SREENIVASA INSTITUTE OF TECHNOLOGY AND MANAGEMENT STUDIES (AUTONOMOUS)

QUESTION BANK

Year / Semester: III B.Tech VI Semester **Regulation: R23**

Subject and Code: DESIGN OF MACHINE MEMBERS & 23MEC362T

SYLLABUS

UNIT –1: INTRODUCTION, DESIGN FOR STATIC AND DYNAMIC LOADS :

Mechanical Engineering Design: Design process, design considerations, codes and standards of designation of materials, selection of materials.
Design for Static Loads: Modes of failure, design of components subjected to axial, bending, torsional and impact loads. Theories of failure for static loads.
Design for Dynamic Loads: Endurance limit, fatigue strength under axial, bending and torsion, stress concentration, notch sensitivity. Types of fluctuating loads, fatigue design for in finite life. Soderberg, Goodman and modified Goodman criterion for fatigue failure. Fatigue design under combined stresses.

UNIT –2: DESIGN OF BOLTED AND WELDED JOINTS:

Design of Bolted Joints: Threaded fasteners, preload of bolts, various stresses induced in the bolts. Torque requirement for bolt tightening, gasketed joints and eccentrically loaded bolted joints, Riveted Joints: Types, Methods and material of riveting – Caulking and fullering
Welded Joints: Strength of lap and butt welds, Joints subjected to bending and torsion. Eccentrically loaded welded joints.

UNIT –3: POWER TRANSMISSION SHAFTS AND COUPLINGS:

Power Transmission Shafts: Design of shafts subjected to bending, torsion and axial loading. Shafts subjected to fluctuating loads using shock factors.
Couplings: Design of flange and bushed pin couplings, universal coupling.

UNIT –4: DESIGN OF CLUTCHES, BRAKES AND SPRINGS:

Friction Clutches: Torque transmitting capacity of disc and centrifugal clutches. Uniform wear theory and uniform pressure theory.
Brakes: Different types of brakes. Concept of self-energizing and self-locking of brake. Band and block brakes, disc brakes.
Springs: Design of helical compression, tension, torsion and leaf springs.

UNIT –5: DESIGN OF BEARINGS AND GEARS:

Design of Sliding Contact Bearings: Lubrication modes, bearing modulus, McKee's equations, design of journal bearing. Bearing Failures.
Design of Rolling Contact Bearings: Static and dynamic load capacity, Steinbeck's Equation, equivalent bearing load, load-life relationships, load factor, selection of bearings from manufacturer's catalogue.
Design of Gears: Spur gears, beam strength, Lewis equation, design for dynamic and wear loads

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Max Marks: 10

S.No.	CO	Questions	BT
Unit I: INTRODUCTION, DESIGN FOR STATIC AND DYNAMIC LOADS			
1	**1**	A flat plate subjected to a tensile force of 5 kN is shown in Fig. The plate material is grey cast iron FG 200 and the factor of safety is 2.5. Determine the thickness of the plate.	**L4**
2	**1**	What are the components of static loads and derive the theories of failures of static loads?	**L3**
3	**1**	A machine component is subjected to a flexural stress which fluctuates between + 300 MN/m2 and – 150 MN/m2 . Determine the value of minimum ultimate strength according to 1. Gerber relation; 2. Modified Goodman relation; and 3. Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5 Ultimate strength; and factor of safety = 2.	**L4**
4	**1**	What are the consideration of Mechanical engineering design process and material selection?	**L3**
5	**1**	A steel rod is subjected to a reversed axial load of 180 kN. Find the diameter of the rod for a factor of safety of 2. Neglect column action. The material has an ultimate tensile strength of 1070 MPa and yield strength of 910 MPa. The endurance limit in reversed bending may be assumed to be one-half of the ultimate tensile strength. Other correction factors may be taken as follows: For axial loading = 0.7; For machined surface = 0.8; For size = 0.85; For stress concentration = 1.0.	**L5**
6	**1**	A rod of a linkage mechanism made of steel 40Cr1 (Sut = 550 N/mm2) is subjected to a completely reversed axial load of 100 kN. The rod is machined on a lathe and the expected reliability is 95%. There is no stress concentration. Determine the diameter of the rod using a factor of safety of 2 for an infinite life condition.	**L4**
7	**1**	Determine the thickness of a 120 mm wide uniform plate for safe continuous operation if the plate is to be subjected to a tensile load that has a maximum value of 250 kN and a minimum value of 100 kN. The properties of the plate material are as follows: Endurance limit stress = 225 MPa, and Yield point stress = 300 MPa. The factor of safety based on yield point may be taken as 1.5.	**L3**
8	**1**	A wall bracket with a rectangular cross-section is shown in Fig. The depth of the cross section is twice of the width. The force P acting on the bracket at 600 to the vertical is 5 kN. The material of the bracket is grey cast iron FG 200 and the factor of safety is 3.5. Determine the dimensions of the cross-section of the bracket. Assume maximum normal stress theory of failure.	**L5**
9	**1**	A steel shaft 35 mm in diameter and 1.2 m long held rigidly at one end has a hand wheel 500 mm in diameter keyed to the other end. The modulus of rigidity of steel is 80 GPa. a. What load applied to tangent to the rim of the wheel produce a torsional shear of 60 MPa? b. How many degrees will the wheel turn when this load is applied?	**L4**
10	**1**	Explain modified Goodman criterion and compare it with Soderberg criterion?	**L3**

