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Code No: RT31033 **R13** SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, October/November - 2017

DESIGN OF MACHINE MEMBERS – I

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**
(Data books may be allowed)

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PART –A

1 a) Discuss in detail the factors which govern the selection of material for a machine component? [3M]
b) Explain the salient features of the maximum principal stress theory and indicate under what conditions such a theory is useful? [4M]
c) Explain the effect of the following factors on the type of fatigue failure [4M]
i) Range of imposed stress
ii) Surface treatment
d) Describe the purpose of gib in cotter joint? What are the applications of cotter joints? [4M]
e) Write a short note on universal coupling? [3M]
f) Define a Spring? What is the purpose of mechanical springs? [4M]

PART -B

2 a) 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 [4M]
i) What load applied to tangent to the rim of the wheel produce a torsional shear of 60MPa?
ii) How many degrees will the wheel turn when this load is applied?
b) Derive a relation for the shear stress developed in a shaft, when it is subjected to torsion. [12M]

3 a) Explain the influence of stress concentration in the design of machine elements? What are the principal causes of stress concentration? Explain with suitable sketches? [8M]
b) Explain the significance of Goodman's line, Soderberg line and modified Goodman line in design of members subjected to reversal of stresses? [8M]

4 A bracket is riveted to a column by 6 rivets (A,B,C,D,E and F) of equal size as shown in Figure 3. The centres of rivets A,B,C are on the same vertical line and the centres of E,F are on the another vertical line. The centres of B, D are on the same horizontal line. The centres of A, E are on one horizontal line and the centres of C,F are on another horizontal line. The vertical distance between A,B and B,C are 75 mm and 75 mm respectively. The horizontal distance between B,D and C,F are 75 mm and 150 mm respectively. It carries a load of 100 KN at a horizontal distance of 250 mm from the central line of rivet D. If the maximum shear stress in the rivet is limited to 63 MPa, find the diameter of the rivet. [16M]

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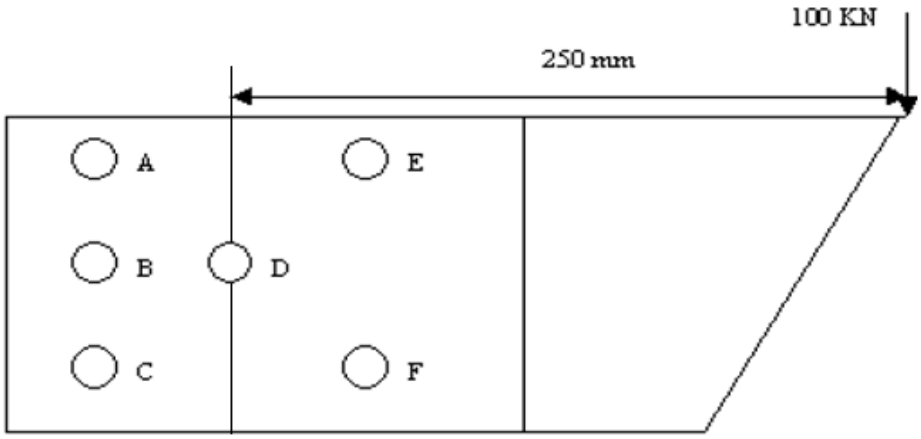

5 A steel shaft 800mm long transmitting 15 kW at 400 rpm is supported at two bearings at the two ends. A gear wheel having 80 teeth and 500mm pitch circle diameter is mounted at 200 mm from the left hand side bearing and receives power from a pinion meshing with it. The axis of pinion and gear lie in the horizontal plane. A pulley of 300mm diameter is mounted at 200mm from right hand side bearing and is used for transmitting power from a belt. The belt drive is inclined at 30^0 to the vertical in the forward direction. The belt lap angle is 180^0. The coefficient of friction between belt and pulley is 0.3. Design and sketch the arrangement of the shaft. Assuming the values of safe stresses as 55 N/mm^2 in shear and 80 N/mm^2 in tension. Take torsion and bending factor 1.5 and 2 respectively. [16M]

6 Design a bushed-pin type flexible coupling for connecting a motor shaft to a pump shaft, with the following service conditions: [16M]

Power to be transmitted = 40kW
Speed of the motor shaft = 1000rpm
Diameter of motor and pump shafts = 45mm
Bearing pressure on the rubber bush = 0.7N/mm^2
Allowable stress in the pins = 60MPa.

7 a) What are the principal characteristics of different types of springs? [4M]

b) A lift system is provided with cushion springs at the bottom of lift. The lift is free to fall. Springs are set in parallel. Specify the required number of springs if the lift has free fall of 1.5m from rest. [12M]

Weight of lift = 30kN
Allowable deflection per spring = 370 mm
Number of active turns = 15
Spring mean coil diameter = 30 mm
Spring wire diameter = 30mm
Modulus of rigidity for spring = 80Gpa.

