Name:
Enrolment No:

UPES

End Semester Examination, December 2023

Course: Design of Machine Elements **Semester: V**

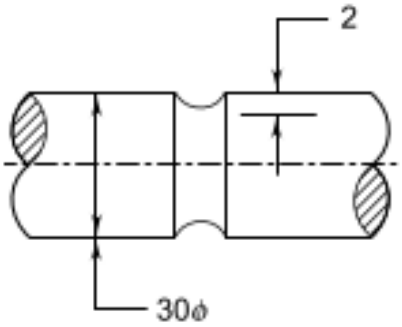
Program: B.Tech Mechanical **Time : 03 hrs.**

Course Code: MECH3001 **Max. Marks: 100**

Instructions: 1. All the questions are compulsory.

2. Use of Design Data Handbook is allowed.

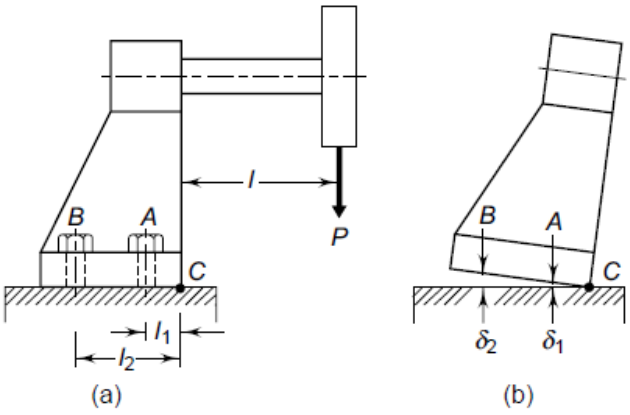
SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Identify the process involved for the approximate estimation of endurance limit.	**4**	**CO1**
Q 2	Define endurance life and endurance limit.	**4**	**CO1**
Q 3	Explain the procedure to minimize the stress concentration in keyways.	**4**	**CO1**
Q 4	It is required to standardize 11 speeds from 72 to 720 rpm for a machine tool. Specify the speeds.	**4**	**CO1**
Q 5	Designate the steel i. carbon = 0.12–0.18%, silicon = 0.15–0.35%, manganese = 0.40–0.60% ii. chromium = 0.55–0.85%carbon = 0.20–0.30%, silicon = 0.15–0.55%, manganese = 0.35–0.55%, nickel = 1.5–2.5%, chromium = 12–22%	**4**	**CO1**
SECTION B (4Qx10M= 40 Marks)			
Q 6	A polished steel bar 30C8 (S_{ut}=1250 N/mm^2) is subjected to axial tensile force P. It has a groove 2 mm deep and having a radius of 3 mm. The notch sensitivity factor at the groove is .95. The outer diameter of the bar is 30 mm. The endurance limit in completely reversed bending is 600 MPa. Find the maximum force that the bar can carry for 10^5 cycles with 90% reliability.  **Table : Values of coefficients a and b in surface finish factor**	**10**	**CO2**

Surface finish	*a*	*b*
Ground	1.58	– 0.085
Machined or cold-drawn	4.51	– 0.265
Hot-rolled	57.7	– 0.718
As forged	272	– 0.995

Table : Values of size factor

Diameter (d) (mm)	K_b
$d \le 7.5$	1.00
$7.5 < d \le 50$	0.85
$d > 50$	0.75

Q 7	It is required to design a cotter joint to connect two steel rods of equal diameter. Each rod is subjected to an axial tensile force of 50 kN. Design the joint and specify its main dimensions.	**10**	**CO2**
Q 8	It is required to design a square key for fixing a pulley on the shaft, which is 75 mm in diameter. The pulley transmits 18 kW power at 100 rpm to the shaft. Select a suitable material & determine the dimensions of the key. OR A taper roller bearing has a dynamic load capacity of 35 kN. The desired life for 90% of the bearings is 10000 h and the speed is 450 rpm. Calculate the equivalent radial load that the bearing can carry.	**10**	**CO2**
Q 9	Cast iron bracket fixed to the steel structure is shown in Fig. It supports a load P of 25 kN. There are two bolts at A and two bolts at B. The distances are as follows, l_1 = 50 mm l_2 = 200 mm l = 400 mm. Determine the size of the bolts, if maximum permissible tensile stress in the bolt is 50 N/mm^2.  	**10**	**CO2**
SECTION-C (2Qx20M=40 Marks)			
Q 10	It is required to design a pair of spur gears The pinion shaft is connected to a 15 kW, 2000 rpm motor. The starting torque of the motor is 125% of the rated torque. The speed reduction is 4:1. Design the gears, specify their dimensions and suggest suitable surface hardness for the gears.	**20**	**CO3**

