UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2019

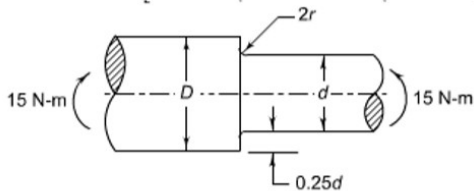Course: **Design of Machine Elements**   Semester: **VI**
Program: **B.Tech** Mechatronics   **Time 03 hrs.**
Course Code: MECH 3001   **Max. Marks: 100**

Instructions: Use of Design data handbook is allowed.
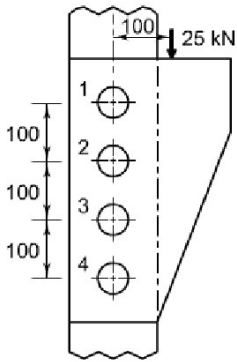
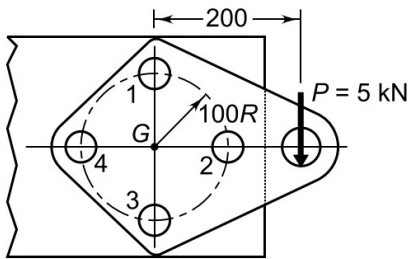|	SECTION A		
S. No.		**Marks**	**CO**
Q 1	Describe the stress concentration and different approaches to minimize stress concentration in threaded members & shaft with keyways ?	5	**CO2**
Q 2	Determine the numbers of R5 basic series from 1 to 10 ?	5	**CO1**
Q 3	List out the steps involved in process of Machine Design?	5	**CO1**
Q 4	A round shaft made of a brittle material and subjected to a bending moment of 15 N-m is shown in fig below. The stress concentration factor at the fillet is 1.5 and the ultimate tensile strength of the shaft material is 200 N/mm2. Determine the diameter d, the magnitude of stress at the fillet and the factor of safety.	5	**CO2**
SECTION B			
Q 3	A bracket, attached to a vertical column by means of four identical bolts, is subjected to an eccentric force of 25 kN as shown in Fig below. Determine the bolt size, if the permissible shear stress is 60 N/mm2.	10	**CO3**

OR

A bolted joint, consisting of four identical rivets, is subjected to an eccentric force of 5 kN as shown in fig. Determine the size of bolts, if the permissible shear stress is 60 N/mm^2.
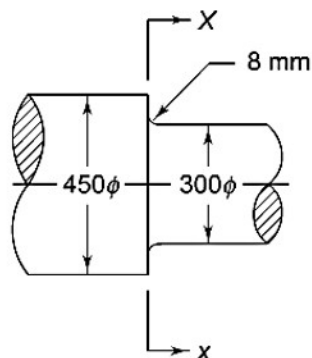

Q 4	The section of a steel shaft is shown in Fig below. The shaft is machined by a turning process. The section at XX is subjected to a constant bending moment of 500 kN-m. The shaft material has ultimate tensile strength of 500 MN/m2, yield point of 350 MN/m2 and endurance limit in bending for a 7.5 mm diameter specimen of 210 MN/m2. The notch sensitivity factor can be taken as 0.8. The reliability is 90% (Kc=.897).Determine the life of the shaft.	15	CO2

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
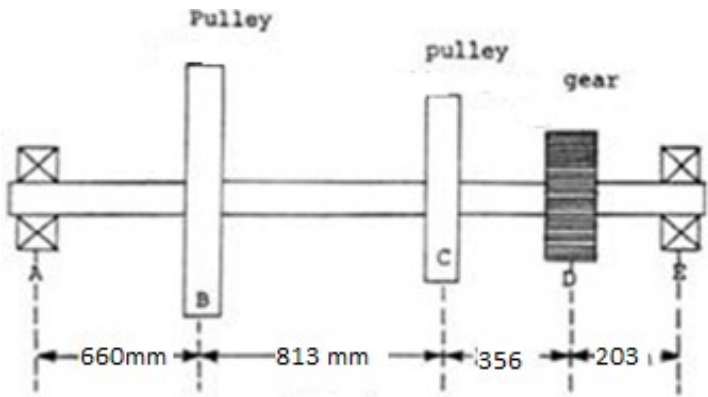
Values of size factor