Prepared by Mr G Narasimhulu, Asst.Professor, ME,SITAMS.

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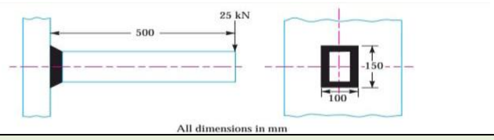
11	**1**	A cylindrical shaft made of steel of yield strength 700 MPa is subjected to static loads consisting of bending moment 10 kN-m and a torsional moment 30 kN-m. Determine the diameter of the shaft using a. According to maximum shear stress theory b. According to maximum strain energy theory Assuming a factor of safety of 2. Take E = 210 GPa and poisson's ratio = 0.25.	**L3**

S.No.	**CO**	**Questions**	**BT**
		Unit II: DESIGN OF BOLTED AND WELDED JOINTS	
1	**2**	A double riveted lap joint is made between 15 mm thick plates. The rivet diameter and pitch are 25 mm and 75 mm respectively. If the ultimate stresses are 400 MPa in tension, 320 MPa in shear and 640 MPa in crushing, find the minimum force per pitch which will rupture the joint. If the above joint is subjected to a load such that the factor of safety is 4, find out the actual stresses developed in the plates and the rivets.	**L4**
2	**2**	A double riveted double cover butt joint in plates 20 mm thick is made with 25 mm diameter rivets at 100 mm pitch. The permissible stresses are : a. σt = 120 MPa; b. τ = 100 MPa; c. σc = 150 MPa Find the efficiency of joint, taking the strength of the rivet in double shear as twice than that of single shear.	**L3**
3	**2**	A double riveted lap joint with zig-zag riveting is to be designed for 13 mm thick plates. Assume σ t = 80 MPa ; τ = 60 MPa ; and σc = 120 MPa State how the joint will fail and find the efficiency of the joint.	**L4**
4	**2**	Design a lap joint for a mild steel flat tie-bar 200 mm × 10 mm thick, using 24 mm diameter rivets. Assume allowable stresses in tension and compression of the plate material as 112 MPa and 200 MPa respectively and shear stress of the rivets as 84 MPa. Show the disposition of the rivets for maximum joint efficiency and determine the joint efficiency. Take diameter of rivet hole as 25.5 mm for a 24 mm diameter rivet.	**L3**
5	**2**	Design a double riveted butt joint with two cover plates for the longitudinal seam of a boiler shell 1.5 m in diameter subjected to a steam pressure of 0.95 N/mm2. Assume joint efficiency as 75%, allowable tensile stress in the plate 90 MPa; compressive stress 140 MPa; and shear stress in the rivet 56 MPa.	**L5**
6	**2**	A plate 100 mm wide and 12.5 mm thick is to be welded to another plate by means of parallel fillet welds. The plates are subjected to a load of 50 kN. Find the length of the weld so that the maximum stress does not exceed 56 MPa. Consider the joint first under static loading and then under fatigue loading.	**L4**
7	**2**	A plate 75 mm wide and 12.5 mm thick is joined with another plate by a single transverse weld and a double parallel fillet weld as shown in Fig. The maximum tensile and shear stresses are 70 MPa and 56 MPa respectively. Find the length of each parallel fillet weld, if the joint is subjected to both static and fatigue loading.	**L3**
8	**2**	A welded joint as shown in Fig. is subjected to an eccentric load of 2 kN. Find the size of weld, if the maximum shear stress in the weld is 25 MPa.	**L5**
9	**2**	A 50 mm diameter solid shaft is welded to a flat plate as shown in Fig. If the size of the weld is 15 mm, find the maximum normal and shear stress in the weld.	**L4**

