Ref. No. : Ex/ME/T/314/2019

B.E. MECHANICAL ENGINEERING THIRD YEAR FIRST SEMESTER – 2019

MACHINE DESIGN- II

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

Answers to a particular question should be at one place
Data if missing may be assumed reasonably
The symbols used in the questions, bear their usual meaning

Group A: *Answer any two questions* (15 × 2)

1. (a) What is longitudinal joint and what is its purpose in the construction of boiler shell? Why the longitudinal joint is preferably made of butt rivet joint? [2+3]

(b) 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. [5]

(c) Discuss some of the locking methodologies followed against loosening of bolted joints [5]

2. (a) Justify that self-locking condition is helpful for brakes in some cases. [3]

(b) Fig. Q2(b) shows an welded joint. Deduce the design equation for strength. [5]

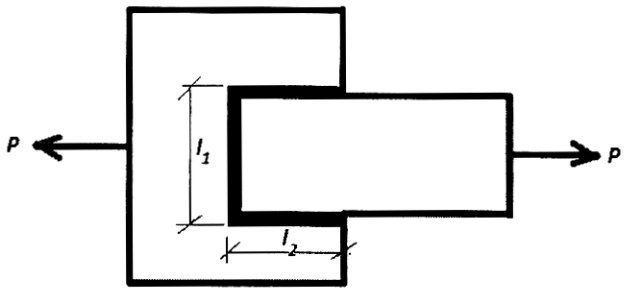

Fig. Q2(b)

(c) Why initial tension is required for belt-pulley drive? How does the value of initial tension affect the maximum power transmission of a drive? [2+5]

3. (a) What is surge in spring and how can it be eliminated? [2+3]

(b) What extra considerations need to be undertaken in the design of helical coil extension springs compared to helical coil compression springs? Discuss. [5]

(c) When does a helical spring tend to buckle? How can buckling be prevented? [2+3]

Group B: *Answer any two questions* (25 × 2)

4. A belt pulley drive is required to design for a rolling mill running at 720 rpm driven by a 28 kW motor with rated speed of 1440 rpm. The drive should be open flat belt type accommodating a maximum shaft to shaft distance of 3.5 m. Use the Tables to select the belt and CI pulley. Assume joint efficiency of belt to be 1. Check the cross-section of arms against induced stresses. [25]

5. (a) Two circular plates with '2d' and 'd' as outer and inner diameters respectively are clamped together by means of a bolt as shown in Fig. Q5. The bolt is made of plain carbon steel (S_{yt} = 380 N/mm^2) while the plates are made of aluminium. If the external force (P) acting on the bolted joint is 10 kN and the initial pre-load given to the bolt is 5 kN, select a standard bolt suitable for the application. Assume a factor of safety of 2.5. [10]

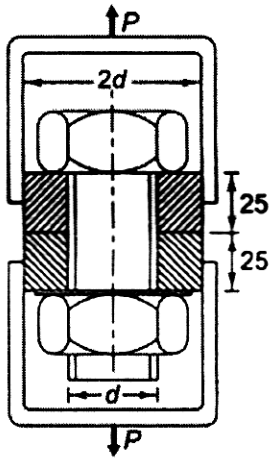

Fig. Q5

(b) A locomotive semi-elliptical steel spring has an overall length of 1.0 m and sustains a load of 70 kN at its centre. The spring has 3 full length leaves and 15 graduated leaves with a central band of 100 mm width. All the leaves are to be stressed to 400 N/mm^2 when fully loaded. The total depth of spring is twice the width of a single leaf. Determine the following:

i) The thickness and width of the leaves (report in standard values).

ii) The initial gap that should be provided between the full length and graduated leaves before the band load is applied.

iii) The load exerted on the band after the spring is assembled. [10]

(c) A 50 kN capacity screw jack consists of a square threaded steel screw meshing with a bronze nut. The nominal diameter is 60 mm and the pitch is 9 mm. The permissible bearing pressure at the

threads is 10 N/mm^2. Evaluate the following: i) Length of the nut and ii) Transverse shear stress in the nut [5]

6. A cone clutch has the following particulars:

(i) Semi cone angle = 12.5^0;

(ii) Mean diameter of the clutch = face width of friction lining;

(iii) $\mu = 0.25$;

(iv) Prime-mover speed = 1440 rpm;

(v) For rotor, mass = 145 kg & radius of gyration = 245 mm;

(vI) Time required for reaching full speed = 45 sec;

(vii) Maximum intensity of pressure between clutch plates = 0.1 N/mm^2.