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DESIGN OF MACHINE MEMBERS – I

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

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(Data books may be allowed)

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PART –A

1 a) Write a brief note on different phases of design. [3M]

b) Discuss various general considerations that are taken into account while designing a machine element. [4M]

c) Explain about the Maximum Normal Stress, Maximum Shear Stress and Maximum Distortion Energy Theories. [4M]

d) Explain the following methods of reducing stress concentration. [4M]
i) Removal of undesired material
ii) Added grooves

e) Discuss the effect of keys and key ways on the strength of the shaft. [3M]

f) Write a short note on universal coupling. [4M]

PART -B

2 a) Discuss the stress and stain relation. Draw a neat sketch of stress-strain diagram and explain various stress points. [8M]

b) Explain the influence of stress raiser on impact strength and Explain the term 'factor of safety'? [8M]

3 A cold drawn steel rod of circular cross-section is subjected to a variable bending moment of 565 N-m to 1130 N-m as the axial load varies from 4500 N to 13500N. The maximum bending moment occurs at the same instant that the axial load is maximum. Determine the required diameter of the rod for a factor of safety 2. Neglect any stress concentration and column effect. Assuming ultimate strength =550 Mpa, yield strength =470Mpa, size factor=0.85, surface finish factor = 0.89. Correlation factors = 0.1 for bending and 0.7 for axial load. The endurance limit is reversed bending may be taken as one half the ultimate strength. [16M]

4 a) Explain the method of determining the size of the bolt when the bracket carries an eccentric load perpendicular to the axis of the bolt. [6M]

b) The cylinder head of a steam engine is subjected to a steam pressure of $0.7N/mm^2$. It is held 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 300mm. Find the size of the bolt so that the stress in the bolts is not to exceed 100 MPa. [10M]

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5 a) Design a socket and spigot type of cotter joint to sustain an axial load of 100kN. The material selected for the joint has the following design stresses. σ_t = 120 MPa, σ_c = 160 MPa and τ = 60 MPa [6M]

b) The engine of a ship develops 420 kW and transmits the power by a horizontal propeller shaft, which runs at 120 rpm. It is proposed to design a hollow propeller shaft with inner diameter as 0.6 of outer diameter. Considering the torsion alone calculate the diameter of the propeller shaft if stress in the material is not to exceed 63 N/mm^2 and also the angular twist over a length of 2500 mm is not be more than 10^0. The modulus of the rigidity of the shaft material is 80 KN/mm^2. [10M]

6 Design a bush type flexible coupling for connecting a motor shaft to a pump shaft for the following service conditions. [16M]

Power to be transmitted = 40 KW
Motor speed = 1000 rev/min.
Diameter of motor shaft = 50mm.
Diameter of pump shaft = 45mm.

The allowable shear stress for pin is 35N/mm^2 and the maximum allowable compressive stress for rubber bush is 2N/mm^2. The coupling is made of FG 200 gray cast Iron.

7 a) Draw a neat sketch of multi leaf spring and show its essential parts. Also explain nipping of leaf spring? [4M]

b) Design a helical compression spring for a maximum load of 1000 N for a deflection of 25mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm^2. [12M]

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DESIGN OF MACHINE MEMBERS – I

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

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3. Answer any **THREE** Questions from **Part-B**
(Data books may be allowed)

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PART –A

1	a)	How do you classify materials for engineering use?	[3M]
	b)	Write a note on important non-metallic materials of construction in engineering practice?	[4M]
	c)	State and explain any two theories of failure	[4M]
	d)	What are the principal causes of stress concentration?	[4M]
	e)	Enumerate the different types of riveted joints.	[3M]
	f)	What is a coupling? Classify shaft couplings?	[4M]

PART -B

2 A pulley is keyed to a shaft midway between two anti-friction bearings. The bending moment of the pulley varies from 150 N-m to 450 N-m as torsional moment of the shaft varies from 50 N-m to 150 N-m. The frequency of variation of the loads is the same as the shaft speed. The shaft is made of cold drawn steel having an ultimate strength of 550 MPa and yield strength of 310 MPa. Determine the required diameter for an indefinite life. The stress concentration factor for the key way in bending and torsion may be taken as 1.6 and 1.3 respectively. Use a design factor of 1.8, size factor 0.85 and surface correction factor 0.88. Use the data for torsion, [16M]
Size correction factor = 0.6 and
The nominal design torsion stress = 0.6 Yield point in tension.

3 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 is reversed bending may be assumed to be one half of the ultimate tensile strength. The correction factors are as follows. [16M]
Load factor = 0.7; surface finish factor = 0.8
Size factor = 0.85; stress concentration factor = 1.

