Ref. No.: Ex/ME/5/T/313/2025

BACHELOR OF ENGINEERING (MECHANICAL ENGINEERING)
THIRD YEAR, FIRST SEMESTER - 2025
MACHINE DESIGN- II

Time: 3 hours **Full Marks: 100**

Data if missing may be assumed reasonably
The symbols used in the questions, bear their usual meaning

Answer any Five questions

1. Design and draw a protective type rigid flange coupling which is expected to transmit a power of 20kW at 720 rpm. The starting torque of the motor to which the coupling is connected may be assumed as 150% of the rated torque. Assume suitable materials and relevant factors for the design. List all the major dimensions at the end. [15+5]

2. Design and draw a knuckle joint for a load capacity of 20kN. Assume suitable materials and factor of safety for the components. List the dimensions at the end. [15+5]

3. (a) Derive the expression for maximum power transfer in case of flat belt drive. [10]

   (b) What is creep and how it is different from slip in case of belt drives? [2+3]

   (c) Why the arms of pulley are kept elliptical in cross section? Explain. [5]

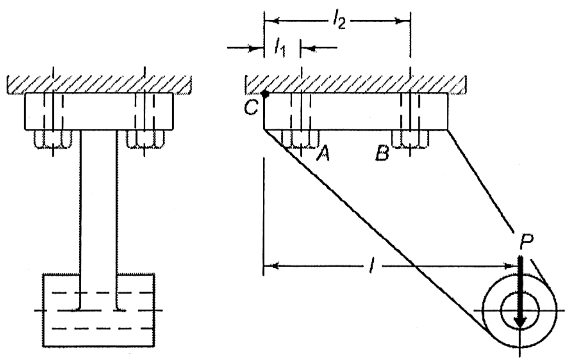

Fig. Q4a

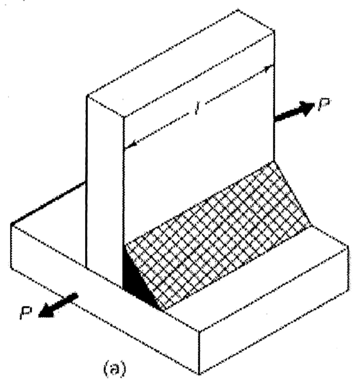

Fig Q5a

4. (a) A cast iron bracket is fixed to the steel structure is shown in Fig. Q4a. It is supposed to support a maximum load (P) of 25kN. There are two bolts (M36 × 2) each at A and at B and the same are made of plain carbon steel (30C8). The distances are as follows, l_1 = 50 mm, l_2 = 200 mm, l = 400 mm. Determine the factor of safety of the system considering the failure of the bolts. [10]

   (b) What is overall efficiency in screw jack? Derive the expression for the same assuming suitable notations. [6]

   (c) How can you enhance the efficiency of screw jack? [4]

5. (a) A welded joint for T-joint made of 20mm thick plates is shown in Fig Q5a. If the load to be carried, P = 40kN, what should be the length of the weldment 'l'. Assume leg of the weld to be the same as thickness of the plate and the permissible tensile and shear stresses in the weld to be 150N/mm^2 and 90 N/mm^2 respectively. [5]

   (b) A structure uses riveted joints but is upgraded to welded joints. Discuss the expected changes in design and performance. [3]

   (c) Differentiate between butt and fillet welds. [2]

(d) A double riveted lap joint with zig-zag riveting is to be designed for 18 mm thick plates. Assume σ_t = 85 MPa; τ = 65 MPa; and σ_c = 120 MPa. State the modes of failure of the joint and find its efficiency. [7]

(e) State a couple of weld inspection processes. [3]

6. (a) What is self-locking in brakes. Explain with the help of a simple block brake and suitable sketches. [5]

(b) For a plate clutch deduce the relation for torque (T) [8]

$$T = \frac{\mu P}{4}(D + d).$$; where P=actuating force, D=outer diameter of friction disc, d= inner diameter of friction disc, μ = coefficient of friction.

