Name: **Enrolment No:**	

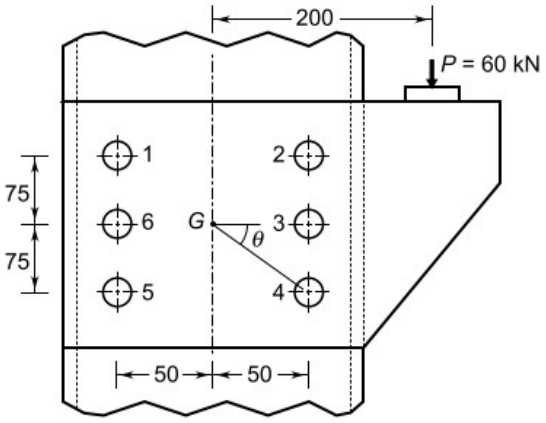
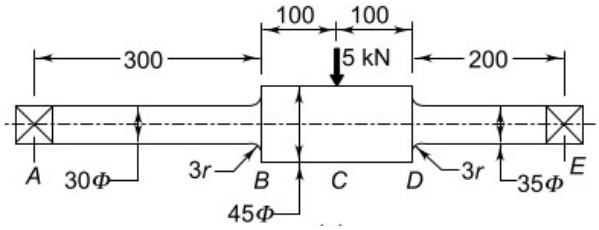
UNIVERSITY OF PETROLEUM AND ENERGY STUDIES
End Semester Examination, May 2022

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

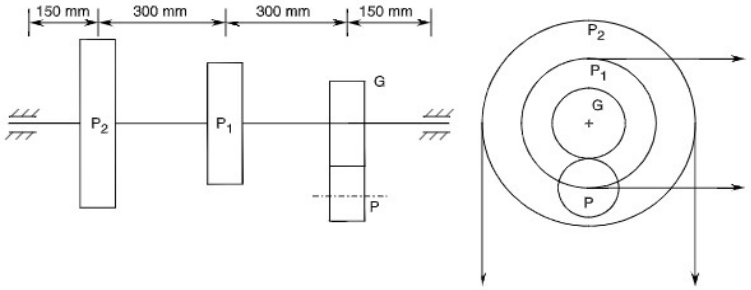
Instructions: 1. All the questions are compulsory and assume any missing data.
2. Use of Design Data Handbook is allowed.

SECTION A
(5Qx4M=20Marks)

S. No.		Marks	CO
Q 1	Briefly summarize the following terminologies: i. Circular Pitch ii. Clearance iii. Pitch Circle iv. Addendum	4	CO4
Q 2	Identify the process involved for the approximate estimation of endurance limit.	4	CO2
Q 3	Identify the different steps involved in design of machine elements.	4	CO1
Q 4	Develop R5 and R10 series.	4	CO1
Q 5	Explain the procedure to minimize the stress concentration in keyways.	4	CO2
	SECTION B **(4Qx10M= 40 Marks)**		
Q 6	A bracket is attached to the vertical column by means of six identical bolts as shown in fig. It is subjected to an eccentric force of 60 kN at a distance of 200 mm from the centre of the column. The maximum permissible shear for the bolt is 150 N/mm^2. Determine the size of the bolts.	10	CO3

			
Q 7	A rotating shaft subjected to a non rotating force of 5 kN and simply supported between two bearings A & e is shown in fig. The shaft is machined from plain carbon steel 30C8 (S_{ut} = 500 N/mm^2) and expected reliability is 90% (i.e. reliability factor is .897). The equivalent notch radius at the fillet section can be taken as 3 mm. what is the life of the shaft?  **OR** A forged steel bar 50 mm in diameter is subjected to a reversed bending stress of 250 N/mm^2. The bar is made of steel 40C8 (S_{ut} = 600 N/mm^2). Calculate the life of the bar for a reliability of 90%(i.e. k_c = 0.897). **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**	**10**	**CO2**

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

Q 8	Design a rigid type of flange coupling to connect two shafts of 36 mm diameter transmitting 15 kW at 720 rpm. The overload capacity is 1.25 times of the rated torque. Select the suitable material for the required components.	**10**	**CO4**
Q 9	It is required to design a square key for fixing a pulley on the shaft, which is 50 mm in diameter. The pulley transmits 10 kW power at 200 rpm to the shaft. The key is made of steel 45C8 (*Syt* = *Syc* = 380 N/mm2) and the factor of safety is 3. Determine the dimensions of the key.	**10**	**CO4**
	SECTION-C **(2Qx20M=40 Marks)**		
Q 10	A line shaft received power through a gear and pinion. The pinion is connected to an electric motor delivering 30 kW at 1200 rpm, of which 20 kW is supplied to a milling machine through a horizontal pulley drive at P1 and the remainder of the power is supplied to a planer through pulley P2 by a vertical belt. The diameters of gear and pinion are 300 mm and 100 mm, respectively. The diameter of pulleys P1 and P2 are 750 mm and 900 mm respectively. The the layout of the shaft is shown in fig below and the ratio of belt tensions in both drives is 2.0, design the shaft on the basis of strength.  **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	**20**	**CO4**

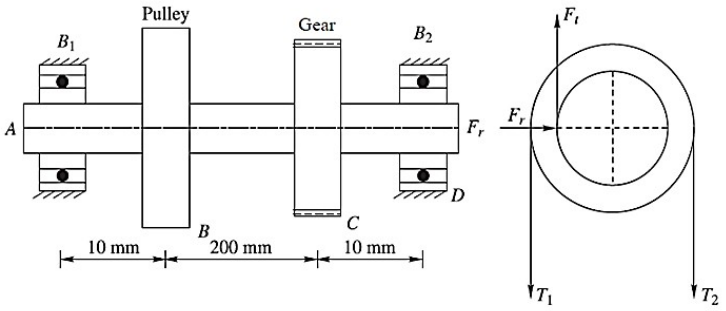
	the life of each bearing in hours? **(Please refer the data given in table)** 		
Q 11	A centrifugal pump is run continuously at 500 rpm by an electric motor that makes 2000 rpm. 50 hp is delivered by the motor shaft to the pump shaft by means of a spur gear drive as shown in the figure below. Design the gear drive.	**20**	**CO4**

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

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
	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

(Contd)

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
	100	18	30700	19600	6013
	120	23	55900	34000	6213
	140	33	92300	56000	6313
	160	37	119000	78000	6413

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