
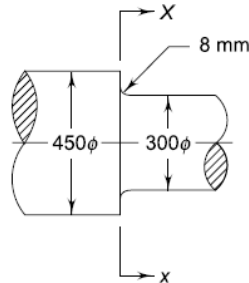


Name: Enrolment No:			
<b>UPES</b> <b>End Semester Examination, December 2024</b>			
<b>Course: Design of Machine Elements</b> <b>Program: B.Tech Mechanical, ADE and Mechatronics</b> <b>Course Code: MECH3024</b>		<b>Semester: V</b> <b>Time : 03 hrs.</b> <b>Max. Marks: 100</b>	
<b>Instructions: 1. All the questions are compulsory.</b> <b>2. Use of Design Data Handbook is allowed.</b>			
<b>SECTION A (5Qx4M=20Marks)</b>			
S. No.		Marks	CO
Q 1	Identify the process involved for the approximate estimation of endurance limit.	4	CO2
Q 2	Define and classify the fluctuating load.	4	CO2
Q 3	Explain the procedure to minimize the stress concentration in stepped shaft.	4	CO1
Q 4	Develop R5 and R10 series.	4	CO1
Q 5	Designate the steel i. Carbon = 0.12–0.20%, silicon = 0.15–0.35%, manganese = 0.60–1.00%, nickel = 0.60–1.00%, chromium = 0.40–0.80%. ii. Carbon = 0.15–0.25%, silicon = 0.10–0.50%, manganese = 0.30–0.50%, nickel = 1.5–2.5%, chromium = 16–20%	4	CO1
<b>SECTION B (4Qx10M= 40 Marks)</b>			
Q 6	The section of a steel shaft is shown in Fig. The shaft is machined by a turning process. The section at XX is subjected to a constant bending moment of 500 kN-m. The shaft material has ultimate tensile strength of 500 MN/m <sup>2</sup> , yield point of 350 MN/m <sup>2</sup> and endurance limit in bending for a 7.5 mm diameter specimen of 210 MN/m <sup>2</sup> . The notch sensitivity factor can be taken as 0.8. The theoretical stress concentration factor may be interpolated from the following tabulated values. where $r_f$ is the fillet radius and $d$ is the shaft diameter. The reliability is 90%. Determine the life of the shaft.	10	CO2

$\left(\frac{r_f}{d}\right)$	0.025	0.05	0.1
$K_t$	2.6	2.05	1.66



**Table : Values of coefficients a and b in surface finish factor**

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)	$K_b$
$d \leq 7.5$	1.00
$7.5 < d \leq 50$	0.85
$d > 50$	0.75

**Table: Reliability factor**

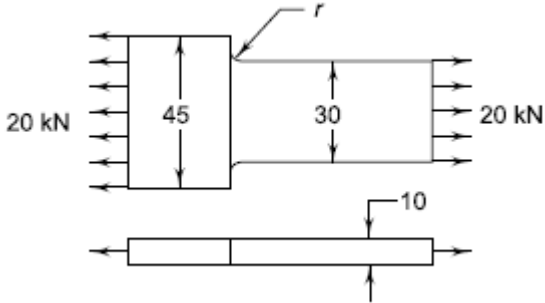
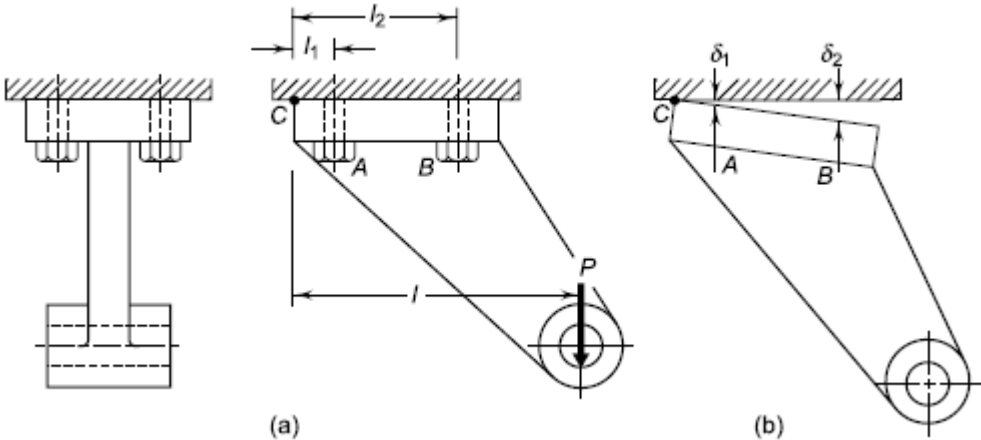
Reliability R (%)	$K_c$
50	1.000
90	0.897
95	0.868
99	0.814
99.9	0.753
99.99	0.702
99.999	0.659

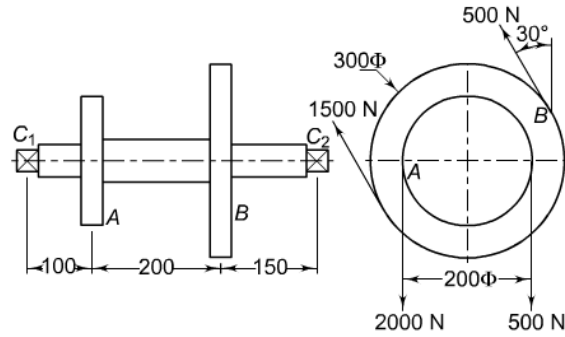
Q 7

A plate, 10 mm thick, subjected to a tensile load of 20 kN is shown in Fig. The plate is made of cast iron ( $S_{ut} = 350 \text{ N/mm}^2$ ) and the factor of safety is 2.5. Determine the fillet radius.

10

CO2

			
Q 8	It is required to design a cottor joint to connect two rods of 25 mm dia subjected under 10 kN load.	10	CO3
Q 9	<p>A 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, <math>l_1 = 50</math> mm <math>l_2 = 200</math> mm <math>l = 400</math> mm. Determine the size of the bolts, if maximum permissible tensile stress in the bolt is <math>50</math> N/mm<sup>2</sup>.</p> 	10	CO3
<b>SECTION-C (2Qx20M=40 Marks)</b>			
Q 10	It is required to design a pair of spur gears. The pinion shaft is connected to a 10 kW, 1440 rpm motor. The starting torque of the motor is 150% 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	CO4
Q 11	A transmission shaft, supporting two pulleys A and B and mounted between two bearings C1 and C2 is shown in Fig. Power is transmitted from the pulley A to B. The shaft is made of plain carbon steel 45C8 ( $S_{ut} = 600$ and $S_{yt} = 380$ N/mm <sup>2</sup> ). The pulleys are keyed to the shaft. Determine the shaft diameter using the ASME code.	20	CO4



OR

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<sup>2</sup> and yield strength of 580 N/mm<sup>2</sup>. 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.

