $84.3\ mm^2$

قوة الشد الابتدائية التي تمنع انفصال الأجزاء = 5000 N

المطلوب :



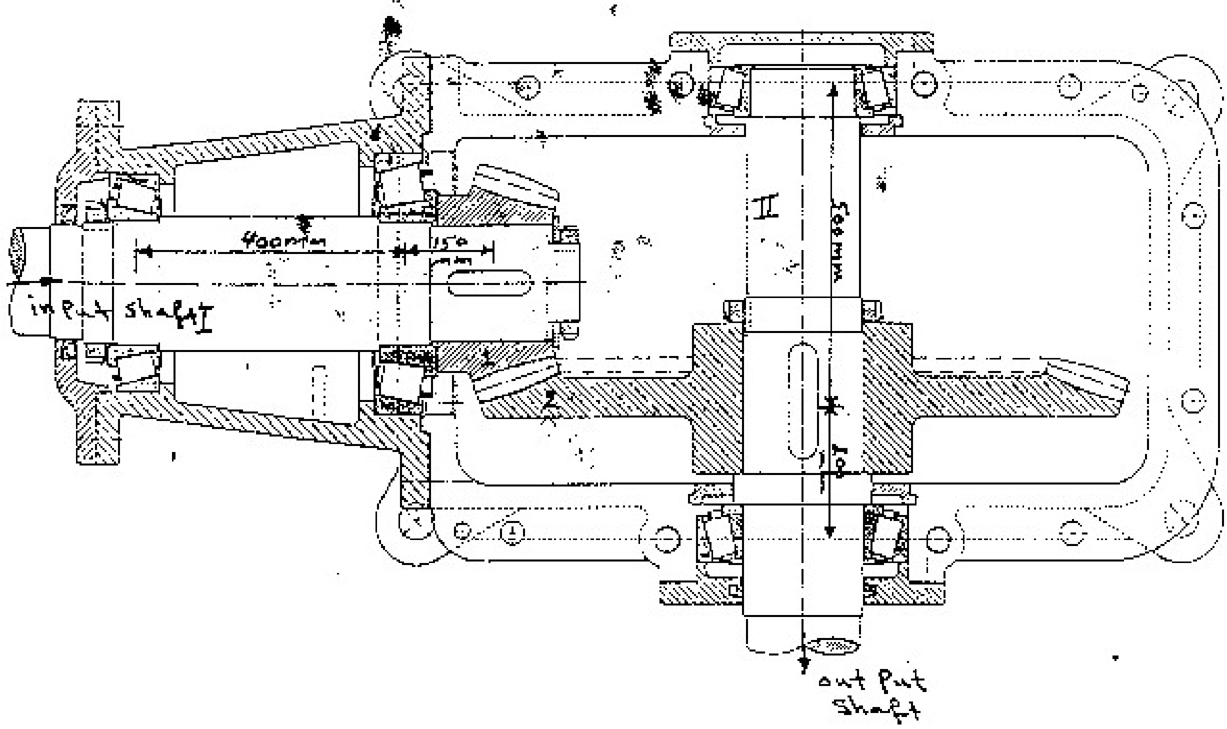
- ارسم العلاقة بين الانحراف والقوة موضحا كافة القوى التي يتعرض لها البرغي والأجزاء .
- ارسم مخطط (σ A) موضحا الحالة التصميمية للبرغي .
- أوجد معامل الأمان للبرغي .
- أوجد اقل قوة واكبر قوة تتعرض لها الأجزاء .

الجامعة التكنولوجية
قسم هندسة المكائن والمعدات
الصف الثالث
كافة الاختصاصات

للعام الدراسي
٢٠٠٦ - ٢٠٠٧
المادة: تصميم مكائن I

التمرين الثاني
للفصل الأول

الشكل أدناه يمثل صندوق تروس ذو مرحلة واحدة،
يستخدم تروساً مخروطية القدرة الداخلة للصندوق (15 KW)
والسرعة الدورانية (1500 rpm)، أوجد قطر العمودين (I & II)
وافترض القيم التي تراها مناسبة في خلال الحل.



Q2: A horizontal shaft **AD** supported in bearings at **A&D** and carrying pulleys at **B&C**, is to transmit a power (**P**) at **500** rpm from drive pulley **B** to off-take pulley **C** as shown in figure (2).

Data:

Diameter of pulley B = **100 mm**, Diameter of pulley C = **200 mm**.

τ allowable for shaft and key = **45 Mpa**, **σ** bearing allowable for key = **90 Mpa.**

Requirements:

1) Find the shaft diameter. (4 marks)
2) Find the capacity of the bearing D.

   Assuming the speed factor = **0.41**, temperature factor = **1**, radial factor (x) = **1**, Life factor = **1**. (3 marks)
3) Find the length of key between pulley **B** and shaft if the cross section of the key is **square**, and width of key = **1/4** length of key. (4 marks)
4) Find the power (**P**). (1 marks)
5) Draw complete construction showing all details (note: chose suitable bearing you seen advisable). (5 marks)

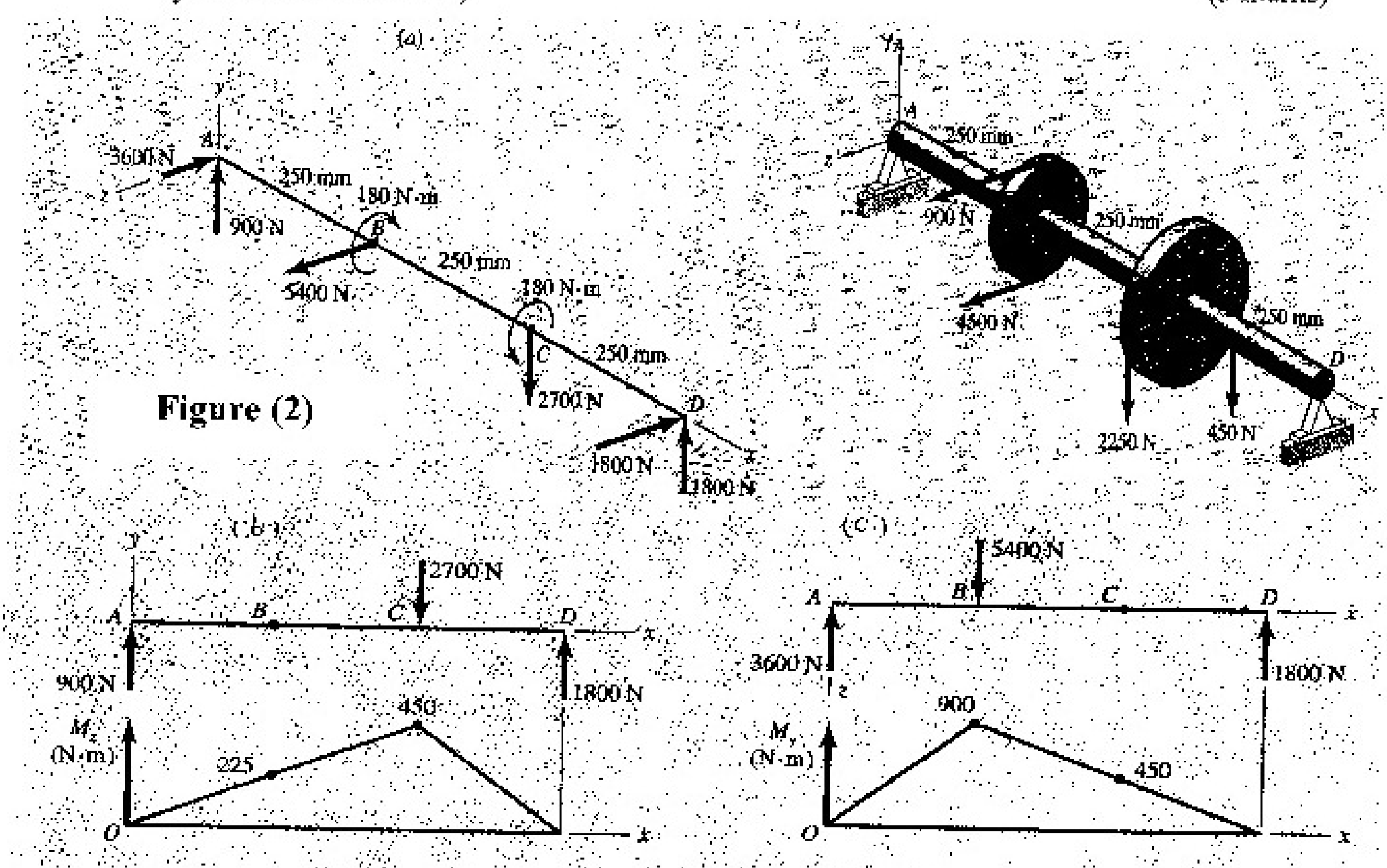


Figure (2)

Q3: **A):** An engine developing a power (P) at **1000 rpm** is fitted with a cone clutch having the face width of the clutch = **106 mm**. The cone has a face angle of **12°**. If the mean normal pressure on the clutch face is not exceed **0.07 N/mm²** and the coefficient of friction is **0.2**, the axial spring force necessary to engage the clutch is **1796 N**, determine:

1) The mean diameter of cone clutch. (3 marks)
2) The developing power (P). (3 marks)
3) Complete constructional drawing showing all detail. (3 marks)

B) A circular cam **(300 mm)** rotates off center with an eccentricity of **24 mm** and operates with roller follower that is carried by the arm as shown in **figure (3).**

The roller follower is held against the cam by means of an extension spring. Assuming that:

Spring diameter = **7.8 mm**, No. of turns of spring = **10**, Spring index **C = 7**,

Stress concentration factor in spring $= \dfrac{4C-1}{4C-4} + \dfrac{0.615}{C}$

Permissible stress in spring steel = **420 Mpa**

Modulus of rigidity of spring steel = **84 KN/mm²**

Requirements:

1) Find the force between the follower and cam at **lowest** position. (4 marks)
2) Find the force between the follower and cam at **highest** position. (4 marks)