10	**2**	The cylinder head of a steam engine is subjected to a steam pressure of 0.7 N/mm2. It isheld in position by means of 12 bolts. A soft copper gasket is used to make the joint leak-proof. The effective diameter of cylinder is 300 mm. Find the size of the bolts so that the stress in the bolts is not to exceed 100 MPa.	**L3**
11	**2**	A rectangular cross-section bar is welded to a support by means of fillet welds as shown in Figure. Determine the size of the welds, if the permissible shear stress in the weld is limited to 75 MPa. 	**L4**

S.No.	CO	Questions	BT
		Unit III: POWER TRANSMISSION SHAFTS AND COUPLINGS	
1	**3**	Find the diameter of a solid steel shaft to transmit 20 kW at 200 r.p.m. The ultimate shear stress for the steel may be taken as 360 MPa and a factor of safety as 8. If a hollow shaft is to be used in place of the solid shaft, find the inside and outside diameter when the ratio of inside to outside diameters is 0.5.	**L4**
2	**3**	A shaft made of mild steel is required to transmit 100 kW at 300 r.p.m. The supported length of the shaft is 3 metres. It carries two pulleys each weighing 1500 N supported at a distance of 1 metre from the ends respectively. Assuming the safe value of stress, determine the diameter of the shaft.	**L3**
3	**3**	A steel spindle transmits 4 kW at 800 r.p.m. The angular deflection should not exceed 0.25° per metre of the spindle. If the modulus of rigidity for the material of the spindle is 84 GPa, find the diameter of the spindle and the shear stress induced in the spindle.	**L4**
4	**3**	A shaft supported at the ends in ball bearings carries a straight tooth spur gear at its mid span and is to transmit 7.5 kW at 300 r.p.m. The pitch circle diameter of the gear is 150 mm. The distances between the centre line of bearings and gear are 100 mm each. If the shaft is made of steel and the allowable shear stress is 45 MPa, determine the diameter of the shaft. Show in a sketch how the gear will be mounted on the shaft; also indicate the ends where the bearings will be mounted? The pressure angle of the gear may be taken as 20°.	**L3**
5	**3**	A mild steel shaft transmits 20 kW at 200 r.p.m. It carries a central load of 900 N and is simply supported between the bearings 2.5 metres apart. Determine the size of the shaft, if the allowable shear stress is 42 MPa and the maximum tensile or compressive stress is not to exceed 56 MPa. What size of the shaft will be required, if it is subjected to gradually applied loads?	**L5**
6	**3**	A 45 mm diameter shaft is made of steel with a yield strength of 400 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with a yield strength of 340 MPa is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety of 2.	**L4**
7	**3**	A 15 kW, 960 r.p.m. motor has a mild steel shaft of 40 mm diameter and the extension being 75 mm. The permissible shear and crushing stresses for the mild steel key are 56 MPa and 112 MPa. Design the keyway in the motor shaft extension. Check the shear strength of the key against the normal strength of the shaft.	**L3**

