BITS Pilani, Dubai Campus

Dubai International Academic City, Dubai

COMPREHENSIVE EXAMINATION (CLOSED BOOK)

Year	: 2nd Year	**Date**	: 22.05.2014
Course No.	: ME C312 / ME F241	**Max. Marks**	: 40 (40%)
Course Title	: Design of Machine Elements / Machine Design & Drawing	**Duration**	: 3 hours

Note: *(i) Answer all the questions. (ii) Draw neat sketches wherever necessary.*
(iii) Make suitable assumptions if required and clearly state them.

1. The rotating shaft shown in Fig. Q1 is machined from AISI 1020 CD steel. It is subjected to a force of F = 6 kN. Find the minimum factor of safety for fatigue based on infinite life. If the life is not infinite, estimate the number of cycles. Be sure to check for yielding. **[5 M]**

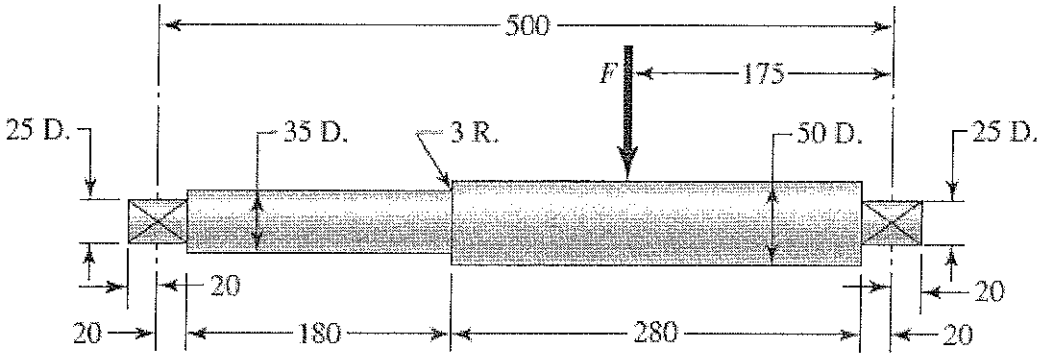
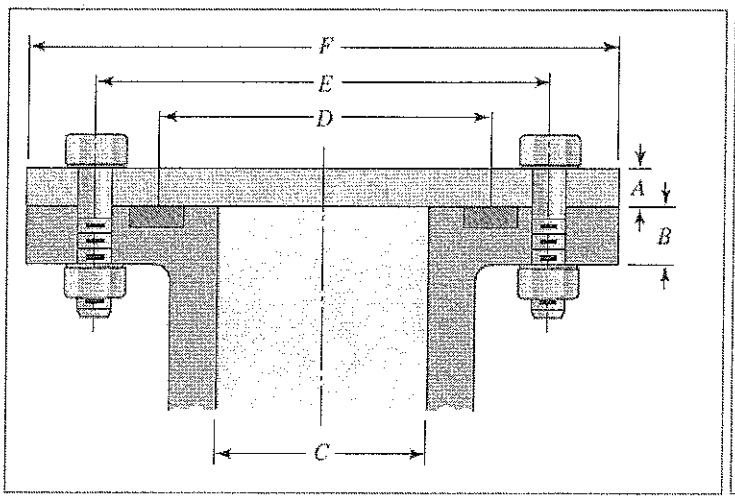


Fig.Q1

2. The upside-down steel A frame shown in fig. Q2 is to be bolted to steel beams on the ceiling of a Fig.Q2 illustrates the connection of a steel cylinder head to a grade 30 cast-iron pressure vessel using N bolts. A confined gasket seal has an effective sealing diameter D. The cylinder stores gas at a maximum pressure p_g. For the specifications given in Fig.Q2, select a suitable bolt length from the preferred sizes. Determine the yielding factor of safety n_p, the load factor n_L, and the joint separation factor n_0. **[5 M]**



A	20 mm
B	25 mm
C	0.8 m
D	0.9 m
E	1.0 m
F	1.1 m
N	36
p_g	550 kPa
Bolt grade	ISO 10.9
Bolt spec.	M10 × 1.5