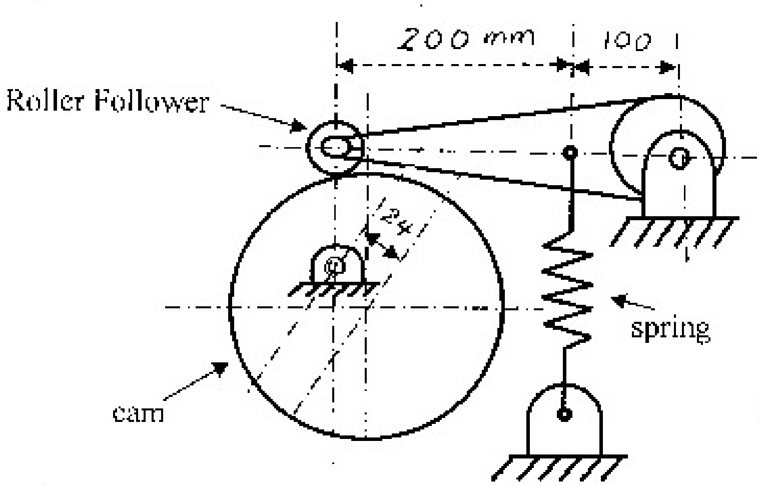


Figure (3)

Clutch: $T = \mu . F_n . r$, uniform wear $r = \frac{R_1+R_2}{2}$, $F_{spring} = 2\pi P_{max} R_2 (R_1 - R_2)$

Spring: Stiffness of spring $= \frac{G.d}{8.C^3.Z}$, shear stress of spring $= K.\frac{8.P.C}{\pi.d^2}$

Q4: A): A single start square threaded screw is to be designed for a C-clamp. The axial load on the screw may be assumed to be **10 kN**. A thrust pad is attached at the end of the screw whose mean diameter may be taken as **30 mm**. the coefficient of friction for the screw threads and for the thrust pads is **0.12 and 0.08** respectively. The allowable tensile strength of the screw is **60 Mpa** and the allowable bearing pressure is **12 N/mm²**. The square thread as under:

Nominal diameter, mm	16	18	20	22
Core diameter, mm	13	15	17	19
Pitch, mm	3	3	3	3

Requirements:

1) Which dimension is suitable for screw out of the four values that given in table. (4 marks)
2) If the force of person on handle = **100 N**, find the length of lever and diameter of lever if the allowable bending stress of the lever = **40 Mpa**. (3 marks)
3) Draw a sectional front view of the system. (5 marks)

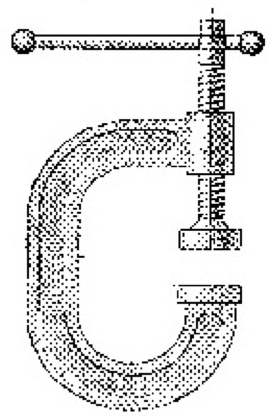


Figure (4)

B) The following data for the pressure vessel;

Inside diameter = **10 cm**, Thickness of vessel = **1.1 cm**,

The pressure inside the pressure vessel varies from **0 to 10 N/mm²**.

$\sigma_w = \sigma_{endurance} = 130\ N/mm^2$, $\sigma_{yield} = 230\ N/mm^2$, $\sigma_{ultimate} = 420\ N/mm^2$.

Requirements:

Draw soderberg line and find the safety factor for the pressure vessel. (5 marks)

Thin cylinder: $t = \frac{p_i . d_i}{2\sigma_h}$, $t = \frac{p_i . d_i}{4\sigma_L}$

Thick cylinder: Lamie's Equation:

Brittle material , $t = \frac{d_i}{2}\left[\sqrt{\frac{[\sigma]+p_i}{[\sigma]-p_i}} - 1\right]$, Ductile material , $t = \frac{d_i}{2}\left[\sqrt{\frac{[\sigma]}{[\sigma]-2p_i}} - 1\right]$

With best wishes in success^^^^^^^Design Group

الجامعة التكنولوجية	للعام الدراسي 2006 – 2007	مدرس المادة
قسم هندسة المكائن والمعدات	امتحان الدور الأول 2007/6/4	د. ذلـــقاء سلـمان
المادة: تصميم مكائن للصف الثالث	كافة الاختصاصات	المدرس جـاسم الجاف

ملاحظة: يسمح للطالب بادخال جميع ما يرتئيه من الكتب والمحاضرات. (الزمن ثلاث ساعات)

(نسـأل الله النـــجاح للجميع)

س1/ الشكل (1) يبين احد المشاريع المقدمة من قبل مجموعة من الطلاب في الفصل الدراسي الثاني لهذا العام والتي تم مناقشتها عمليا في المراسم ، وهي منظومة مكونة من يده عزم (Handle) تعمل على تدوير لولب نقل القدرة مزدوج (Double Power Screw) ومن خلال الحركة الأفقية المتعاكسة للصامولتين نحصل على إيقاف اسطوانة الموقف (Brake Drum) .

المعلومات :

مقدار القوة (S=3000N)

قطر لولب نقل القدرة d1=16.5mm

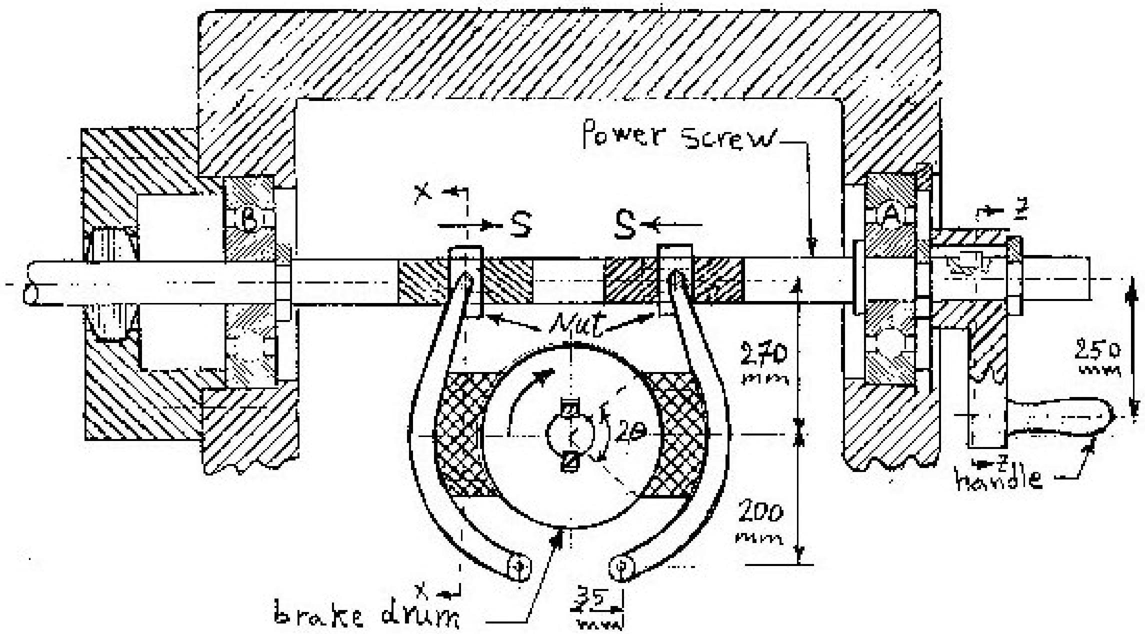
نوع أسنان اللولب Trapezoidal Threads

أهمل Collar Friction

معامل الاحتكاك في الموقف (Brake)(μ=0.35)

زاوية الاحتكاك في الموقف (2θ=100)

قطر اسطوانة الموقف (D=330mm)



الشكل (1)

المطلوب :

1-اوجد مقدار العزم المنقول إلى اسطوانة الموقف ....(8 درجة)

2- اوجد عرض بطانة الاحتكاك ، علما ان إجهاد السحق بين البطانة والاسطوانة (5N/mm²) ....(3 درجة)

3-اوجد مقدار القوة التي تعمل على تدوير يده العزم (Handle) في حالة الكبح أي وجود حمل على لولبي نقل القدرة.................(8 درجة)

4- اوجد عمر الركيزتين (A&B) علما ان رد الفعل العمودي على كل ركيزة هو (Pr=3000N) ....(4 درجة)

5- ارسم المقطع (x-x) والمقطع (z-z)...................(7 درجة)

الجامعة التكنولوجية	للعام الدراسي 2006 – 2007	مدرس المادة
قسم هندسة المكائن والمعدات	امتحان الدور الأول 2007/6/4	د. ذلـــفاء سلـــمان
المادة: تصميم مكائن للصف الثالث	كافة الاختصاصات	المدرس جـاسم الجاف

س2/ في الشكل (2) يسلط الذراع (A) حملا مقداره (0 الى F1) على حزمة من الورق يراد كبسها . حيث ان ذراع المكبس (C) يتعرض الى قـوة ضغط مقداره (0 الى F2).علما ان في حالة كبس الاوراق تكون اقصى قوة في نهاية الذراع A عند النقطة (X) هي (F1) بينما في نفس اللحظة عند النهاية الاخرى للذراع عند النقطة (Z) تكون القوة (F2) ، وفي حالة عدم الكبس تكون القوى في نهايتي الذراع (A) هي (صفر).

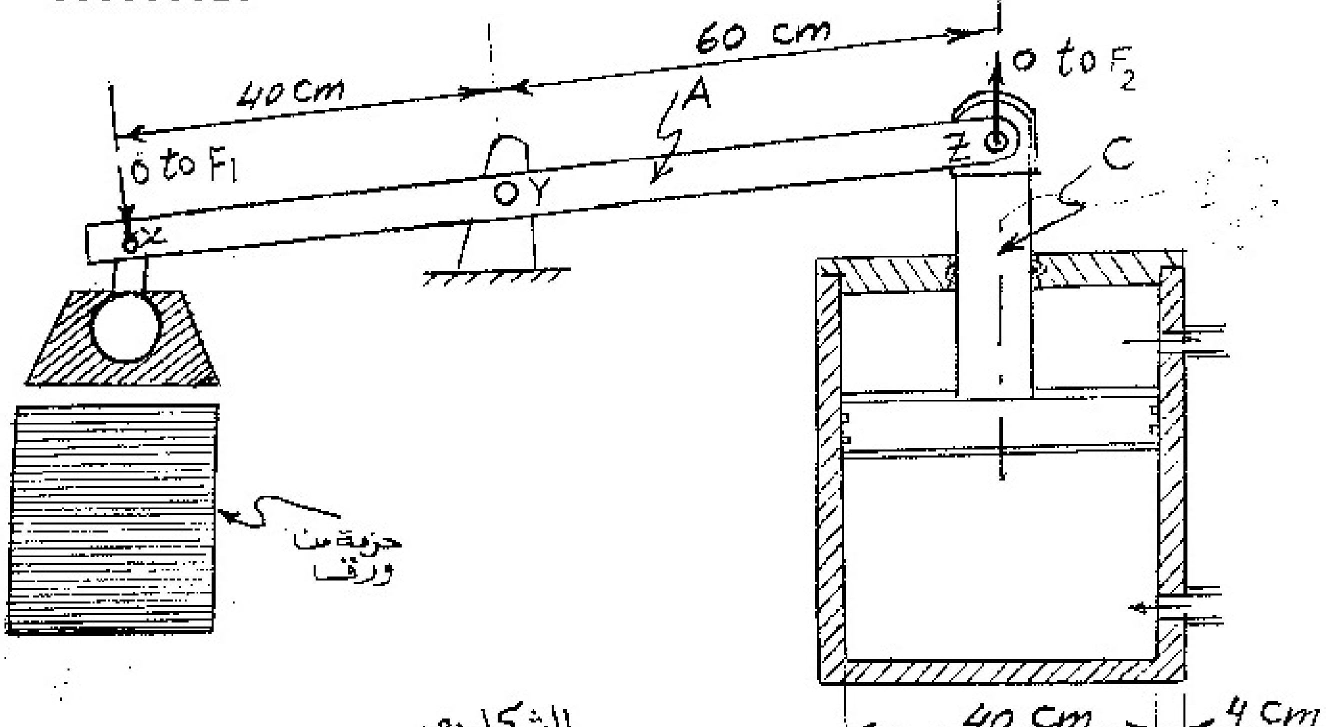
المطلوب:

?? 1-اذا كان قطر الذراع (A) المصنوع من(St.50:11) يساوي (20 mm) وقطر المسمار الذي يثبت الذراع (A)في النقطة (Y) يساوي (3.5mm). اوجد اقصى عزم حناية على الذراع (A)(Mbmax) علما ان معامل الامان للــــذراع نتيجة الحـــناية (n=2) ، ان ($\sigma B=50Kg\ f/mm^2$).
& ($\sigma F=27Kg\ f/mm^2$)..................(8 درجة)

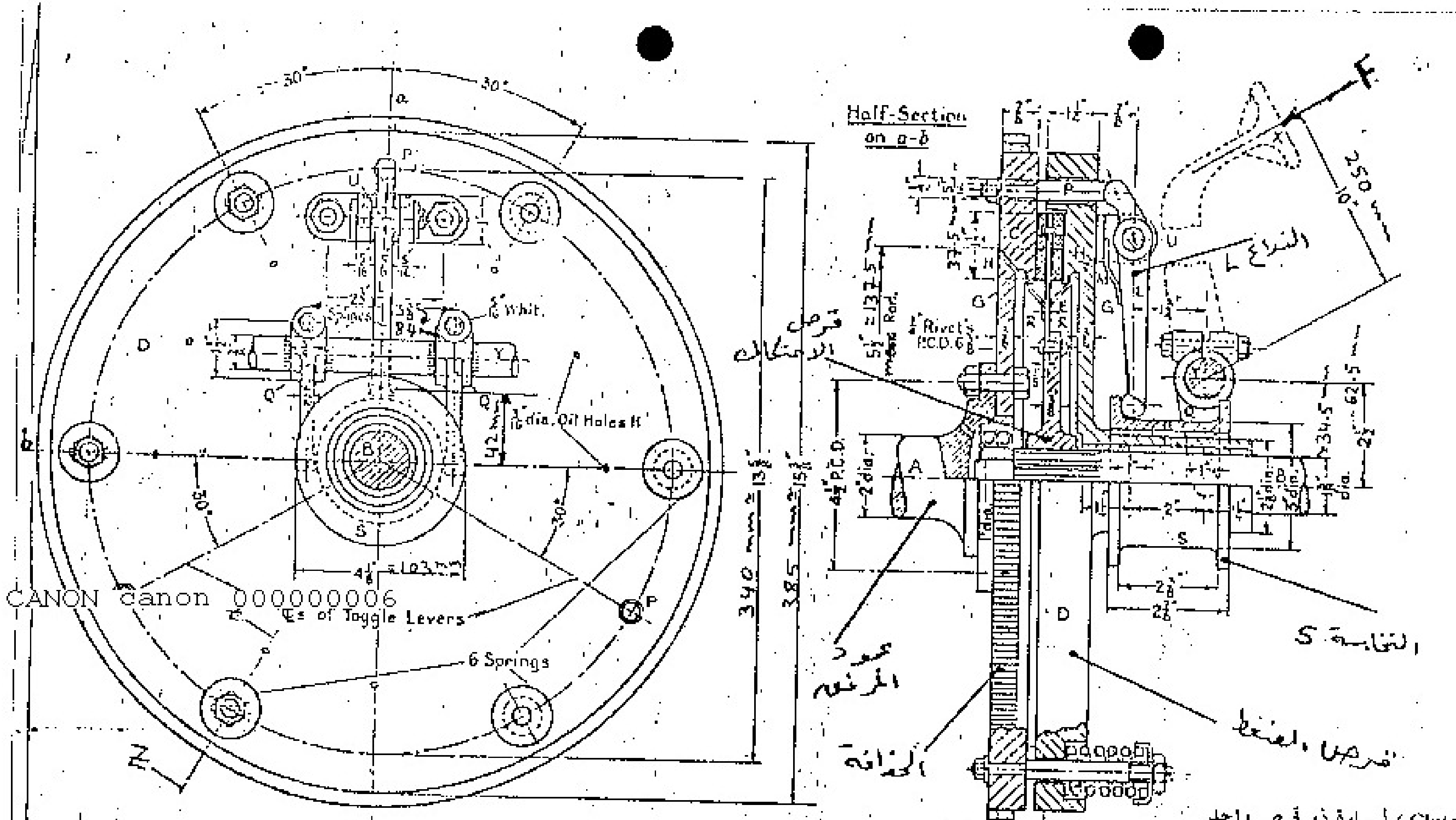
2-كم يبلغ قطر المقطع الدائري لذراع المكبس المصنوع من (St.34:11) ،اذا كان معـــــامل الامان لذراع المكـــــبس نتـــيجة الــضغط (n=1.5)، ($\sigma B=34\ Kg\ f/mm^2$).& ($\sigma F=19Kg\ f/mm^2$) واذكر رأيك بالنتيجة. ....(7 درجة)

3- اوجد الضغط داخل اسطوانة الضغط المصنوعة من (St.34:11). ....(6 درجة)

4-ارسم مقطع يوضح هذا النظام موضحا كيفية تثبيت ذراع المكبس بالمكبس ،وغطاء الاسطوانة بالاسطوانة وكيفية تثبيت الذراع (A) بذراع المكبس، والتثبيتات في المنطقة (y&x)..............(9 درجة)



الشكل(2)



SINGLE-PLATE CLUTCH

شكل يمثل قابض (Clutch) لسيارة ذو قرص واحد .

ات:

ة ألد ورانية لعمود المرفق A =(1500 rpm)

وة على النابض = 1.3 * اقل قوة على النابض

ب:

الأبعاد الموجودة على الرسم للقابض أوجد قدرة ماكنة السيارة ....25 درجة .

جد مقدار القوة (F)................25 درجة .

الجامعة التكنولوجية
قسم هندسة المكائن والمعدات
الصف : الثالث (كافة الفروع)
الموضوع : تصميم مكائن

امتحان الفصل الأول (للموحدين)
2004–2005
مدرسو المادة : السيد عبد الكريم سلمان
د. ابراهيم علي محسن
السيد جهاد عبد الحميد
السيد قاسم الجاف

الملاحظات : ... بالنتائج
الزمن 30 دقيقة فقط

س1/ الشكل أدناه يوضح سد ذو بوابة للتحكم بتدفق مياه النهر

المعلومات:

وزن البوابة (2 طن)

القوة الناتجة من مقاومة بوابة السد للماء(4000 N)

نوع لولب نقل القدرة (Trapezoidal thread)

عدد البدايات للسن(Single Start)

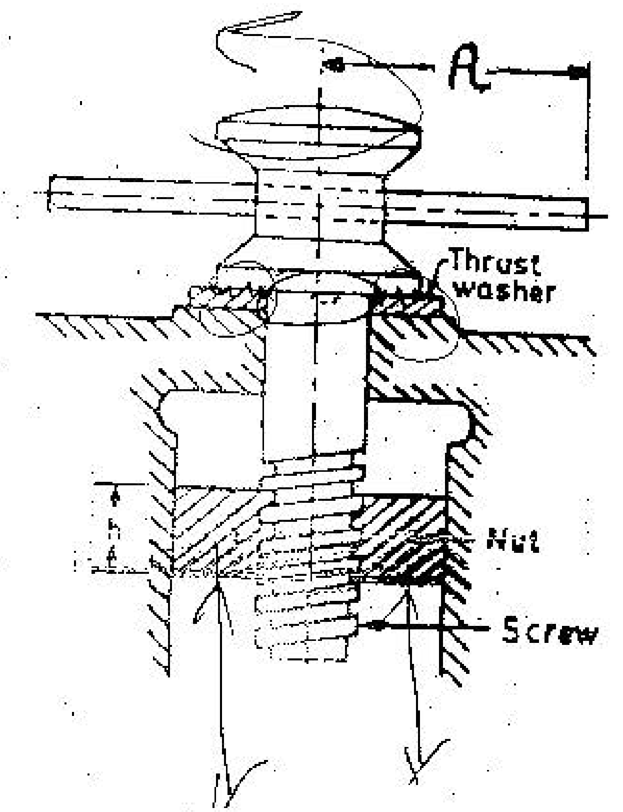
القطر الخارجي للولب نقل القدرة(d= 60mm)

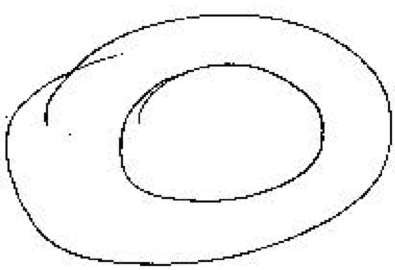
القطر الداخلي للواشر (Di= 50mm)

القطر الخارجي للواشر (Do= 150mm)

معامل الاحتكاك بين الواشر والبوابة (μ_c =0.105)

معامل الاحتكاك بين أسنان Screw & Nut (μ =0.1)





المطلوب :