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

Q 5	A rigid coupling is used to connect a 45 kW, 1440 rpm electric motor to a centrifugal pump. The starting torque of the motor is 225% of the rated torque. There are 8 bolts and their pitch circle diameter is 150 mm. Select suitable materials for various parts of the coupling, design the coupling and specify the dimensions of its components.	15	CO4

SECTION-C

Q 6	A textile industry, due to specific adjustments, requires the configuration of a power transmission shaft as shown in Figure 1. The prime mover is an electric motor supplying 50 kW, to the 15° involute gear D of 405 mm. pitch circle diameter, with the shaft rotating at 300 rpm. Pulley C, 710 mm. diameter, distributes 45 kW, to a loom, at an angle of 50° to the horizontal below the main shaft. Pulley B, 813 mm. diameter, distributes 15 kW to a conveyor belt starting at a location vertically down to the main shaft. The angle of wrap and the belt tension ratio for both the pulleys are 180° and 2.5, respectively. Since the loading on the shaft is fluctuating, the combined fatigue and shock factors can be taken as 2 and 2.5, respectively. Working stresses, for the material selected, are 70 N/mm² in tension and 48 N/mm² in shear. Calculate for the safe diameter of the shaft.	20	CO4

OR

A centrifugal pump is run continuously at 500 rpm by an electric motor that makes 2000 rpm. 50 hp is delivered by the motor shaft to the pump shaft by means of a spur gear drive as shown in the figure below. Design the gear drive.

| Q 7	A shaft transmitting 50 kW at 125 rpm from the gear G1 to the gear G2 and mounted on two single-row deep groove ball bearings B1 and B2 is shown in Fig below. The gear tooth forces are $Pt1 = 15915$ N $Pr1 = 5793$ N $Pt2 = 9549$ N $Pr2 = 3476$ N. The diameter of the shaft at bearings B1 and B2 is 75 mm. The load factor is 1.4 and the expected life for 90% of the bearings is 10000 h. Select suitable ball bearings.	20	CO4

G₂

150

B₂

500

P_{r2}

P_{t2}

G₁

125

P_{t1}

B₁

P_{r1}
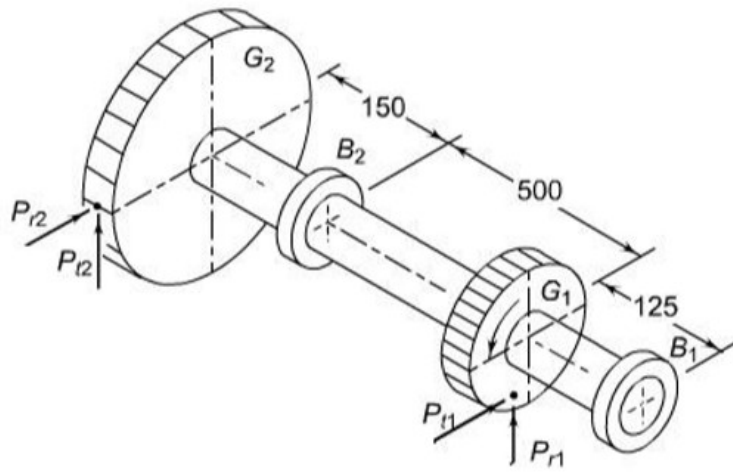
Table : *Dimensions and static and dynamic load capacities of single-row deep groove ball bearings*[4]

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

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
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

Principal dimensions (mm)			Basic load ratings (N)		Designation
d	D	B	C	C_0	
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