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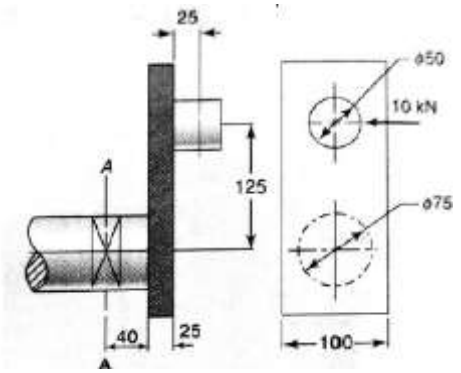
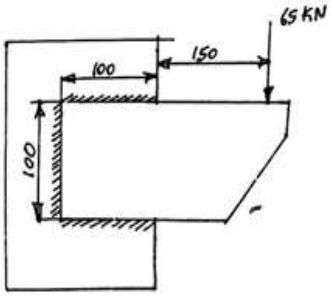
Model Question Paper 2022-23 (CBCS Scheme)
Sixth Semester B.E. Degree Examination (Mechanical Engineering)

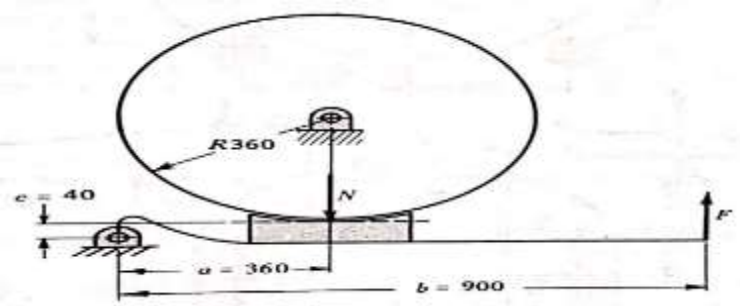
MACHINE DESIGN

TIME: 03 Hours **Max. Marks: 100**

Note: 01.Answer any **FIVE** full questions, choosing at least **ONE** question from each **MODULE**.
02. M: Marks, L: Blooms Level, C: Course outcomes
03. Use of Design Data Handbook is permitted.
04. Assume missing data suitably

Q. No.	Questions	M	L	C
	Module- I			
1 (a)	Explain the necessary stages for the design of a machine element.	5	L2	CO1
1 (b)	Determine the maximum normal stress and maximum shear stress at section A-A for the crank shown in Fig. Q1b, when a load of 10 KN is assumed to be concentrated at the center of the crank pin.  Fig.Q.1(b)	15	L3	CO1
	OR			
2 (a)	Explain the following theories of failure i. maximum normal stress theory ii. distortion energy theory	5	L2	CO1
2 (b)	A hot rolled steel shaft is subjected to an axial load that varies from 1000 N to -500 N as an applied bending moment at the critical section varies from +440 Nm to -220 Nm. The shaft is of uniform cross section and no keyway is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 MPa and yield strength of 410 MPa. Factor of safety = 1.5. Size and surface correction factors are 0.85 and 0.62 respectively.	15	L3	CO1
	Module- II			
3 (a)	Explain the following i. Function of keys ii. Types of keys (Any 3)	5	L2	CO2
3 (b)	A hollow transmission shaft, having an inside diameter 0.6 times the outside diameter, is made of plain carbon steel 30C8 (σ_{yt} = 380 N/mm^2) and the factor of safety is 3. A belt pulley, 1000 mm in diameter, is	15	L3	CO2

	mounted on the shaft, which overhangs the right hand bearing by 250 mm. The belts are vertical and transmit power to a machine shaft below the pulley. The tension on the tight and slack sides of the belt are 3 kN and 1 kN respectively, while the weight of the pulley is 500 N. The angle of wrap of the belt on the pulley is 180°. Calculate the outside and inside diameters of the shaft.			
OR				
4(a)	Prove that the maximum shear stress for square key is 1.5 times the average shear stress.	5	L2	CO2
4(b)	Design a cast iron flange coupling to connect two shafts to transmit 20 kW power at 400 rpm. The permissible shear stress for the shaft, bolt and key is 50N/mm^2 and the permissible compressive stress is 120N/mm^2. The permissible shear stress for cast iron is 15N/mm^2. Assume starting torque is 30 percent higher than the nominal torque. Design the coupling assuming the bolts are fitted in reamed holes.	15	L3	CO2
Module- III				
5(a)	A triple riveted lap joint is made of 16 mm plates. If the safe working stresses in tensile, crushing and shear are 130, 170 and 100 MPa respectively. Design the riveted joint if the outermost row is twice the pitch of the rivets in the inner row. Assume chain type.	10	L3	CO3
5(b)	Determine the size of the weld required for an eccentrically loaded weld as shown in fig.Q.4.b. Assume steady load and fillet weld.  Fig.Q.5(b)	10	L3	CO3
OR				
6	Design a pair of spur gear required for transmitting 8 kW. The pinion is driver and has a speed of 500 rpm while the gear rotates at 250 rpm. The teeth are 20^o full depth involute. The approximate Centre distance between the shafts is 500 mm. The material for gears is cast iron FG200, having σ_d = 75 N/mm^2 and 180 BHN core hardness.	20	L3	CO3
Module- IV				
7	Design a pair of helical gears to transmit a power of 12 kW at 2400 rpm with a speed reduction ratio of 4:1. Pinion is made of cast steel 0.4% carbon untreated (allowable static stress = 51.7 MPa), gear is made of high-grade CI (allowable static stress = 31 MPa). The helix angle is limited to 23o and not less than 20 teeth are to be used on either gear. The pressure angle in the normal plane is 14.5^o . Suggest suitable surface hardness for gear pair.	20	L3	CO4
OR				

8	Design a pair of straight bevel gears, mounted on shafts which are intersecting at right angles, consists of a 27 teeth pinion meshing with a 36 teeth gear. The pinion shaft is connected to electric motor developing 14 kW rated power at 1440 rpm. The starting torque of the motor is 150 % of rated torque. The pressure angle is 20^o. Both gears are made of case-hardened steel (σ_{ut} = 750 Mpa). The teeth on gears are generated and finished by grinding and lapping processes to meet the requirements of class – III grade.	20	L3	CO4
	Module- V			
9 (a)	Explain the condition for self-locking in Block and Band brakes.	5	L2	CO5
9 (b)	A 360 mm radius brake drum contacts a single shoe as shown in Fig.Q.9(b) sustains 225 N-m torque at 500 rpm for a coefficient of friction of 0.3. Determine (i)The total normal force on the shoe (ii)The required force to apply the brake for clockwise rotation (iii) The required force to apply the brake for counterclockwise rotation (iv) The dimension c required to make the brake self-locking (v)The rate of heat generation.  Fig.Q.9(b)	15	L3	CO5
	OR			
10 (a)	Explain the principle of theory of hydrodynamic lubrication with neat sketches.	5	L2	CO5
10 (b)	A lightly loaded journal bearing has a load of 1 kN, the oil used is SAE60 and the mean effective temperature of operation is 400 C. Journal has a diameter of 50 mm and the bearing has a diameter of 50.5 mm. The l/d ratio is limited to 1.2. Determine the coefficient of friction, the power loss due to friction and Sommerfeld number.	15	L3	CO5