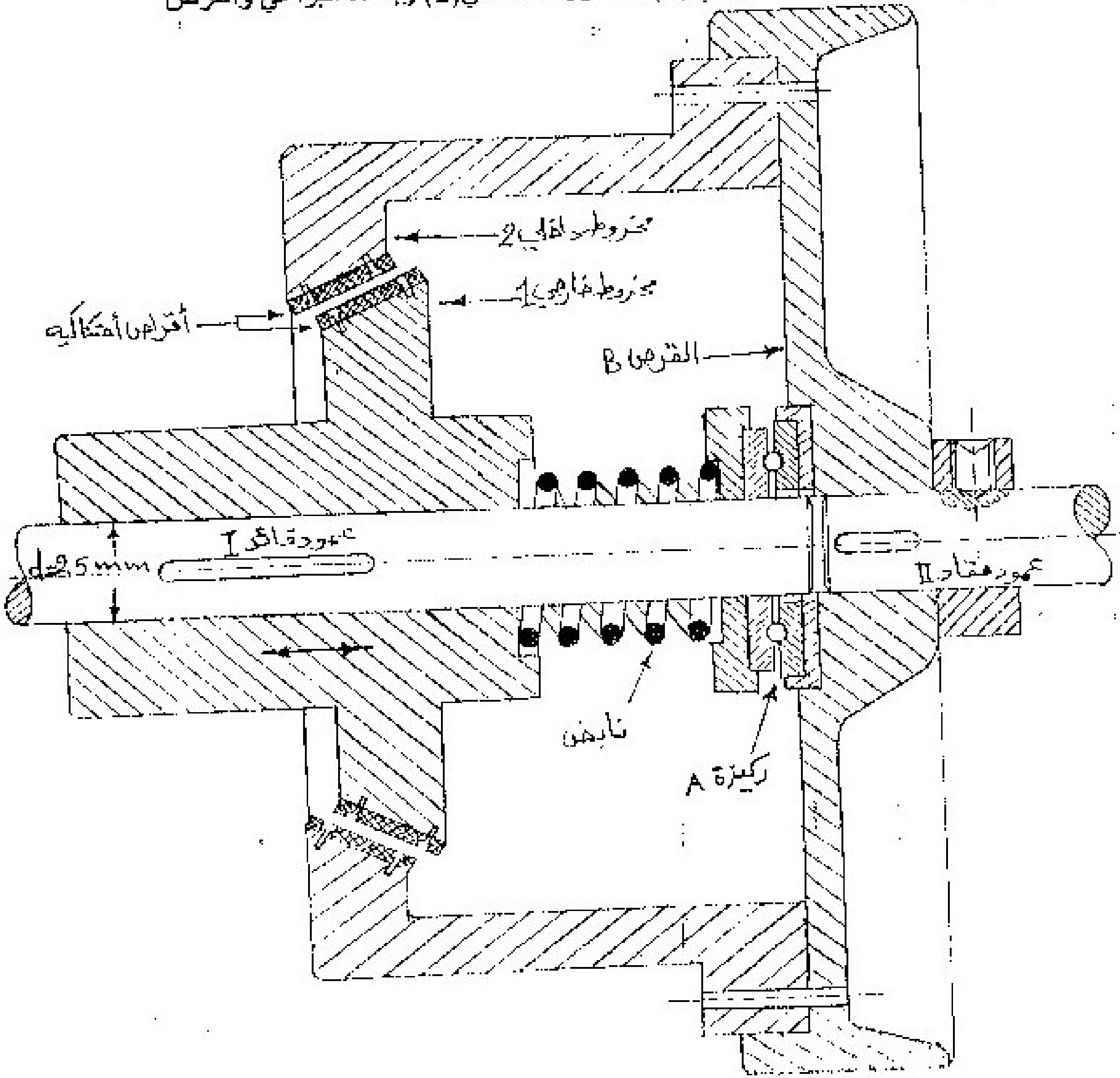
1. أحسب أكبر قوة اللازمة لتدوير الذراع (Handle) وذلك رفع بوابة السد علماً ان (R=105 mm)
2. أحسب عدد أسنان Nut إذا كان اجهاد السحق المسموح به بين الأسنان σ_b= ½ الاجهاد الشعاعي Screw (σ_c
3. ارسم مقطع كامل للشكل بحيث تلغي Collar friction باستخدام ركيزة مع كافة التفاصيل وكيفية جعل البوابة تتحرك حركة خطية .

ملاحظة: 1-افرض القيم التي تراها مناسبة بالحل.
2-يسمح للطالب ادخال جميع ما يرتئيه من كتب والمحاضرات

الجامعة التكنولوجية	العام الدراسي : 2007-2008	مدرس المادة
قسم هندسة المكائن والمعدات	المادة : تصميم مكائن I	المدرس♦ جاسم الجاف
أمتحان الفصل الأول 31\1\2008	الصف: الثالث كافة الأختصاصات	المدرس المساعد♦ مهند يوسف حنا

اجب على سؤال واحد فقط *(نسأل الله النجاح للجميع)*

س1/ الشكل (1) يوضح قابض مخروطي لغرض نقل السرعة والعزم من خلال العمود القائد(I) ومن ثم المخروط الخارجي (1) والمخروط الداخلي(2) وبعدها البراغي والقرص (B) ومن ثم العمود المقاد(II).



المعلومات:

نسبة انصاف اقطار القرص الاحتكاكي (R2=0.8R1)

قطر العمود القائد (I) =25mm

السرعة الدورانية لعمود القائد (I) =1000rpm

العمود القائد مصنوع من معدن (st.42:11)

اكبر قوة على النابض =1.4 * اقل قوة على النابض

اقل قوة على النابض = Fn sinα

معامل النابض (C = 8)

الحمل على النابض متوسط & ($G = 8.3 * 10^4\ N/mm^2$)

الحمل المثالي على الركيزة هو ($P = X.Fr + 3.6\ Pa$)

(heavy series) الحمل

المطلوب:

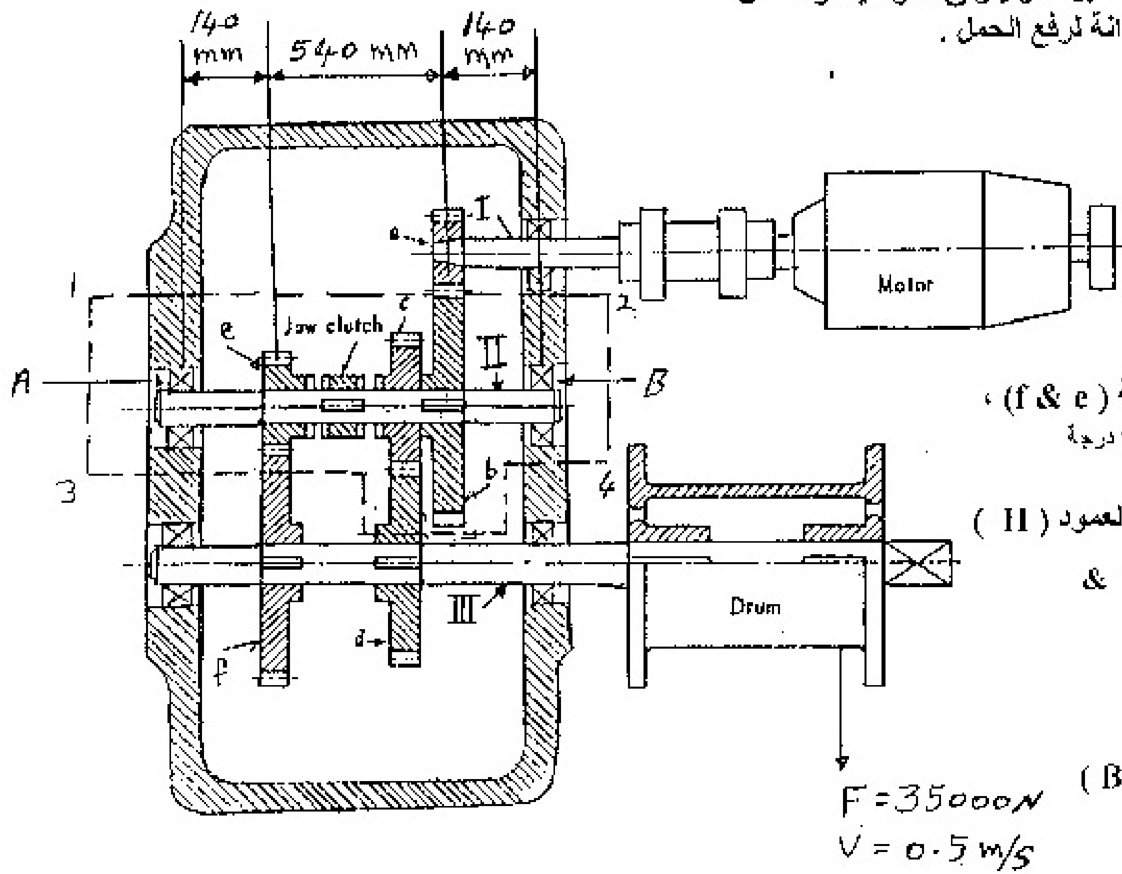
1-اوجد انصاف اقطار القرص الاحتكاكي (R1 & R2) ....(6درجة).

2-اوجد مقدار الانظغاط الانحراف بالنابض (S) (Deflection). ....(6درجة).

3-اوجد عمر الركيزة (A) . ...(3درجة).

4-صمم منظومة تعمل على فصل وتعشيق الاقراص الاحتكاكية وذلك من خلال حركة المخروط الخارجي حركة افقية لليمين واليسار ، صمم المنظومة عن طريق الرسم وليس الحسابات. ....(5درجة).

س2/الشكل أدناه يمثل صندوق تروس ذو سرعتين لرفع حمل ، حيث أن السرعة الخارجة من الماطور تخفض بشكل أولي عن طريق الترسين (b,a) وتنتقل الحركة الى العمود (II) .
الترسين (e,c) مثبتين على العمود (II) بحيث يدوران بحرية حول العمود(II) (سائبين) وتنتقل الحركة اليهما عن طريق القابض الفكي (jaw clutch) بواسطة الخابور مع العمود (II) .
القابض الفكي (jaw clutch) يمكنه الأنزلاق على العمود (II) فيمكن ان ينزلق نحو اليمين لتنتقل الحركة عبر الترسين (d,c)(السرعة العالية) ومنهما الى الاسطوانة لرفع الحمل بواسطة الحبل ، أو ينزلق نحو اليسار لتنتقل الحركة عبر الترسين (f,e)(السرعة البطيئة) ومنهما الى الخارج الى الأسطوانة لرفع الحمل .



في حالة كون التروس معشقة على السرعة البطيئة (f,e)
تقوم الأسطوانة برفع حمل مقداره (35000 N)
مقدار السرعة الخطية للاسطوانة (0.5 m/s)
قطر الاسطوانة هو (550 mm)
كفاءة النقل لكل أجزاء المنظومة (%100)
المعلومات حول التروس موضحة بالجدول أدناه .