Fig.Q2

3. The permissible shear stress for the weldment shown in Fig.Q3 is 140 MPa. Estimate the load, F, that will cause this stress in the weldment throat. **[5 M]**

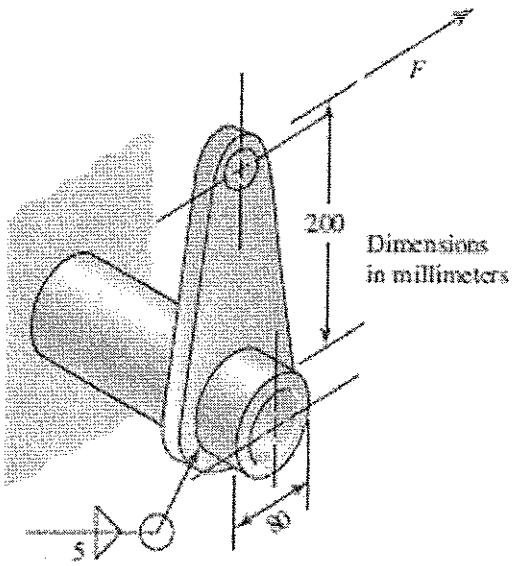


Fig.Q3

4. Consider a helical compression spring with: A228 music wire, square and ground ends, d = 1.2 mm, OD = 6.5 mm, L_0 = 15.7 mm, N_t = 10.2. Investigate to see if it is solid safe. If not, what is the largest free length to which it can be wound using n_s = 1.2? **[5 M]**

5. A certain application requires a ball bearing with inner ring rotating with a design life of 25 kh at a speed of 350 rpm. The radial load is 2.5 kN and an application factor of 1.2 is appropriate. The reliability goal is 0.90. Find the multiple of rating life required, x_D and the catalogue rating C_{10}.
   a. Find for a 02-series deep groove ball bearing, and estimate the reliability in use.
   b. Find for a 02-series cylindrical roller bearing, and estimate the reliability in use.
   c. Which of the two bearings would you select? Why? **[5 M]**

6. A full journal bearing has a journal diameter of 32 mm, with a unilateral tolerance of -0.012 mm. The bushing bore has a diameter of 32.05 mm and a unilateral tolerance of 0.032 mm. The bearing is 64 mm long. The journal load is 1.75 kN and it runs at a speed of 900rpm. If the average viscosity is 55mPa-s, find the:
   a. Minimum film thickness
   b. Maximum film pressure
   c. Total oil flow rate for minimum clearance assembly
   d. Power loss **[5 M]**

7. a. Mention any two types of belt drives. **[2 M]**

   b. Two annular pads, r_i = 98 mm, r_o = 140 mm, subtend an angle of 108°, have a coefficient of friction of 0.37, and are actuated by a pair of hydraulic cylinders 38 mm in diameter. The torque requirement is 1470 N-m. For uniform wear, find:
      i. Largest normal pressure p_a.
      ii. Actuating force F.
      iii. Hydraulic pressure. **[3 M]**

8. Pinion 2 in Fig. Q7(a) runs at 1750 rpm and transmits 2.5 kW to idler gear 3. The teeth are cut on 20° full-depth system and have a module of m = 2.5 mm. For the free body diagram of gear 3 shown in fig. Q7(b), find all the forces that act upon it. **[5 M]**