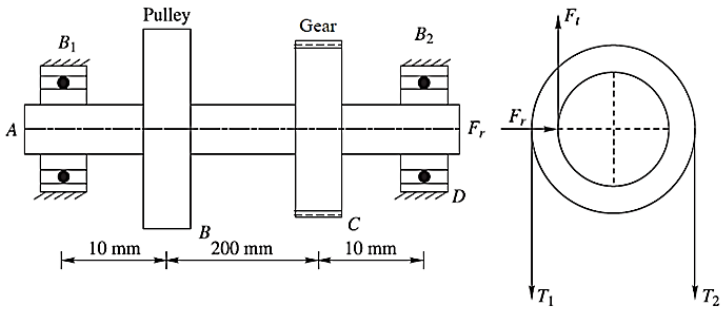
Q 11	The armature shaft of a 40 kW, 720 rpm electric motor, mounted on two bearings A and B, is shown in Fig. The total magnetic pull on the armature is 7 kN and it can be assumed to be uniformly distributed over a length of 700 mm midway between the bearings. The shaft is made of steel with an ultimate tensile strength of 770 N/mm^2 and yield strength of 580 N/mm2. Determine the shaft diameter using the ASME code if, C_m = 1.5 and C_t = 1.0. Assume that the pulley is keyed to the shaft. **OR** A shaft made of steel receives 7.5 kW at 1440 rpm. A pulley mounted on the shaft has a diameter of 0.4 m and ratio of belt tensions is 3.5. (See figure given below) The teeth on gear of 250 mm pitch circle diameter has a 20° involute profile. Shaft diameter at bearing B1 is 25 mm and 20 mm at bearing B2. Taking load factor as 1.4, select the suitable deep-groove ball bearings for B1 and B2, respectively. What is the life of each bearing in hours? **(Please refer the data given in table)** 	**20**	**CO3**

Table : X & Y Factors for single row deep groove ball bearings

$\left(\frac{F_a}{C_0}\right)$	$\left(\frac{F_a}{F_r}\right) \le e$		$\left(\frac{F_a}{F_r}\right) > e$		e
	X	Y	X	Y	
0.025	1	0	0.56	2.0	0.22
0.040	1	0	0.56	1.8	0.24
0.070	1	0	0.56	1.6	0.27
0.130	1	0	0.56	1.4	0.31
0.250	1	0	0.56	1.2	0.37
0.500	1	0	0.56	1.0	0.44

Table *Dimensions and static and dynamic load capacities of single-row deep groove ball bearings*[4]

Principal dimensions (mm)			*Basic load ratings (N)*		*Designation*
d	*D*	*B*	*C*	C_0	
10	19	5	1480	630	61800
	26	8	4620	1960	6000
	30	9	5070	2240	6200
	35	11	8060	3750	6300
12	21	5	1430	695	61801
	28	8	5070	2240	6001
	32	10	6890	3100	6201
	37	12	9750	4650	6301
15	24	5	1560	815	61802
	32	9	5590	2500	6002
	35	11	7800	3550	6202
	42	13	11400	5400	6302
17	26	5	1680	930	61803
	35	10	6050	2800	6003
	40	12	9560	4500	6202
	47	14	13500	6550	6303
	62	17	22900	11800	6403
20	32	7	2700	1500	61804
	42	8	7020	3400	16404
	42	12	9360	4500	6004
	47	14	12700	6200	6204
	52	15	15900	7800	6304
	72	19	30700	16600	6404
25	37	7	3120	1960	61805
	47	8	7610	4000	16005
	47	12	11200	5600	6005
	52	15	14000	6950	6205
	62	17	22500	11400	6305
	80	21	35800	19600	6405
30	42	7	3120	2080	61806
	55	9	11200	5850	16006
	55	13	13300	6800	6006
	62	16	19500	10000	6206
	72	19	28100	14600	6306
	90	23	43600	24000	6406
35	47	7	4030	3000	61807
	62	9	12400	6950	16007
	62	14	15900	8500	6007
	72	17	25500	13700	6207
	80	21	33200	18000	6307
	100	25	55300	31000	6407
40	52	7	4160	3350	61808
	68	9	13300	7800	16008
	68	15	16800	9300	6008
	80	18	30700	16600	6208
	90	23	41000	22400	6308
	110	27	63700	36500	6408
45	58	7	6050	3800	61809
	75	10	15600	9300	16009
	75	16	21200	12200	6009
	85	19	33200	18600	6209
	100	25	52700	30000	6309
	120	29	76100	45500	6409
50	65	7	6240	4250	61810
	80	10	16300	10000	16010
	80	16	21600	13200	6010
	90	20	35100	19600	6210
	110	27	61800	36000	6310
	130	31	87100	52000	6410
55	72	9	8320	5600	61811
	90	11	19500	12200	16011
	90	18	28100	17000	6011
	100	21	43600	25000	6211
	120	29	71500	41500	6311
	140	33	99500	63000	6411
60	78	10	8710	6100	61812
	95	11	19900	13200	16012
	95	18	29600	18300	6012
	110	22	47500	28000	6212
	130	31	81900	48000	6312
	150	35	108000	69500	6412
65	85	10	11700	8300	61813
	100	11	21200	14600	16013
	100	18	30700	19600	6013
	120	23	55900	34000	6213
	140	33	92300	56000	6313
	160	37	119000	78000	6413

(Contd)