8	**3**	Design a muff coupling which is used to connect two steel shafts transmitting 40 kW at 350 r.p.m. The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses may be taken as 40 MPa and 80 MPa respectively. The material for the muff is cast iron for which the allowable shear stress may be assumed as 15 MPa.	**L5**
9	**3**	Design a clamp coupling to transmit 30 kW at 100 r.p.m. The allowable shear stress for the shaft and key is 40 MPa and the number of bolts connecting the two halves are six. The permissible tensile stress for the bolts is 70 MPa. The coefficient of friction between the muff and the shaft surface may be taken as 0.3.	**L4**
10	**3**	The shaft and the flange of a marine engine are to be designed for flange coupling, in which the flange is forged on the end of the shaft. The following particulars are to be considered in the design: a. Power of the engine =3 MW b. Speed of the engine =100 r.p.m. c. Permissible shear stress in bolts and shaft =60 MPa d. Number of bolts used =8 e. Pitch circle diameter of bolts =1.6 × Diameter of shaft Find : 1. diameter of shaft ; 2. diameter of bolts ; 3. thickness of flange ; and 4. diameter of flange.	**L3**

S.No.	CO	Questions	BT
		Unit IV: DESIGN OF CLUTCHES, BRAKES AND SPRINGS	
1	**4**	Design a spring for a balance to measure 0 to 1000 N over a scale of length 80 mm. The spring is to be enclosed in a casing of 25 mm diameter. The approximate number is 30. The modulus of rigidity is 85 kN/mm2. Also calculate the maximum shear stress induced.	**L4**
2	**4**	Design a leaf spring for the following specifications: Total load = 140 kN ; Number of springs supporting the load = 4 ; Maximum number of leaves = 10; Span of the spring = 1000 mm ; Permissible deflection = 80 mm. Take Young's modulus, E = 200 kN/mm2 and allowable stress in spring material as 600Mpa.	**L3**
3	**4**	A spiral spring is made of a flat strip 6 mm wide and 0.25 mm thick. The length of the strip is 2.5 metres. Assuming the maximum stress of 800 MPa to occur at the point of greatest bending moment, calculate the bending moment, the number of turns to wind up the spring and the strain energy stored in the spring. Take E = 200 kN/mm^2.	**L4**
4	**4**	A helical torsion spring of mean diameter 60 mm is made of a round wire of 6 mm diameter. If a torque of 6 N-m is applied on the spring, find the bending stress induced and the angular deflection of the spring in degrees. The spring index is 10 and modulus of elasticity for the spring material is 200 kN/mm^2. The number of effective turns may be taken as 5.5.	**L3**

5	**4**	Two 35 mm shafts are connected by a flanged coupling. The flanges are fitted with 6 bolts on 125 mm bolt circle. The shafts transmit a torque of 800 N-m at 350 r.p.m. For the safe stresses mentioned below, calculate 1. Diameter of bolts; 2. Thickness of flanges; 3. Key dimensions ; 4. Hub length; and 5. Power transmitted. Safe shear stress for shaft material = 63 MPa Safe stress for bolt material = 56 MPa Safe stress for cast iron coupling = 10 MPa Safe stress for key material = 46 MPa	**L5**
6	**4**	A helical spring is ma e from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity 84 kN/mm^2, find the axial load which the spring can carry and the deflection per active turn.	**L4**
7	**4**	Determine the maximum, minimum and average pressure in a plate clutch when the axial force is 4kN,The Inside radius of the contact surface is 50mm and the outside surface is 100mm.assume uniform wear.	**L3**
8	**4**	A single plate clutch, effective on the both side is required to transmit 25Kw at 3000 r.p.m determine the outer and inner diameter of the frictional surface if the coefficient of the friction is 0.255,ratio of the diameter is 1.25 and the maximum pressure is not to be exceed 0.1N/mm^2. Also determine the axial thrust to be provided by springs.	**L5**
9	**4**	A single block brake is shown in Fig. 25.5. The diameter of the drum is 250 mm and the angle of contact is 90°. If the operating force of 700 N is applied at the end of a lever and the coefficient of friction between the drum and the lining is 0.35, determine the torque that may be transmitted by the block brake.	**L4**
10	**4**	A brake shoe applied to a drum by a lever AB which is pivoted at a fixed point A and rigidly fixed to the shoe. The radius of the drum is 160 mm. The coefficient of friction of the brake lining is 0.3. If the drum rotates clockwise, find the braking torque due to the horizontal force of 600 N applied at B.	**L3**
11	**4**	The block brake, as shown in Fig. 25.7, provides a braking torque of 360 N-m.The diameter of the brake drum is 300 mm. The coefficient of friction is 0.3. Find : 1. The force (P) to be applied at the end of the lever for the clockwise and counter clockwise rotation of the brake drum; and 2. The location of the pivot or fulcrum to make the brake self locking for the clockwise rotation of the brake drum.	**L3**

