Basavarajeswari Group of Institutions

BALLARI INSTITUTE OF TECHNOLOGY & MANAGEMENT

(Autonomous Institute under Visvesvaraya Technological University, Belagavi)

USN											Course Code	2	1	M	E	6	2

Sixth Semester B.E. Degree Examinations, September/October 2024

MACHINE DESIGN

Duration: 3 hrs **Max. Marks: 100**

Note: ***1. Answer any* FIVE *full questions choosing ONE full Question from each Module.***
2. Use of Design Data Handbook is permitted
3. Missing data, if any, may be suitably assumed

Q. No		Question	Marks	(RBTL:CO: PO)
		Module-1		
1.	**a.**	Explain the following theories of failure: (i) Maximum normal stress theory (ii) Maximum shear stress theory (iii) Distortion Energy Theory.	**06**	(2 :1: 1.4.1)
	b.	A cantilever circular rod has a diameter of 50 mm and 300 mm in length. Find the values of principal stress and maximum shear stress under the following conditions. (i) Applying an axial load of 20 kN (ii) Apply 4 kN load at an end, acting downwards creating bending stress	**14**	(3 :1: 2.4.1)
		(OR)		
2.	**a.**	Derive Soderberg's equation for designing a machine element, with a change in cross-section to sustain loads that fluctuate between two limits.	**08**	(2 :1: 1.4.1)
	b.	A machine element is loaded as shown in Fig.Q2 (b). Determine a safe value for the thickness of the plate. The material selected for the machine element has a design stress of 200 MPa.	**12**	(3 :1: 2.4.1)

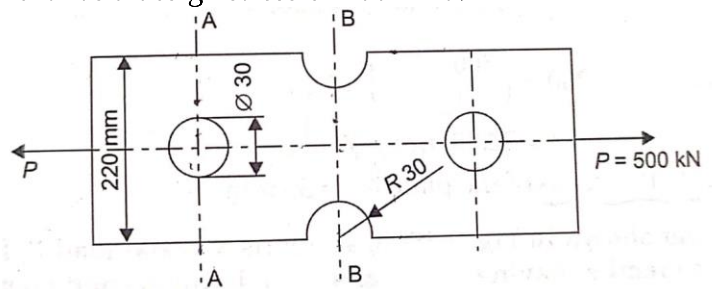

Fig.Q2 (b)

Q. No		Question	Marks	(RBTL:CO: PO)
		Module-2		
3.	**a.**	Design a socket and spigot-type cotter joint to connect two rods subjected to a steady axial pull of 100 kN. The material used for the spigot end and the cotter is (40 steel $C_{40}C_8$) having design stresses: 82.15 MPa for tension, 54.77 MPa for shear, and 109.53 MPa for crushing.	**10**	(3 :2: 2.4.1)
	b.	Design a CI flange coupling to transmit 18 kW at 1440 rpm. The allowable stresses for shaft, keys, and bolts are 75 MPa in shear and 150 MPa in crushing. The allowable shear stress for the CI flange is 5 MPa.	**10**	(3 :2: 2.4.1)
		(OR)		
4.	**a.**	Design a helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the load range is 6 mm, Assume a spring index of 5, permissible shear stress of 420 MPa and modulus of rigidity of 84 kN/mm^2.	**10**	(3 :2: 2.4.1)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)

b. A semi-elliptical laminate leaf spring with two full-length leaves and ten graduated leaves is to be designed to support a central load of 6 kN over two points 1000 mm apart. The central band width is 100 mm. The ratio of the total depth of the spring to its width is 2.5. The design normal stress of the material of the leaves is 400 MPa and the modulus of elasticity is 208 GPa. Determine (i) Width and thickness of the leaves. (ii) The initial gap between full-length and graduated leaves (iii) The central bolt load — **10** (3 :2: 2.4.1)