(c) Explain the working principle of a centrifugal clutch? What is its advantage? [7]

7. (a) A helical compression spring, made of circular wire, is subjected to an axial force, which varies from 2.5kN to 3.5kN. Over this range of force, the deflection of the spring should be approximately 5mm. The spring index can be taken as 5.0. The spring has square and ground ends. The spring is made of patented and cold-drawn steel wire with ultimate tensile strength of 1050N/mm^2 and modulus of rigidity of 81370 N/mm^2. The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate: (i) wire diameter; (ii) mean coil diameter; (iii) number of active coils; (iv) total number of coils; (v) solid length of the spring; (vi) free length of the spring; (vii) required spring rate; and (viii) actual spring rate [10]

(b) What is surge in helical springs? How can this be eliminated? [5]

(c) What is nip in leaf spring? Explain. [5]

Data for Reference

Table 1: List of materials and their properties

Grade	Tensile strength (N/mm^2)	Yield strength (N/mm^2)
	Cast Iron	
FG 150	150	--
FG 200	200	--
FG 260	260	--
FG 300	300	--
FG 400	400	--
	Plain carbon steel	
7C4	320	--
10C4	340	--
30C8	500	400
40C8	580	380
45C8	630	380
50C4	660	460
55C8	720	460

Table 2: Proportions of standard parallel, tapered and gib head keys

Shaft diameter (mm) upto and including	*Key cross-section*		*Shaft diameter (mm) upto and including*	*Key cross-section*	
	Width (mm)	*Thickness (mm)*		*Width (mm)*	*Thickness (mm)*
6	2	2	85	25	14
8	3	3	95	28	16
10	4	4	110	32	18
12	5	5	130	36	20
17	6	6	150	40	22
22	8	7	170	45	25
30	10	8	200	50	28
38	12	8	230	56	32
44	14	9	260	63	32
50	16	10	290	70	36
58	18	11	330	80	40
65	20	12	380	90	45
75	22	14	440	100	50

Table 3 Basic dimensions for ISO metric screw threads (fine series)

Designation	*Nominal or major dia d/D (mm)*	*Pitch (p) (mm)*	*Pitch diameter d_p/D_p (mm)*	*Minor diameter* d_c (mm)	*Minor diameter* D_c (mm)	*Tensile stress area* (mm^2)
M 6 × 1	6	1.00	5.350	4.773	4.917	20.1
M 6 × 0.75	6	0.75	5.513	5.080	5.188	22.0
M 8 × 1.25	8	1.25	7.188	6.466	6.647	36.6
M 8 × 1	8	1.00	7.350	6.773	6.917	39.2
M 10 × 1.25	10	1.25	9.188	8.466	8.647	61.2
M 10 × 1	10	1.00	9.350	8.773	8.917	64.5
M 12 × 1.5	12	1.50	11.026	10.160	10.376	88.1
M 12 × 1.25	12	1.25	11.188	10.466	10.647	92.1
M 16 × 1.5	16	1.50	15.026	14.160	14.376	167
M 16 × 1	16	1.00	15.350	14.773	14.917	178
M 20 × 2	20	2.00	18.701	17.546	17.835	258
M 20 × 1.5	20	1.50	19.026	18.160	18.376	272
M 24 × 2	24	2.00	22.701	21.546	21.835	384
M 24 × 1.5	24	1.50	23.026	22.160	22.376	401
M 30 × 3	30	3.00	28.051	26.319	26.752	581
M 30 × 2	30	2.00	28.701	27.546	27.835	621
M 36 × 3	36	3.00	34.051	32.319	32.752	865
M 36 × 2	36	2.00	34.701	33.546	33.835	915
M 42 × 4	42	4.00	39.402	37.093	37.670	1150
M 42 × 3	42	3.00	40.051	38.319	38.752	1210
M 48 × 4	48	4.00	45.402	43.093	43.670	1540
M 48 × 3	48	3.00	46.051	44.319	44.752	1600