DEPARTMENT OF MECHANICAL ENGINEERING

QUESTION BANK

Subject code/Name: ME1302 – DESIGN OF MACHINE ELEMENTS   **Year/Sem:** III / V

UNIT- I (STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS)

PART-A (2 marks)

1. Define: "Design"

2. What is 'Adaptive design '? Where is it used? Give examples.

3. What are the various phase of design process?

4. List some factors that influence machine design.

5. Define: "Optimization"

6. Define Principal plane, principal stress

7. Give examples for curved beams

8. Why normal stress theory is not suitable for ductile materials?

9. Define stress concentration and stress concentration factor. ,

10 Define: "Factor of safety"

11. How is factor of safety defined for brittle and ductile materials?

12. What are the various factors to be considered in deciding the factor of safety?

13. What are the factors to be considered in the selection of materials for a machine element?

14· Differentiate between static and variable stresses.

15. Define amplitude stress and stress ratio. What is the value of stress ratio for a cyclic stress?

16. What are various theories of failure?

17. What is the use of Goodman & Soderberg diagrams?

18. Differentiate between Endurance limit and Endurance strength.

19. Define endurance limit. What are the factors affecting endurance strength.

20. What is an S-N Curve?

UNIT- I (STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS)
PART -B

1. (a) A piston of a reciprocating compressor has a diameter of 60mm. The maximum pressure on the piston fall is $1.25MN/m^2$. Assuming the gudgeon pin passing through the small end of the connecting rod can be safely loaded in shear up to $10MN/m^2$, Calculate the minimum diameter of the gudgeon pin.

(8)

   (b) Explain with mathematical expressions.
     Maximum principal stress theory and Von-Mises-Henky theory   (8)

2. (a) Determine the diameter of the steel bar, which is a ductile in a nature subjected to an axial load of 60KN and torsional moment of 1600N-m.Use the factor of safety 2.5.E=200GPa.   (8)

   (b) Explain with mathematical expressions.
     Maximum shear theory and Venant's theory   (8)

3. A steel member is subjected to a 3-D stress system and resulting principal stress are $120N/mm^2$ tension, $80N/mm^2$ and $40N/mm^2$ compression. If the proportional limit of the material in simple tension is $280N/mm^2$ and its poison's ratio is O.3.Determine the factor of safety according to (a) Maximum principal stress theory (b) Maximum principal strain theory (c) Maximum shear stress theory.

(16)

4. A bolt is subjected to a tensile load of 25KN and a shear load of 10KN. Determine the diameter of the bolt according to (a) Maximum principal stress theory (b) Maximum principal strain theory (c) Maximum shear stress theory. Assume factor of safety 2.5, Yield point stress in simple tension $300N/mm^2$, Poisson's ratio is 0.25. (16)

5. Taking stress concentration in to account find the maximum stress induced when a tensile load of 20KN is applied to (i) A rectangular plate 80mm wide and 12mm thick with a transverse hole of 16mm diameter.(ii)A stepped shaft of diameters 60mm and 30mm width a fillet radius of 6mm. (16)

6. A circular bar is simply supported with a span of 0.5mand is subjected to a concentrated cyclic load at its midspan. The load varies from a minimum value of20KN to maximum value of 45 KN. The load

direction is transverse to the shaft axis. Decide upon the diameter of the bar taking a factor of safety of 1.5 and factor of 0.85 and 0.89 respectively for size effect and surface finish. Take often following values for material properties.

Ultimate strength = 650N/mm^2 ,Yield strength = 450N/mm^2

Endurance strength =350N/mm^2 (16)

7. The bending stress in a machine part fluctuates between a tensile stress of 280N/mm^2 and a compressive stress of 140N/mm2• What should be the minimum ultimate tensile strength of this part to carry this fluctuation indefinitely according to (i) Goodman's formula (ii) Soderberg formula Factor of safety is 1. 75. Assume that the yield point is never likely to be less than 55% of the Ultimate tensile strength or greater than 93 % of it. (16)

8. Determine the thickness of a 120mm wide uniform plate for safe continuous operation if the plate is to be subjected to a tensile load that has a maximum value of 1000N.The properties of the plate materials are as follows. Endurance limit stress is 225MPa and yield point stress is 300MPa.

      The factor of safety based on yield point may be taken as 1.5. (16)

9. A hot rolled bar of steel is subjected to a torsional load varying from-150N-m to 450N-m. Determine the required diameter of the bar using a factor of safety of 1.7. Properties of the material may be assumed as follow.

      Ultimate tensile stress = 450MPa

      Yield stress = 300MPa (16)

10.A transmission of shaft made C45 steel subjected to a fluctuating torque varying from -100N-m to +500N-m.Also a fluctuating bending moment acts on the shaft which varies from +500N-m to -500N-m.Let the stress concentration factor be 2. The shaft is machined for a factor of safety 1.5.Determine the required diameter of the shaft. (16)

UNIT -II (DESIGN OF SHAFTS, KEYS AND COUPLINGS)
PART-A (2 marks)

1. What is a shaft?

2. Write down the formula for finding equivalent twisting moment.

3· Define the term critical speed.