Determine the following: (i) inner & outer diameters (ii) face width of friction lining, (iii) engaging force and (v) heat generated for each engagement.

Assume that uniform wear condition operates. [25]

Group C: *Answer any one question* (20 × 1)

7. A bushed-pin type flexible coupling is to be designed for connecting a motor shaft to a pump shaft for transmitting a power of 40 kW. The speed of the motor shaft is 1000 rpm. The bearing pressure in the rubber bush is to be limited to 0.45 N/mm^2. Tabulate all the dimensions and make a neat sketch of the coupling. [15+5]

8. In a bridge structure tension links are made of knuckle joint. The links are subjected to a maximum tensile force of 60 kN. Design the joint considering all stresses. Select suitable materials from Table for the parts. Tabulate the dimensions. Also draw a neat sketch of the joint. [15+5]

Reference Tables

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. Standard bolt size

Designation	Nominal or major dia d/D (mm)	Pitch (p) (mm)	Pitch diameter d_p/ D_p (mm)	Minor diameter (mm)		Tensile stress area (mm^2)
				d_c	D_c	
M 4	4	0.70	3.545	3.141	3.242	8.78
M 5	5	0.80	4.480	4.019	4.134	14.20
M 6	6	1.00	5.350	4.773	4.917	20.10
M 8	8	1.25	7.188	6.466	6.647	36.60
M 10	10	1.50	9.026	8.160	8.376	58.00
M 12	12	1.75	10.863	9.853	10.106	84.30
M 16	16	2.00	14.701	13.546	13.835	157
M 20	20	2.50	18.376	16.933	17.294	245
M 24	24	3.00	22.051	20.319	20.752	353
M 30	30	3.50	27.727	25.706	26.211	561
M 36	36	4.00	33.402	31.093	31.670	817
M 42	42	4.50	39.077	36.479	37.129	1120
M 48	48	5.00	44.752	41.866	42.587	1470
M 56	56	5.50	52.428	49.252	50.046	2030
M 64	64	6.00	60.103	56.639	57.505	2680
M 72	72	6.00	68.103	64.639	65.505	3460
M 80	80	6.00	76.103	72.639	73.505	4340
M 90	90	6.00	86.103	82.639	83.505	5590
M 100	100	6.00	96.103	92.639	93.505	7000

Table 4. Standard dimensions for leaves

Standard thickness of leaves (mm)	Standard width of leaves (mm)
3.2, 4.5, 5, 6, 6.5, 7, 7.5, 8, 9, 10, 11, 12, 14, 16	32, 40, 45, 50, 55, 60, 65, 70, 75, 80, 90, 100, 125

Table 5. Preferred CI and MS pulley diameters (mm): 40, 50, 56, 63, 71, 80, 90, 100, 112, 125, 140, 160, 180, 200, 224, 250, 280, 315, 355, 400, 500, 560, 630, 710, 800, 900, 1000, 1120, 1250, 1400, 1600, 1800, 2000

Table 6. Load Correction Factor for belt drive

	Type of Load	Fa
1.	Normal Load	1.0
2.	Centrifugal pump, fans etc.	1.2
3.	Heavy duty fans, blowers etc	1.3
4.	Vacuum pumps, rolling mills etc.	1.5

Table 7. Arc of contact factor

αs (deg)	120	130	140	150	160	170	180	190	200
Fd	1.33	1.26	1.19	1.13	1.08	1.04	1.00	0.97	0.94

[Turn over

Table 8. Power transmitting capacities for Dunlop belts based on arc of contact of 180^0 & belt velocity of 5.08 m/s.	
HI-SPEED	0.0118 kw/mm width/ply
FORT	0.0147 kw/mm width/ply

Table 9. Standard belt width (mm)									
3-ply	25	40	50	63	76				
4-ply	40	44	50	63	76	90	100	112	125
5-ply	76	100	112	125	152				
6-ply	112	125	152	180	200				

Table 10.	
Belt width (mm)	Pulley to be wider than belt by (mm)
Up to & including 125	13
From 125 up to 250	25
From 250 up to 375	38
From 375 up to 500	50

Table 11					
No. of plies	Max belt speed (m/s)				
	10	15	20	25	30
3	90	100	112	140	180
4	140	160	180	2200	250
5	200	224	250	315	355
6	250	315	355	400	450
7	355	400	450	500	560
8	450	500	560	630	710
9	560	630	710	800	900