المطلوب :

1- أحسب سرعة الماطور بوحدات (rpm) .....3 درجة
2- أحسب قطر العمود (II) في حالة كون التروس معشقة على السرعة البطيئة (f & e) ، أذا علمت ان المعدن المستخدم للعمود هو (St: 50.11) .....7 درجة
لسهولة الحل أعتبرأن كل التروس مستقيمة وزاوية الضغط ($\alpha = 20°$)
3- أحسب طول الخابور (key) الذي يربط القابض الفكي (jaw clutch) مع العمود (II)
أذا علمت أن الاجهادات المسموح بها للخابور هي : $\sigma_b = 90\ N/mm^2$ & $\tau = 60\ N/mm^2$
هل أن طول الخابور في القابض هو الطول الذي نحتاجه فعلا في التصميم أم لا, أذكر رأيك حول ذلك ؟ .....4 درجة
4 – أرسم المنطقة المؤشرة بالرسم (1,2,3,4) حول العمود (II) موضحا
أ- تثبيت الركيزتين (A , B) داخل صندوق التروس بحيث تتحمل الركيزة (B) (Axial Force) بأتجاهين مع (Radial Force) وتتحمل الركيزة (A) (Radial Force) فقط .
ب – تثبيت الترسين (e,c) على العمود (II) بحيث يدوران بحرية حوله .
ج – أرسم القابض الفكي وكيفية أنزلاقه على العمود (II) . .....6 درجة

Gear	a	b	C	d	e	f
Number of teeth	15	75	32	52	13	71
module	10	10	13	13	13	13

الجامعة التكنولوجية
قسم هندسة المكائن والمعدات
امتحان الدور الأول 2008\6\3
العام الدراسي 2007-2008
المادة : تصميم مكائن
الصف : الثالث كافة الاختصاصات
[illegible]

الزمن : ثلاث ساعات
مع تمنياتنا للجميع بالنجاح انشاء الله

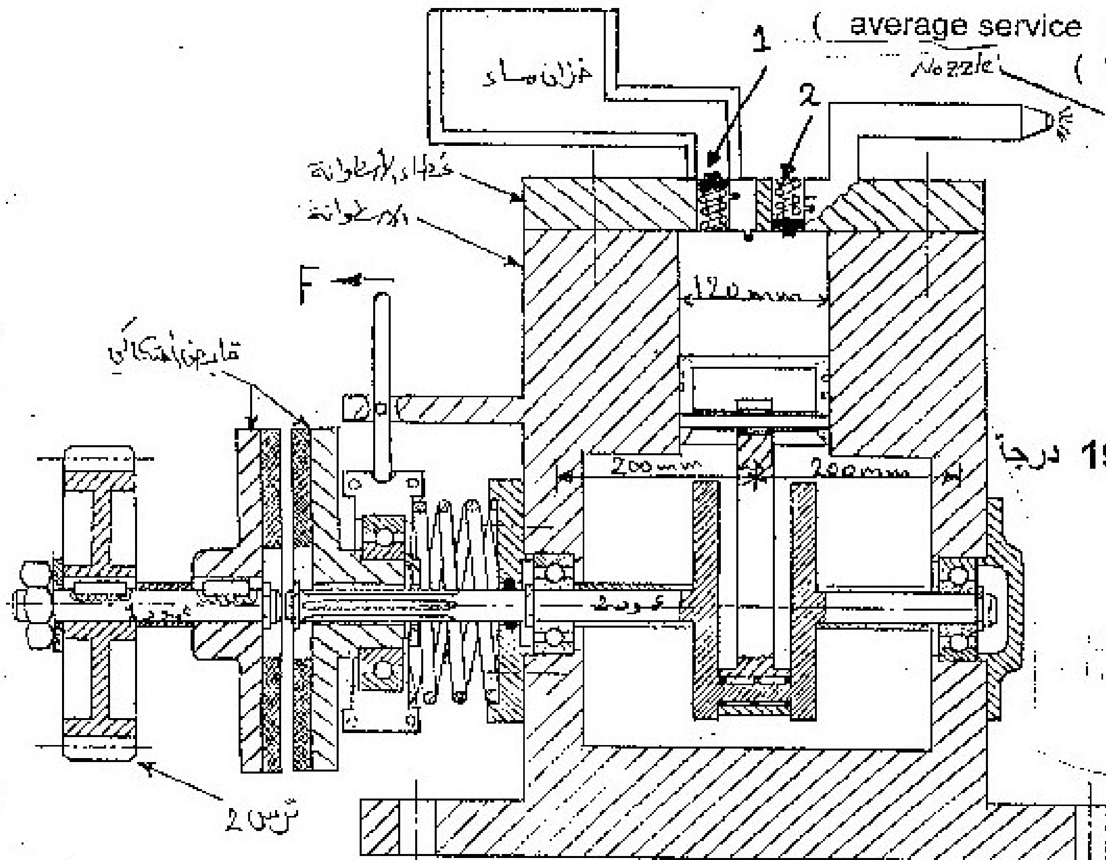
ملاحظة : أترك أحد السؤالين أما الثاني أو الرابع

س1 : الشكل (1) يمثل منظومة تجهيز ماء مضغوط لتبريد سكاكين حفارة زراعية غير واضحة بالرسم , تم اعداد نظام كامل للحفارة الزراعية من قبل احد طلبة القسم كمشروع تخرج لعام 2007-2008 والشكل يمثل جزء من النظام المقدم .

الية الحركة: عن طريق صندوق تروس غير واضح بالرسم تنتقل الحركة الى الترس رقم (2) فيدير العمود (1) و عن طريق القابض الأحتكاكي و ضغط النابض تنتقل الحركة الى العمود رقم (2) حيث يعمل جزء منه كعمود مرفق مربوط به مكبس , و من خلال الحركة الترددية للمكبس يضغط الماء النازل من صمام (1) و يمر عبر صمام رقم (2) و بعدها الى النوزلات .

المعلومات : أبعاد القرص الأحتكاكي (R_1 = 120 mm) & (R_2 = 90 mm)
معامل الأحتكاك (μ = 0.3) , معامل النابض (spring index) (C = 8) .
اكبر قوة على النابض = 1.2 * أقل قوة على النابض
أستخدم نظرية التآكل المنتظم (uniform wear)، الحمل على النابض متوسط (average service)
الضغط داخل الأسطوانة يتغير (من 20 N / cm ^{2} الى 100 N / cm ^{2})
نسبة معامل الصلابة المكافئ (k = 0.4)
البراغي مصنوعة من معدن (st:60:11)
قطر البرغي (db = 11 mm), عدد البراغي (4)
قوة الشد الأبتدائي على البرغي الواحد = 3500 N
قطر الأسطوانة الداخلي = 120 mm

المطلوب :
1- أوجد مقدار القوة (F) التي تعمل على فصل القابض
2- أوجد قطر السبرنك (d)
3- أوجد قطر العمود (2)
4- أوجد عامل الأمان (n) للبرغي الذي يربط غطاء الأسطوانة بالأسطوانة (19 درجة)

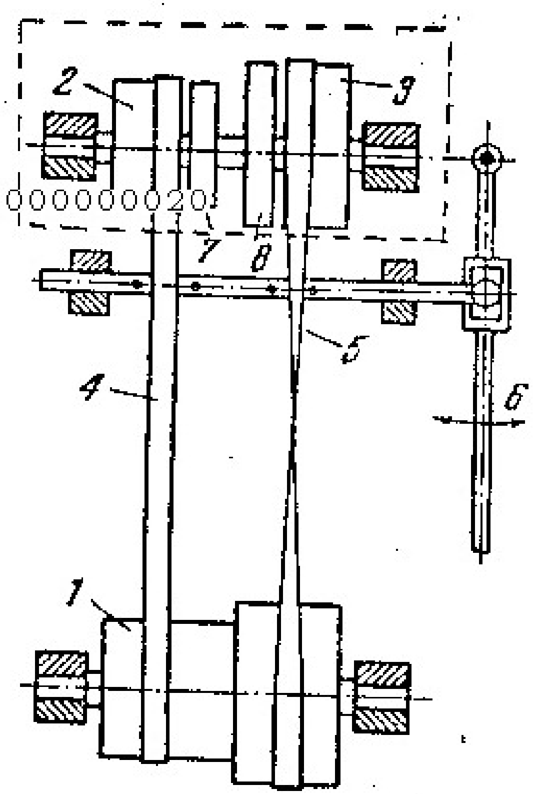


الشكل (1)

س2: الشكل (2) يوضح منظومة نقل و عكس الحركة من خلال أحزمة مسطحة و بكرات , تتكون المنظومة من بكرة مزدوجة رقم (1) و حزام مسطح مفتوح (4) و حزام مسطح مغلق (5) لعكس الحركة و عتلة (6) تعمل على حركة الأحزمة الى اليمين و اليسار .
العمود الخارج الذي يثبت عليه { بكرة (7) و بكرة (8) ثابتتان على العمود الخارج أما البكرة (2) و البكرة (3) سائبتان على العمود الخارج } .

الية العمل : 1- عند حركة العتلة (6) الى اليمين فأن الحزام المغلق (6) يتحرك افقيا من البكرة (8) الى البكرة السائبة (3) أما الحزام المسطح المفتوح (4) يتحرك افقيا من البكرة السائبة (2) الى البكرة الثابتة (7) فتنتقل الحركة الى العمود الخارج عبر البكرة (7).
2- أما في حالة حركة العتلة (6) الى اليسار فأن الحزام المفتوح (4) يتحرك من البكرة الثابتة (7) الى البكرة السائبة (2) أما الحزام المغلق (5) يتحرك من البكرة السائبة (3) الى البكرة الثابتة (8) فتحصل على أتجاه معاكس للحركة الخارج من المنظومة عن طريق الحزام المغلق (5) و البكرة (8).