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S.No.	CO	Questions	BT
Unit V: DESIGN OF BEARINGS AND GEARS			
1	5	Describe the Lewis equation for beam strength in spur gears and its role in gear design for dynamic and wear loads.	L4
2	5	Define a journal bearing for a centrifugal pump from the following data: Load on the journal=20000N; Speed of the journal=900 r.p.m.; Type of oil is SAE10, for which the absolute viscosity at 55^0C=0.017 kg/m-s; Ambient temperature of oil = 15.5ºC; Maximum bearing pressure for the pump=1.5 N/mm^2. Calculate also mass of the lubricating oil required for artificial cooling, if rise of temperature of oil be limited to 10^0C.Heat dissipation coefficient=1232 W/m^2/ºC.	L3
3	5	**A** 150mm diameter shaft supporting a load of 10kN has a speed of 1500 r.p.m. The shaft runs in a bearing whose lenth is is 1.5 times the diameter. if the diametral clearance of the bearing is 0.15mm and the absolute viscosity of the oil at the operating temperature is 0.011kg/m-s.find the power wasted in friction.	L4
4	5	What are the different lubrication modes in sliding contact bearings, and how do they affect bearing performance?	L3
5	5	A footstep bearing supports a shaft of 150 mm diameter which is counter-bored at the end with a hole diameter of 50 mm. If the bearing pressure is limited to 0.8 N/mm² and the speed is 100 r.p.m.; find: 1. The load to be supported; 2. The power lost in friction; and 3. The heat generated at the bearing. Assume coefficient of friction = 0.015.	L5
6	5	A journal bearing 60 mm in diameter and 90 mm long runs at 450 r.p.m. The oil used for hydrodynamic lubrication has an absolute viscosity of 0.06 kg/m-s. If the diametral clearance is 0.1 mm, find the safe load on the bearing.	L4
7	5	A bronze spur pinion rotating at 600 r.p.m. drives a cast iron spur gear at a transmission ratio of 4 : 1. The allowable static stresses for the bronze pinion and cast iron gear are 84 MPa and 105 MPa respectively. The pinion has 16 standard 20° full depth involute teeth of module 8 mm. The face width of both gears is 90 mm. Find the power that can be transmitted from the standpoint of strength.	L3
8	5	A pair of straight-teeth spur gears, having 20° involute full-depth teeth, is to transmit 12 kW at 300 r.p.m. of the pinion. The speed ratio is 3:1. The allowable static stresses for the gear of cast iron and pinion of steel are 60 MPa and 105 MPa respectively.	L5

Note: L1-Remembering, L2-Understanding, L3-Applying, L4-Analyzing, L5-Evaluating, and L6-Creating

References: A Textbook of Machine Design 1.R S KHURMI , 2.J K GUPTHA

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The Six Levels of Bloom's Taxonomy:

1. **Remembering:** Retrieving, recognizing, and recalling relevant knowledge from long-term memory (e.g., list, define, name, locate).
2. **Understanding:** Constructing meaning, explaining ideas, or concepts (e.g., summarize, interpret, classify, compare).
3. **Applying:** Using information in new situations or implementing procedures to solve problems (e.g., solve, use, demonstrate, implement).
4. **Analyzing:** Breaking material into constituent parts, determining how the parts relate to one another and to an overall structure (e.g., contrast, categorize, distinguish, diagram).
5. **Evaluating:** Making judgments based on criteria and standards through checking and critiquing (e.g., judge, critique, justify, defend, argue).
6. **Creating:** Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure (e.g., design, construct, develop, formulate).

Instruction to Faculty Members:

- **Strictly follow the prescribed question paper template without deviation.**
- **Text book reference to quoted end of the fifth unit**
- **Set a** minimum of ten (10) **and a** maximum of fifteen (15) **subjective questions per unit. Each question shall carry** ten (10) marks**.**
- **Questions may include sub-questions as per the prescribed pattern: B.Tech: 10M** or **5M + 5M** or **6M + 4M**
- **For** M.Tech**, questions shall be set as per the following pattern only: 12M** or **6M + 6M**