4 A bracket is supported by means of four rivets of same size as shown in Fig. Determine the diameter of the rivet if the maximum shear stress is 140Mpa. (16M) [16M]

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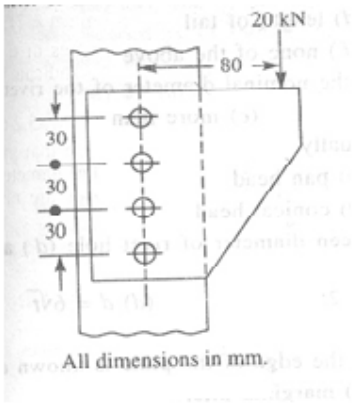

5 a) Design a cotter joint to withstand an axial load varying from 35kN in tension to 35kN in compression. The allowable for the steel used in the joint are 60Mpa in tension; 70 Mpa in crushing; 45 Mpa in shear. [8M]

b) A shaft is required to transfer 43kW of power at 600rpm. The outside diameter must not exceed 50mm and the maximum shear stress is not to exceed 70N/mm^2. Find out the dimensions of hollow and solid shaft, which would meet these requirements. Also compare their weights. [8M]

6 a) The bolt in the flange coupling should be made weaker than the other components of coupling? Why? [4M]

b) In a flange shaft coupling having 37.5mm bore it is desired that torsional stress in the shaft will not exceed 25 N/mm^2. The outside diameter of the coupling limited by space is 200mm. There are three 15mm bolts on a bolt circle diameter of 140mm. The radial flange thickness is 18mm. Determine the following: [12M]
i) The power that may be transmitted at 600 rev/min.
ii) The shearing stress in the bolts.
iii) The bearing pressure on the bolts.

7 a) Explain the buckling of springs? [4M]

b) Find the maximum shear stress and deflection induced in a helical spring of the following specifications, if it has to absorb 1000 N-m of energy. Mean diameter of spring = 100 mm; Diameter of steel wire, used for making the spring = 20 mm; Number of coils = 30; Modulus of rigidity of steel = 85 kN/mm^2. [12M]

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DESIGN OF MACHINE MEMBERS – I

(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

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2. Answering the question in **Part-A** is compulsory
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(Data books may be allowed)

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PART –A

1 a) What are the steps to be followed while designing a machine element? [3M]

b) Define the following properties of a material: [4M]
i) Ductility
ii) Toughness
iii) Hardness and
iv) Creep.

c) What is factor of safety? List the important factors that influence the magnitude of factor of safety? [4M]

d) Explain the following methods of reducing stress concentration [4M]
i) Drilled holes
ii) Using large fillet radius
iii) Added grooves

e) What do you understand by the term riveted joint? Explain the necessity of such a joint. [3M]

f) Write short notes on leaf springs? [4M]

PART-B

2 a) What are alloy steels? Discuss the effect of adding different alloying elements in steel? [4M]

b) A rotating shaft carries a 18 KN pulley at the center of a 0.75 m simply Supported span. The average torque is 230 N m. Assume the torque range to be 10 % of the average torque. The material has yield point of 770 MPa and the endurance limit of 450MPa. Determine the required diameter of the shaft based on [12M]
i) Maximum stress theory and
ii) Distortion energy theory.
Stress concentration factor may be taken as 1.5 and a factor of safety 2.

3 a) A 50mm diameter steel shaft is supported on bearings 1.5m apart and carries a fly wheel weighing 'W'. The allowable bending stress for the shaft material and the maximum deflection are limited to 100MPa and 2 mm respectively. The young's modulus for the shaft material is 210GPa. Determine the Maximum permissible weight of the flywheel. [6M]

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b) A hot rolled steel shaft is subjected to a torsional moment that varies from 330N-m clockwise to 110 N-m counter clock wise and an applied bending moment at a critical section varies from 440 N-m to 220 N-m. The shaft is of uniform cross-section and no key is present at the critical section. Determine the required shaft diameter. The material has an ultimate strength of 550 M N/m^2 and yield strength of 410MN/m^2. Take the endurance limit as half the ultimate strength, factor of safety of 2, size factor of 0.85 and surface finish factor of 0.62. [10M]

4 a) Derive an expression for the maximum load in a bolt when a bracket with circular base is bolted to a wall by means of four bolts? [4M]

b) A flanged bearing is fastened to a frame by means of four bolts spaced equally on 500 mm bolt circle. The diameter of bearing flange is 650mm and a load of 400 KN acts at a distance 250 mm from the frame. Determine the size of the bolts, taking safe tensile stress as 60 MPa for the material of the bolts. [12M]

5 a) Derive suitable equations in terms of torque, cross section of key for same shaft and key material? [4M]

b) A square key is to be used to key a gear to a 35 mm diameter shaft. The length of the hub of the gear is 60mm. Both shaft and key are made of same material, having an allowable shear stress of 55Mpa. What are the minimum dimensions of the key if 400N-m of torque is to be transmitted? [12M]

6 Design a cast iron protective type flange coupling to connect two shafts in order to transmit 7.5kW at 720rpm. The following permissible stresses may be used: [16M]
Permissible shear stress for shaft, bolt and key material = 33MPa
Permissible crushing stress for shaft, bolt and key material = 60MPa
Permissible shear stress for the cast iron = 15MPa.

7 a) Describe different end connections for compression springs? [4M]

b) 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 of turns is 30. The modulus of rigidity is 85 kN/mm^2. Also calculate the maximum shear stress induced. [12M]

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