المطلوب : صمم المنطقة المنقطة { العمود الخارج و البكرات الثابتة (8 ,7) و البكرات السائبة (2, 3) بحيث تعمل المنظومة و تدور دون أن تتفكك }
(**<u>تصميم متكامل من خلال الرسم وليس الحسابات</u>**) **(12 درجة)**



الشكل (2)

الجامعة التكنولوجية — العام الدراسي 2007-2008
قسم هندسة المكائن والمعدات — المادة: تصميم مكائن
امتحان الدور الأول 2008\6\3 — الصف الثالث كافة الاختصاصات

الزمن : ثلاث ساعات
مع تمنياتنا للجميع بالنجاح انشاء الله

س3: الشكل (3) يمثل منظومة لكبس التمور و هي مكونة من ماطور كهربائي سرعته (**900 rpm**) و تخفض سرعته بواسطة صندوق تروس ومن ثم تخفض مرة اخرى عبر الترسين (B,A) لتكون نسبة التخفيض الكلية هي (**45/1**)

الترس (B) يعمل في نفس الوقت كصامولة (NUT) لتحريك لولب القدرة (Power Screw) نحو الأسفل لكبس التمر الموجود في الأسطوانة

الـ (Collar) مثبت على غطاء الأسطوانة وهو مجوف ولا يدور مع الـ (Power Screw)

أذا علمت أن مقدار الضغط الذي يسلطه المكبس هو ($600 \ N/cm^2$)

وان قطر الاسطوانة الداخلي هو (13 cm)

أوجد :

1- قطر الـ Power Screw بأفتراض (single start thread)

2- القدرة اللازمة للمحرك مع الأخذ بنظر الاعتبار العزم اللازم لتحريك البرغي وعزم الاحتكاك (**T1&T2**)

3- سمك الاسطوانة (t) أذا علمت أن **Allowable tensile stress = $5000 \ N/cm^2$**

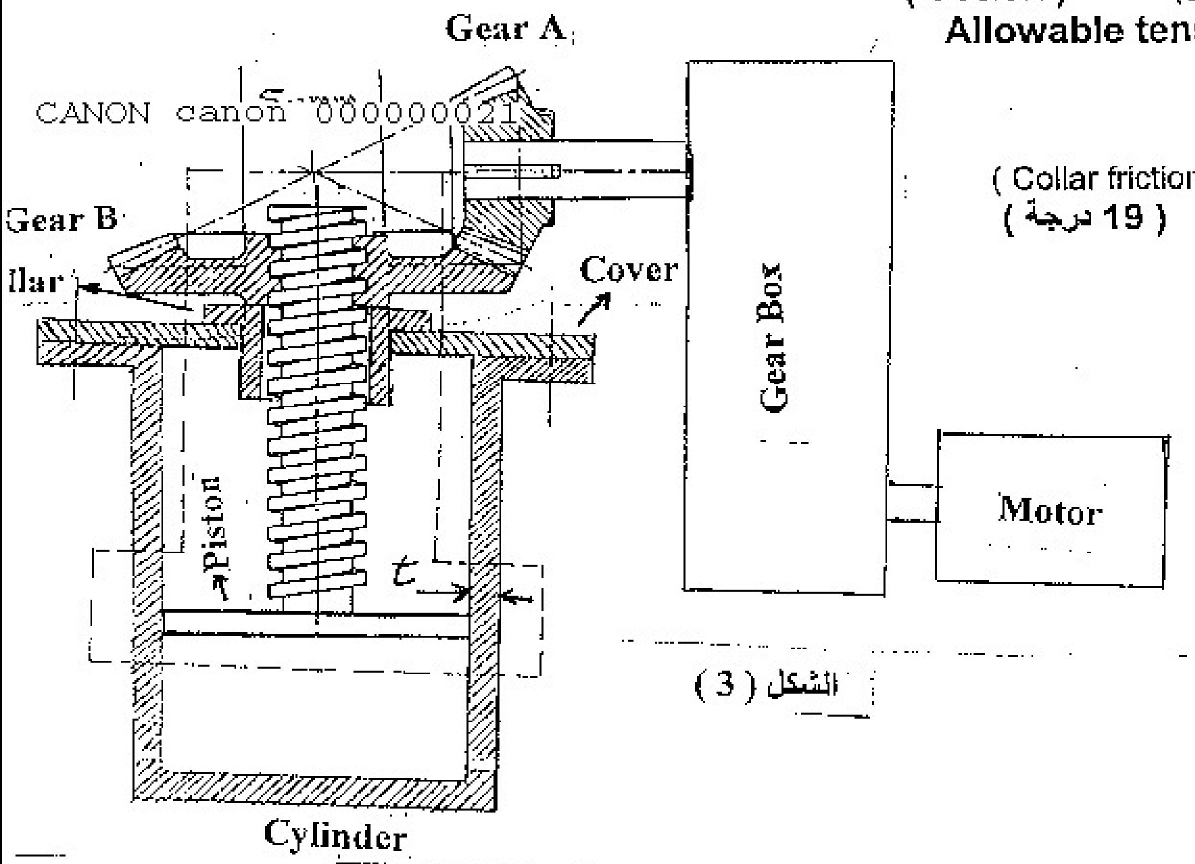
4- أرسم المنطقة المنقطة موضحا

أ- تثبيت لولب القدرة على المكبس

ب- تثبيت الـ collar على غطاء الأسطوانة

ت- تثبيت الترس (B) بحيث يدور بحرية بدون أحتكاك مع الـ Collar (الغاء الـ Collar friction)

ث- وضعية و حركة المكبس داخل الأسطوانة بحيث تعمل الالية وتقوم بكبس التمور (**19 درجة**)



الشكل (3)

س4: الشكل رقم (4) يمثل وصلة ربط.

المعلومات : مقدار القوة (p) هو (90 KN)

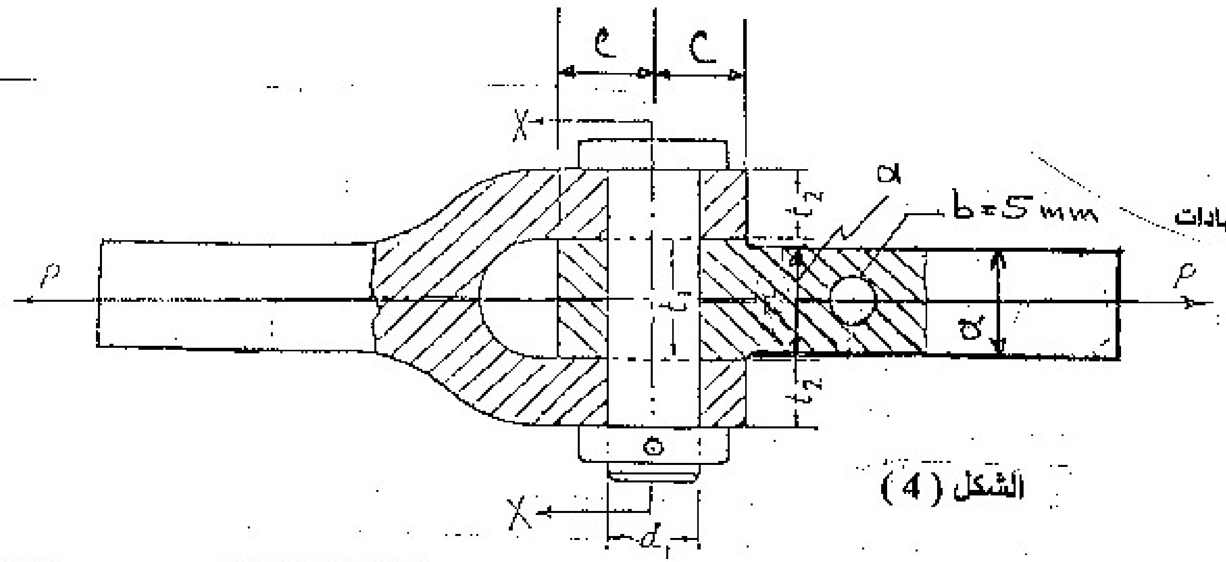
اجهاد الشد المسموح به أينما وجد هو ($150\ N/mm^2$)

اجهاد القص المسموح به أينما وجد هو ($100\ N/mm^2$)

اجهاد التحميل المسموح به أينما وجد هو ($90\ N/mm^2$)

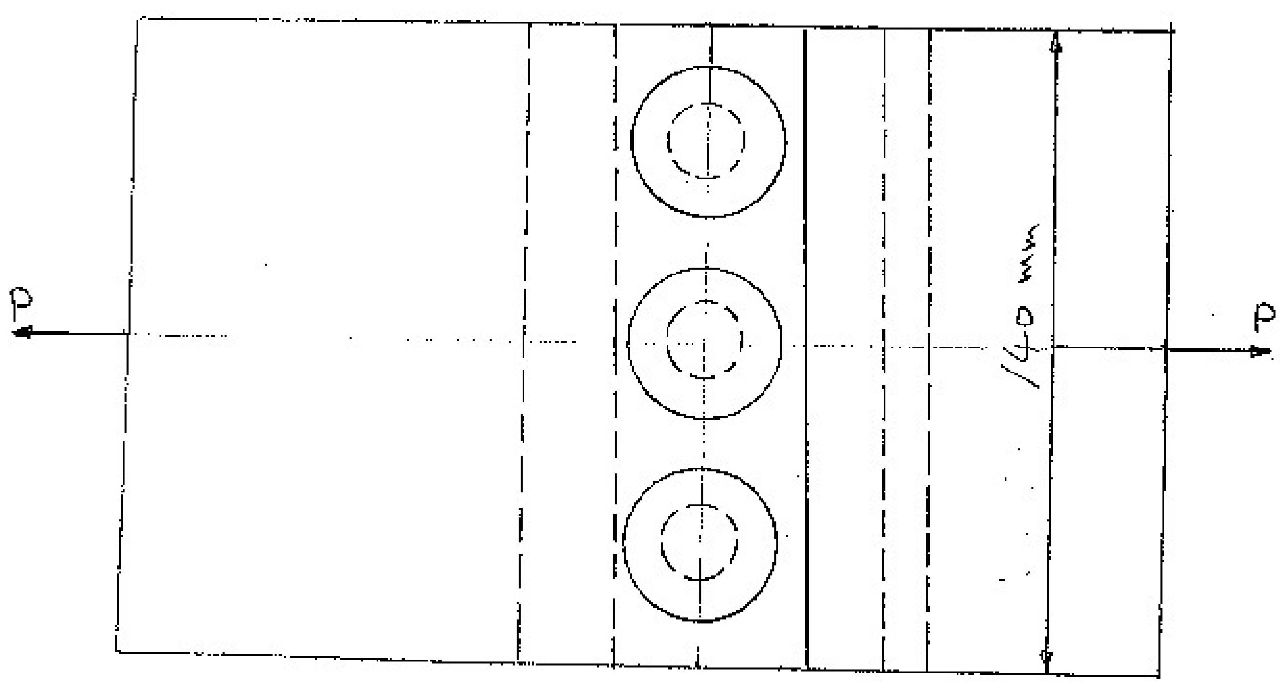
المطلوب : 1- أوجد الأبعاد (t_1, t_2, e, d_1, c, a) تحت تاثير جميع الأجهادات