4. What is a key?

5. What are the types of keys?

6. Differentiate between keys and splines.

7. What is the function of a coupling between two shafts?

8. What are flexible couplings used?

9. What is the material used for flange or flange coupling?

10. Differentiate between a cotter joint and a knuckle joint

UNIT -II (DESIGN OF SHAFTS, KEYS AND COUPLINGS)
PART-B

1. A line shaft rotating at 200rpm is to transmit 20KW power. the allowable shear stress for the shaft material is 42N/mm2.If the shaft carries a central load of 900N and is simply supported between bearing 3meters apart determine the diameter of the shaft. The maximum tensile or compressive stress is not to exceed 56N/mm^2• (16)

2. An electric generator rotates at 200rpm and receives 300KW from the driving engine. The armature of the generator is 60cm long and located between bearing 120cm center to center. Owing to the combined weight of armature and magnetic pull, the shaft is subjected to 9000kg acting at right angles to the shaft. The ultimate stress for the shaft is 4480kg/cm2 and shear stress is 3920kg/cm2.Find the diameter of the shaft for a factor of safety of 6. (16)

3. A mild steel shaft transmit 23KW to 200rpm.It carries a central load of 900N and is simply supported between the bearing 2.5meters apart. Determine the size of the shaft, if the allowable shear stress is 42MPa and the maximum tensile or compressive stress is not exceed 56MPa. What size of the shaft will be required, if it is subjected to gradually applied load? (16)

4. A shaft to transmit 50KW at 1200rpm.It is also subjected to a bending moment of 275NNm.Allowable shear stress is 60N/mm^2.The shaft is not to twist more than 20 in a length of 2m.G=80XI03N/mm^2.Design a shaft. (16)

5. A factory line shaft is 4.5m long and is to transmit 75KW at 200rpm.The allowable stress in shear is 45MPa and maximum allowable twist is 10 in a length of 20mm diameter. Determine the required shaft diameter. (16)

6. Design and draw a cast iron flange coupling for a mild steel shaft transmitting 90KW at 250rpm. The allowable shear stress in the shaft is 40MPa and the angle of twist is not to exceed 10mm in a length of 20mm diameters. The allowable shear stress in the coupling bolt is 30MPa. (16)

7. Design a cast iron protective type flange coupling to transmit 15KW at 900rpm from an electric motor to a compressor. The service factor may be assumed as 1.35.
The following permissible stress may be used:
Shear stress for the shaft, bolt and key material=40MPa Crushing stress for bolt and key=80Mpa
Shear stress for cast iron=8Mpa (16)

8. A rigid type coupling is used to connect two shaft transmit 15KW at 200rpm.The shaft, key and bolts are made ofC45 steel and the coupling is of C.I. Design the coupling. (16)

9. Design and sketch protective type C.I flange coupling to transmit 10KW at 250rpm. The permissible shear stress for key, shaft, and bolt as 50N/mm2.Take crushing stress of key as 90N/mm^2 and shear stress for C.I as 14N/mm2.Assume maximum torque is 30% higher than mean torque.
(16)
10. A knuckle joint is to transmit a force of 140KN.Allowable stresses in tension, shear and compression are 75N/mm^2, 65N/mm^2 and 140N/mm^2 repectively.Design the joint.
(16)

UNIT-III (DESIGN OF FASTNERS AND WELDED JOINTS)

PART-A (2 marks)

1. What are the purposes of screws?

2. How is a bolt designated?

3· Define the term self-locking of power screws.

4. Why are welded joints preferred over riveted joints?

5. What are the types of welded joints?

6. Write down the formula for the strength of single transverse fillet weld

7. Differentiate with a neat sketch the fillet welds subjected to parallel loading and transverse loading.

8 When will the weld deposit be weaker?

9. Define eccentrically loaded welded joints.

10. What are the two types of stresses are induced in eccentric loading of loaded joint?

UNIT-III (DESIGN OF FASTNERS AND WELDED JOINTS)
PART-B

I. The cylinder head of a steam engine with 250mm bore is fastened by eight stud bolts made of 30C8 steel. Maximum pressure inside the cylinder is 1MPa.Determine the bolt size and approximate tightening torque. Take 20% over load. Assume σy=300MPa.   (16)

2. A steam of effective diameter 300mm is subjected to a steam pressure of 1.5N/mm2.The cylinder head is connected by 8 bolts having yield point 330MPa and endurance limit at 240MPa.The bolts are tightened with an initial per load 1.5 times the steam load. A soft copper gasket is used to make the joint leak proof. Assuming a factor of safety 2, find engine size of bolt required. The stiffness factor for copper gasket may be taken as 0.5.   (16)

3. A steam engine cylinder has an effective diameter of350mm and the maximum steam pressure acting on the cylinder cover is 1.25N/mm^2.calculate the number and the size of studs are required to fix the cylinder cover. Assume the permissible stress in the stud 70N/mm^2•   (16)