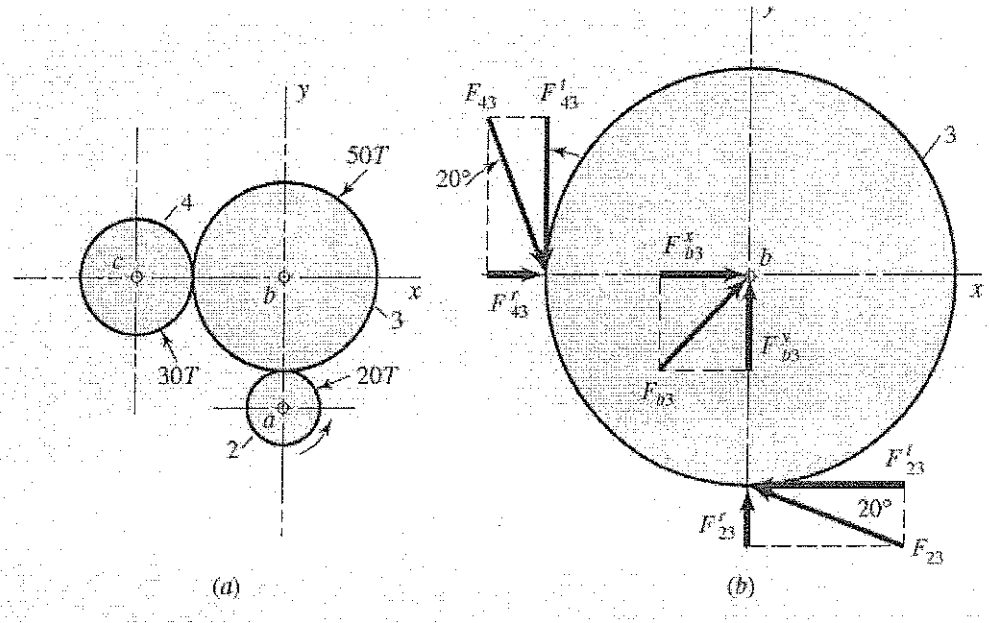


Fig.Q7

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TEST - 2 (OPEN BOOK)

Year	: 2nd Year	**Date**	: 20.04.2014
Course No.	: ME C312 / ME F241	**Max. Marks**	: 20 (20%)
Course Title	: Design of Machine Elements / Machine Design & Drawing	**Duration**	: 50 minutes

Note: *(i) Answer all the questions. (ii) Draw neat sketches wherever necessary.*
(iii) Make suitable assumptions if required and clearly state them.

Q.1 The figure 1 shows a cast-iron bearing block that is to be bolted to a steel ceiling joist and is to support a gravity load of 18 kN. Bolts used are M24 ISO 8.8 with coarse threads and with 4.6 mm thick steel washers under the bolt head and nut. The joist flanges are 20 mm in thickness, and the dimension A, shown in the figure is 20 mm. (a) Find the wrench torque required if the fasteners are lubricated during assembly and the joint is to be permanent. (b) Determine the factors of safety guarding against yielding, overload and joint separation. [10 M]

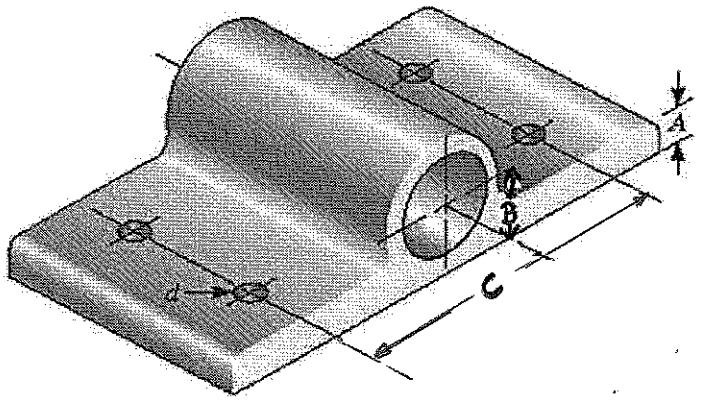


Fig. Q1

Take: Washers: t = 4.6 mm, d = 24mm, D = 36 mm, E = 207 Gpa

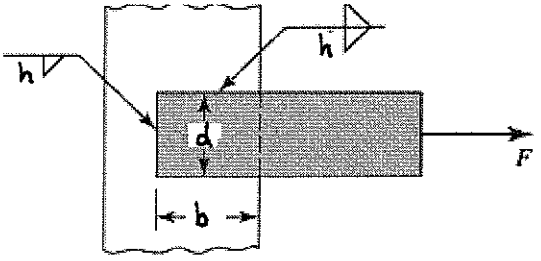
Cast-Iron bearing block: t = 20 mm, d = 24 mm, D = 41.31mm, E = 135 Gpa