Module-3

5. a. Design a double riveted lap joint with chain riveting for mild steel plates 20 mm thick taking the allowable value of stress in shear, tension, and compression to 60 MPa, 90 MPa, and 120 MPa respectively. — **08** (3 :3: 2.4.1)

b. Design a double riveted butt joint with two equal widths of cover plates to join two plates of thickness 10 mm. The allowable stress for the material of the rivets and the plates are as follows: For plate material in tension, $\sigma_t = 80$ MPa, for rivet material in shear, $\tau = 60$ MPa, and for rivet material in compression, $\sigma_c = 120$ MPa. — **12** (3 :3: 2.4.1)

(OR)

6. a. Derive the equation for torque required to lift the load on the square thread screws. — **10** (3 :3: 2.4.1)

b. A mild steel plate of 15 mm thickness is welded to another plate by two parallel welds to carry a load of 50 kN as shown in Fig.Q6 (b). Determine the length of the weld required:
(i) Load is static (ii) Load is dynamic. — **10** (3 :3: 2.4.1)

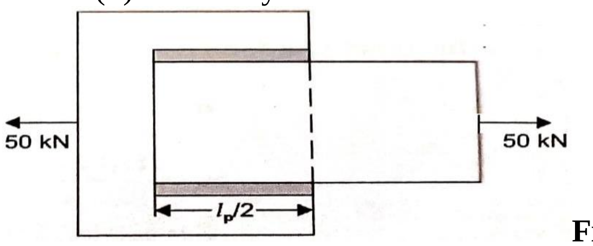

Fig.Q6 (b)

Module-4

7. a. A single plate friction clutch of both sides effectively has 0.3 m outer diameter and 0.16 m inner diameter. The coefficient of friction is 0.2 and it runs at 1000 rpm. Find the power transmitted for uniform wear and uniform pressure distribution cases if the allowable maximum pressure is 0.08 MPa. — **10** (3 :4: 2.4.1)

b. A multiple-disc clutch has five plates having four pairs of active friction surfaces. If the intensity of pressure is not to exceed 0.127 N/mm^2, find the power transmitted at 500 rpm. The outer and inner radii of friction surfaces are 125 mm and 75mm respectively. Assume uniform wear and take the coefficient of friction as 0.3. — **10** (3 :4: 2.4.1)

(OR)

8. a. A pair of spur gears has to transmit 20 kW from a shaft rotating at 1000 rpm to a parallel shaft which is to rotate at 310 rpm. The number of teeth on the pinion is 31 with 20° full-depth involute tooth form. The material for pinion is steel SAE 1040 untreated with allowable static stress 206.81 MPa and the material for the gear is cast steel 0.20%C untreated with allowable static stress 137.34 MPa. Determine the module and face width of the gear pair. Also, find the dynamic tooth load on the gears. Take the service factor as 1.5. — **20** (3 :4: 2.4.1)

Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)

Module-5

9.	**a.**	Design a worm drive for a speed reducer to transmit 30 kW at a worm speed of 600 rpm. The required velocity ratio is 25:1. The worm is made of C30 heat-treated steel (220.6 MPa) and the worm wheel is made of phosphor bronze (82.4 MPa). The service conditions are intermittent operations with medium shock loads.	**20**	(3 :5: 2.4.1)

(OR)

10	**a.**	Derive Petroff's equation for frictional power loss for a lightly loaded journal bearing rotating at high speed concentric to the bearing.	**10**	(3 :5: 2.4.1)
	b.	A lightly loaded bearing of 70 mm long and 70 mm in diameter is acted on by a 1.5 kN radial load. The radial clearance is 0.07 mm and the journal bearing is rotating at 25000 rpm. The viscosity of the oil is 3.45×10^{-3} Pa-s. Determine frictional powder loss using Petroff's equation.	**10**	(3 :5: 2.4.1)

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Note: (RBTL - Revised Bloom's Taxonomy Level: CO - Course Outcome: PI– Performance Indicator)