2- ارسم المقطع (x—x) (12 درجة)



الشكل (4)

CANON canon 000000022



مدرسو المادة	امتحان الفصل الأول	الجامعة التكنولوجية
د.ابراهيم علي د.ذلفاء سلمان	للعام الدراسي 2005–2006	قسم هندسة المكائن والمعدات
السيد جاسم الجاف	مادة:تصميم المكائن I	الصف الثالث كافة الاختصاصات

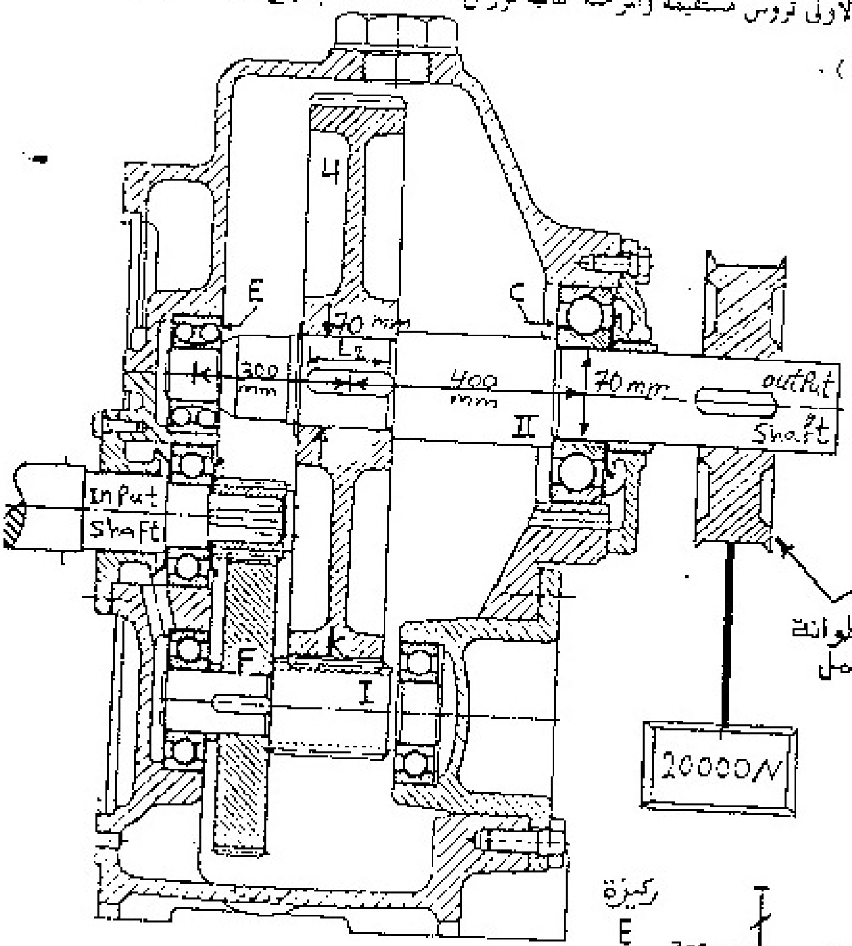
اجب على جميع الأسئلة (الزمن ساعتان)

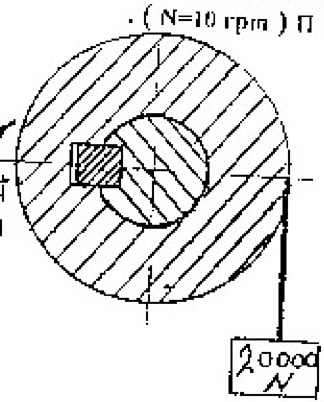
ملاحظة : يسمح بإدخال الكتب ومحاضرات مدرس المادة فقط .

س1/ الشكل (1) يمثل صندوق تروس ذو مرحلتين المرحلة الأولى تروس مستقيمة والمرحلة الثانية تروس مائلة، تستخدم لرفع حمل مقداره (20000 N) عن طريق اسطوانة تربط مع العمود الخارج (Output Shaft) .

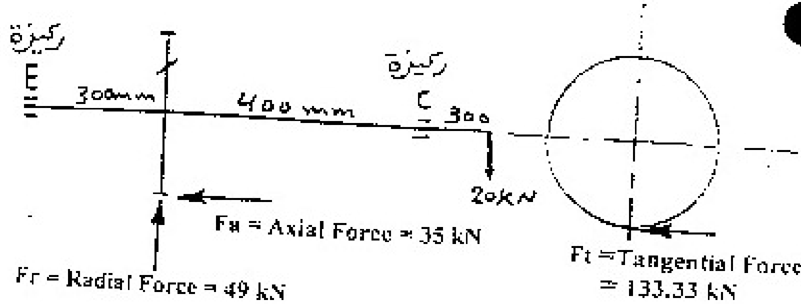
المعلومات :

قطر العمود II (d=70 mm) .
قطر اسطوانة الحمل (D=500 mm) .
تخفيض المرحلة الثانية (I = 5) .
لسهولة الحل افرض الكفاءة (100%) في كل مرحلة .
القوى على الترس المائل 4 هي :-
Ft = Tangential Force = 133.33 kN
Fr = Radial Force = 49 kN
Fa = Axial Force = 35 kN
سرعة دوران العمود II (N=10 rpm) .





(الشكل (1))



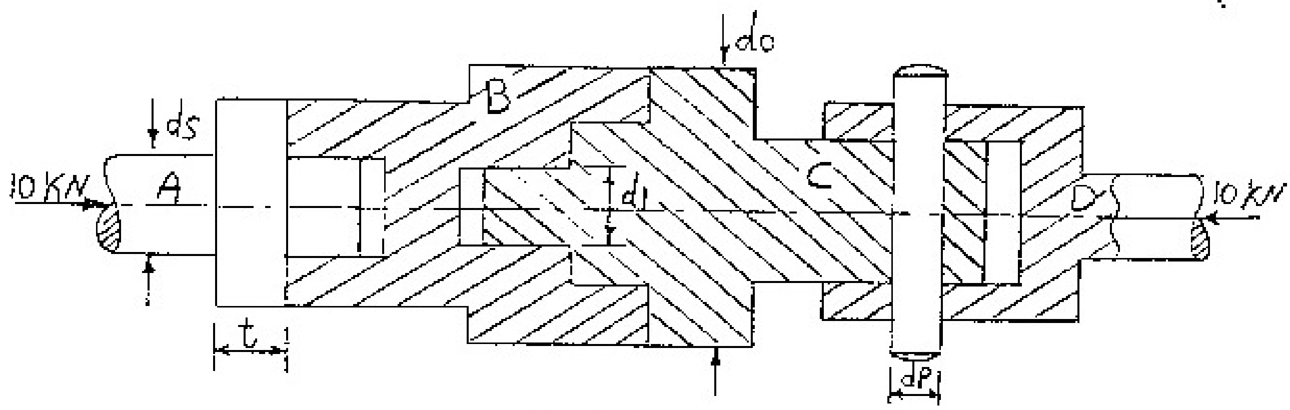
المطلوب :

1- احسب عمر الركيزة (C) (Deep Grove) إذا كان قطر العمود (d = 70 mm) والقوى على الترس المائل4 كما موضح بالرسم قيمها واتجاهاتها
2- احسب إجهاد القص المسموح به (τ_{all}) على الخابور الذي يربط الترس4 إذا علمت أن طول الخابور (L2 = 15 mm) .
3- احسب قطر العمود I عند نقطة (K) وقطر العمود عنده نقطة (F) إذا علمت أن :
اكبر عزم انحناء على العمود I عنده نقطة (K) M_{bK} = 900000 N.mm
اكبر عزم انحناء على العمود I عنده نقطة (F) M_{bF} = 200000 N.mm
افرض معدن العمود I هو St.50:11 .

٩٠/ 50

الجامعة التكنولوجية	امتحان الفصل الأول	مدرسو المادة
قسم هندسة المكائن والمعدات	للعام الدراسي 05—2006	د.ابراهيم علي د.ذلفاء سلمان
الصف الثالث كافة الاختصاصات	مادة تصميم المكائن 1	السيد جاسم الجاف

س2/ الشكل (2) يوضح أربع قطع (A – B – C – D) مركبة مع بعضها ، كل القطع المذكورة ذات مقطع دائري ، تم تسليط قوة خارجية عليها مقدارها (10kN) ، اذا علمت أن (d1=10 mm) أوجد قيمة (do , dp , t , ds) افرض المعدن المناسب ومعامل الأمان المناسب .

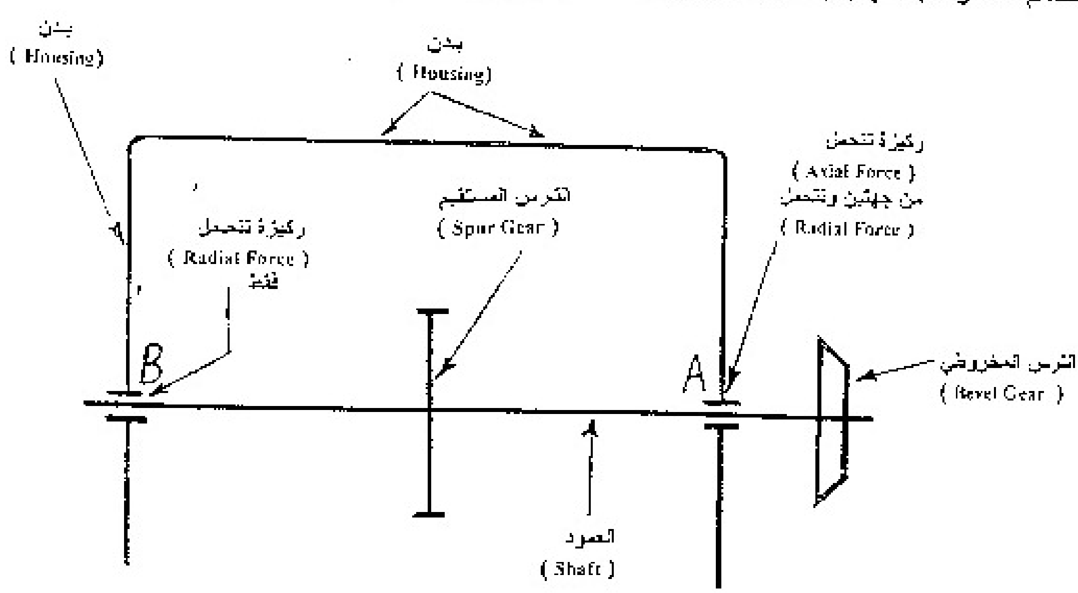


الشكل (2)

35 درجة

س3/ ارسم مقطع كامل للشكل (3) موضحا كافة التفاصيل بحيث تثبت (Bevel Gear) على العمود (Shaft) ، واختار في المنطقة (A) ركيزة تتحمل (Axial Force) من جهتين وتتحمل (Radial Force) ، ثبت الترس المستقيم على العمود ، واختار ركيزة مناسبة في المنطقة (B) بحيث تتحمل (Radial Force) فقط .