Steel ceiling joist = t = 20 mm, d = 24mm, D = 41.31 mm, E = 207 Gpa

Bolt: l =49.2 mm, d = 24 mm

Q.2. A shaft is loaded in bending and torsion such that M_a = 60 N-m, T_a = 40 N-m, M_m= 50 N-m and T_m = 30N-m. For the shaft, S_u = 700 Mpa and S_y = 560 Mpa, and a fully corrected endurance limit of S_e = 210 Mpa is assumed. Let K_f = 2.2 and k_{fs} = 1.8, with design factor of 2.0. Determine the minimum acceptable diameter of the shaft using the (a) DE-Gerber criterion (b) DE-Elliptic criterion [4 M]

Q.3 The weldment shown in the figure is subjected to an alternating force *F*. The hot-rolled steel bar has a thickness 'h' and is of AISI 1010 steel as shown in Fig.Q 3. The vertical support is likewise AISI 1010 HR steel. Take: b= 50mm, d= 50mm. h= 5mm. The electrode is 6010. Estimate the fatigue load *F* the bar will carry if three fillet welds are used. [6 M]



Dimensions in millimeters

Fig. Q 3

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Dubai International Academic City, Dubai

TEST - 1 (CLOSED BOOK)

Year	: 2nd Year	**Date**	: 23.02.2014
Course No.	: ME C312 / ME F241	**Max. Marks**	: 20 (20%)
Course Title	: Design of Machine Elements / Machine Design & Drawing	**Duration**	: 50 minutes

Note: *(i) Answer all the questions. (ii) Draw neat sketches wherever necessary.*
(iii) Make suitable assumptions if required and clearly state them.

1. Explain the numbering system for the metal designated as 'G10250'. How will you specify the AISI designation for the same metal? **[2 M]**

2. A beam is to be supported and loaded as shown in Fig. Q2. Find the diameter of the beam using *singularity function* and appropriate failure theory/theories, if the beam is a ductile material with S_y = 300 MPa. Stock verification report shows that 18 mm, 20 mm, 22 mm and 25 mm diameter beams are available in inventory. As a Design Engineer, what decision would you take regarding the diameter? Why? Take: $a = 0.4$ m; $b = 0.6$ m; $l = 1.0$ m; $w = 200$ N/m; $F = 500$ N; $2.3 \leq n \leq 3.3$. **[8 M]**

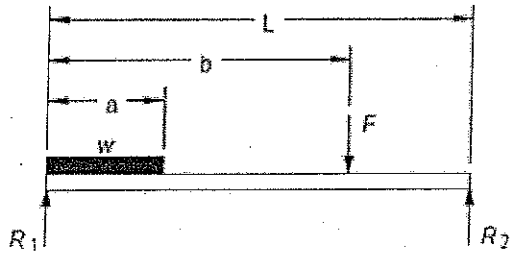
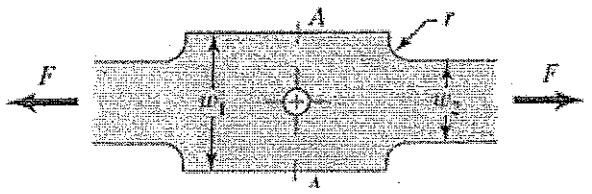


Fig. Q2

3. A connecting-link portion having stress concentration at three sections is shown in Fig. Q3. Neglect column action and find the radius of the fillet '*r*' if the theoretical stress concentration factor is not to exceed 2.0 at the fillet. Also find the maximum stress at the fillet if the force F = 15 kN. Take the thickness of the link as 10 mm. **[3 M]**



$w_1 = 90$ mm

$w_2 = 60$ mm

Fig. Q 3

4. A 25 mm diameter solid round bar has a groove 2.5 mm deep with a 2.5 mm radius machined into it as shown in Fig.Q4. The bar is made of AISI 1018 CD steel and is subjected to a purely reversing torque of 200 N-m. Estimate the number of cycles to failure. Assume the Marin factors are equal to one except 's_e' and s_e'. **[7 M]**

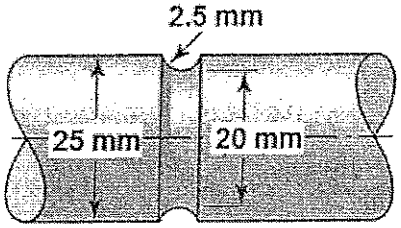


Fig. Q4

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QUIZ - 1 (CLOSED BOOK)

Year	: 2nd Year	**Date**	: 16.03.2014
Course No.	: ME C312 / ME F241	**Max. Marks**	: 5 (5%)
Course Title	: Design of Machine Elements / Machine Design & Drawing	**Duration**	: 20 minutes

Note: *(i) Answer all the questions. (ii) Draw neat sketches wherever necessary.*
(iii) Make suitable assumptions if required and clearly state them.

1. Draw the fatigue diagram showing the various criteria of failure. Also list the failure criteria in the increasing order of conservativeness. Give reasons. **[1.5 M]**

2. With neat diagrams, illustrate the stress-time relations for fluctuating stress, completely reversed stress and repeated stress. Show σ_{max} and σ_{min} for each relation. **[1.0 M]**

3. Mention the type of fit for Fig. 3a & Fig. 3b. **[1.0 M]**

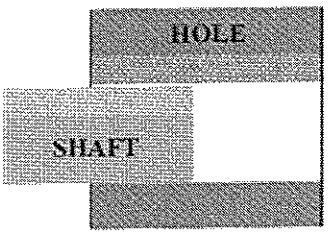

Fig. 3a

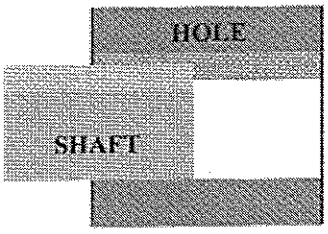

Fig. 3b

4. What dimensions are needed for a lightly loaded journal and bushing assembly for a 50 mm basic size with a H8/f7 close running fit? Make use of the tables given below. **[1.5 M]**

Basic Sizes	Tolerance Grades					
	IT6	IT7	IT8	IT9	IT10	IT11
0–3	0.006	0.010	0.014	0.025	0.040	0.060
3–6	0.008	0.012	0.018	0.030	0.048	0.075
6–10	0.009	0.015	0.022	0.036	0.058	0.090
10–18	0.011	0.018	0.027	0.043	0.070	0.110
18–30	0.013	0.021	0.033	0.052	0.084	0.130
30–50	0.016	0.025	0.039	0.062	0.100	0.160
50–80	0.019	0.030	0.046	0.074	0.120	0.190

Basic Sizes	Upper-Deviation Letter					Lower-Deviation Letter				
	c	d	f	g	h	k	n	p	s	u
0–3	−0.060	−0.020	−0.006	−0.002	0	0	+0.004	+0.006	+0.014	+0.018
3–6	−0.070	−0.030	−0.010	−0.004	0	+0.001	+0.008	+0.012	+0.019	+0.023
6–10	−0.080	−0.040	−0.013	−0.005	0	+0.001	+0.010	+0.015	+0.023	+0.028
10–14	−0.095	−0.050	−0.016	−0.006	0	+0.001	+0.012	+0.018	+0.028	+0.033
14–18	−0.095	−0.050	−0.016	−0.006	0	+0.001	+0.012	+0.018	+0.028	+0.033
18–24	−0.110	−0.065	−0.020	−0.007	0	+0.002	+0.015	+0.022	+0.035	+0.041
24–30	−0.110	−0.065	−0.020	−0.007	0	+0.002	+0.015	+0.022	+0.035	+0.048
30–40	−0.120	−0.080	−0.025	−0.009	0	+0.002	+0.017	+0.026	+0.043	+0.060
40–50	−0.130	−0.080	−0.025	−0.009	0	+0.002	+0.017	+0.026	+0.043	+0.070
50–65	−0.140	−0.100	−0.030	−0.010	0	+0.002	+0.020	+0.032	+0.053	+0.087

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