ملاحظة : يجب أن تصمم المنظومة بأكملها بحيث تدور دون أن تتفكك أثناء الدوران .



35 درجة

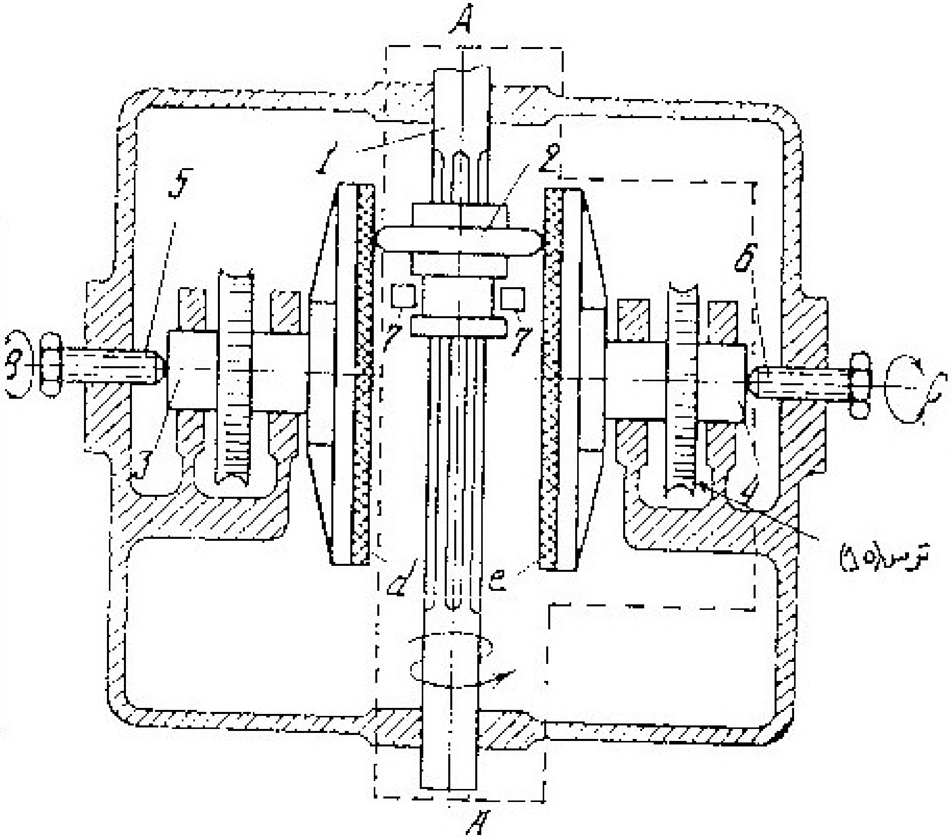
الشكل (3)

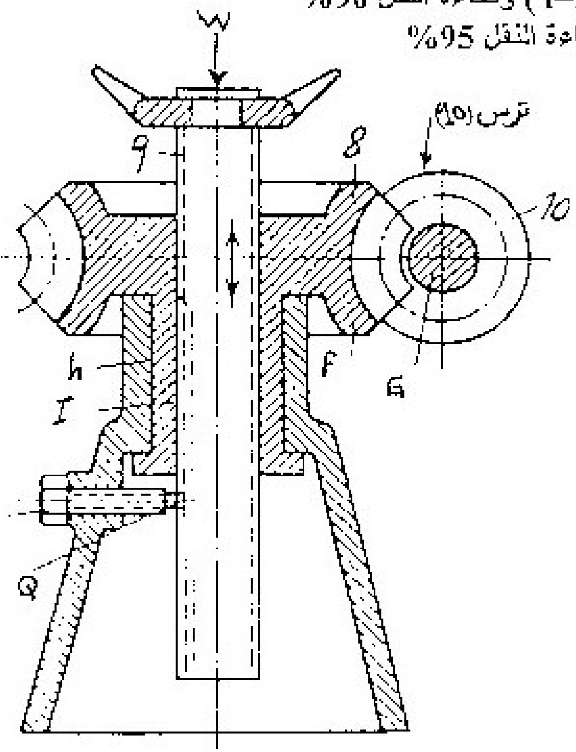
الجامعة التكنولوجية	للعام الدراسي 2006 - 2007	مدرس لمادة
قسم هندسة المكائن والمعدات	المادة: تصميم مكائن للصف الثالث	د. ذلـــفاء سلـــمان
أمتحان الفصل الثاني 2007/4/11	كافة الاختصاصات	المدرس جـــاسم الجاف

ملاحظة: يسمح للطالب بإدخال جميع مايرتبه من الكتب والمحاضرات. (الزمن ساعتان)

(مع اطيب امنياتنا بالنجاح)

المنظومة المبينة في الشكل تعمل على رفع قطعة معدنية وزنها W الى حزام ناقل غير مبين بالرسم عن طريق لولب نقل القدرة الأيمن ثم تدخل القطعة الى قالب فتكبس ومن ثم تنزل الى الأسفل عن طريق لولب نقل قدرة الأيسر الغير واضح بالرسم أيضا . وان جميع العمليات أعلاه مبرمجة وممكن تغير السرعة للمنظومة من خلال حركة القرص (2) للأعلى والأسفل.





المعلومات :

قطر لولب نقل القدرة d1=20.5mm

نوع اللولب trapezoidal threads

عدد البدايات منفردة signal start

نسبة تخفيض بين الأقراص الاحتكاكية (2&e) (i=2) وكفاءة النقل 90%

نسبة تخفيض بين التروس (10&8) (i=3) وكفاءة النقل 95%

قطر العمود(1) d= 50 mm

معدن العمود(1) = St 42 : 11

المطلوب :

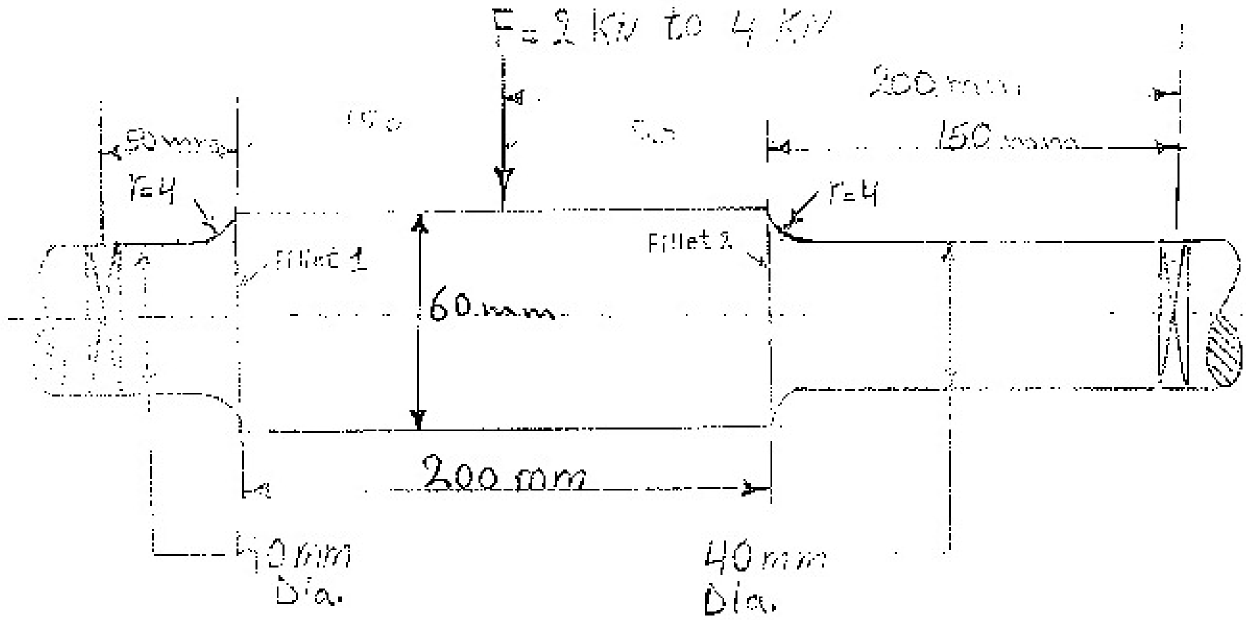
1- صمم مقطع تفصيلي متكامل للمنطقة المنقطة الموضحة بالرسم بحيث تعمل المنظومة ، وكيفية تثبيت القرص الاحتكاكي (e) والترس (10) على العمود (4) وتثبيت العمود (4) على البدن باستخدام ركيزتين نوع (taper roller bearings) مع الأخذ بنظر الاعتبار مقدار المسافة لغرض المعايرة عن طريق البرغي (6) . وامكانية صعود ونزول القرص الاحتكاكي (2) على العمود (1) وكيفية تثبيت العمود (1) على البدن باستخدام ركيزتين نوع (angular contact bearings) ....(70 درجة)

2- احسب وزن القطعة المعدنية (w) المراد رفعها الى الحزام الناقل عن طريق اللولب الايمن مع الأخذ بنظر الاعتبار عدم وجود (collar friction) ومن الضروري تثبيت رايك وما هي الأسباب اذا كان الوزن (w) كبير جدا أو صغير جدا عند أجراءك الحسابات ....(50 درجة)

الجامعة التكنولوجية	للعام الدراسي 2006 – 2007	مدرس المادة
قسم هندسة المكائن والمعدات	المادة: تصميم مكائن الصف الثالث	د. شــفاء سلمان
امتحان الفصل الثاني 2007/3/2	كافة الاختصاصات	المدرس جــاسم الجف

ملاحظة : يسمح للطالب بإدخال جميع ما يرتئية من الكتب والمحاضرات. (الزمن ساعة ونصف)

(مع أطيب أمنيتنا بالنجاح)



في الشكل أعلاه القوة (F) تتغير من (2 الى 4 kN) .

المعلومات :

σB – 38 kgf/mm^2

σF – 19 kgf/mm^2

المطلوب :

أوجـــد عامل الأمـــان في منطـقتي التـــخصر (Fillet) الأولى والثانية من خلال رسم مخطط (σA Diagram) لهذه الحالة.