4. A plate 100m wide and 12.5mm thick is to be welded to another plate by means of two parallel fillet welds. The plates are subjected to a load of 50KN.Find the length of the weld so that the maximum stress does not exceed 56N/mm^2. (Do the calculations under static loading).   (16)

5. A plate 75mm wide and 10mm thick is jointed with another plate by a single transverse weld and double parallel fillet as shown in fig. The joint is subjected to a maximum tensile force of 55KN.The

permissible tensile and shear stress are 70MPa and 50MPa respectively. Find the length of each parallel fillet weld. (16)

6. Determine the length of the weld run for a plate of size 120mm wide and 15mm thick to be welded to another plate by means of (1) A single transverse weld (2) Double parallel fillet welds when the joint is subjected to variable loads. Assume (Tensile stress =70MPa, shear stress =56MPa.) (16)

UNIT -IV (DESIGN OF SPRINGS AND LEVERS)

PART-A (2 marks)

1. What are the various types of springs?
2. Classify the helical springs.
3. Define: Leaf springs.
4. What are conical springs?
5. What is spring index?
6. What are active coils and inactive coils?
7. What is stiffness of spring?
8. What are the various spring materials?
9. What is a laminated leaf spring?
10. What are semi-elliptical leaf springs?
11. What is nipping of laminated leaf spring? Discuss its role in spring design.

UNIT -IV (DESIGN OF SPRINGS AND LEVERS)
PART-B

1. A helical valve spring is to be designed for an operating load range of 90N to 135N.The deflection of the spring for this load range is 7.5mm.Assuming a spring index of 10, a permissible shear stress of 480N/mm^2 and a modulus of rigidity of 0.8Xl0^5 N/mm^{2}for the material, determine the dimensions of the spring. (16)

2. A gas engine valve spring is to have a mean diameter 37.5mm.The maximum load will have to sustain is 450N with a corresponding deflection of 12.5mm.The spring is to be subjected to repeated loading and fatigue must be considered a low working stress of 300N/mm2 will be used. Find the size for the wire and number of coil used. Take rigidity of modulus as 0.8XI0^5 N/mm^2• (16)

3. A compressive helical spring is required to exert a minimum force 250N and maximum force of 600N and the deflection for this change in load to be 15mm. The spring must fit in a hole of 30mm diameter. The load is static. Ultimate tensile stress is 1393N/mm^2 and shear stress is 606Mpa. (16)

4. A closely coil helical spring is made of 10mm diameter steel wire, the coil consisting of 10 complete turns with a mean diameter of 120mm.The springs carries an axial pull of 200N.Determine also deflection in the spring, its stiffness and strain energy stored by it if the modulus of rigidity of the material is 80KN/mm^2• (16)

5. A helical compression of spring made of oil tempered carbon steel is subjected to a load which varies from 400N to 1000N. The spring index is 6 and the design factor of safety is 1.25.If the yield stress in shear is 770Mpa ,and endurance stress in shear is 350Mpa,find,(1) Size of the spring wire (2) Diameter of the spring wire (3) Number of turns of the spring (4) Free length of the spring. The compression of the spring at the maximum load is 30mm.The modulus of rigidity for the spring material may be taken as 80KN/mm^2. (16)

6. A semi-elliptical leaf spring of 1m long and is required to resist a load of 50KN.The spring has 15 leaves of which three are full length leaves. The width of central band is 100mm. All the leaves are to be stressed to 420MPa.The ratio of total depth to width is 3.Take, =2.1Xl0^{5}MPa.Determine,

    (i) The thickness and width of the leaves.

    (ii)The initial gap that should be provided between the full lengths and graduated leaves before assembly.

    (iii)The load exerted on the band for the assembly. (16)

7. A leaf spring for a small trailer is to support a load of 8KN. The spring has 8 graduated leaves and 2 free full length leaves of spring steel of safe stress 380MPa.The over all length 1m and the central band is 80mm wide. Taking ratio of total depth of leaves as 3.Design the spring and also determine the deflection of the spring. Take, E=2.1XI0^{5}MPa. (16)

8. Design of leaf spring for a truck to the following specifications:

    Maximum load on the spring = 140KN No of spring = 4

Material for spring chromium vanadium steel Permissible tensile stress = $600N/mm^2$

Maximum number of leaves =10

Span of spring = 1000mm

Permissible deflection = 80mm

Young's modulus of the spring = $200N/mm^2$ (16)

9. Design a cantilever leaf spring to absorb 600N-m energy without exceeding a deflection of 150mm and a stress of $800N/mm^2$• The length of the spring is 600mm. The material of the spring is steel.Take,E=$200KN/mm^2$ (16)

UNIT-V (DESIGN OF BEARING AND FLYWHEELS)
PART-A (2 marks)

1. What is a spring?
2. What are the applications of springs?
3. What are the various types of springs?
4. What are the types of thrust ball bearings?
5. Classify the roller hearings.
6. What is load rating?
7. State any points to be considered for selection of bearings.
8. What is bearing?
9. Classify the types of bearings.
10. List any six types of bearing materials.
11. What are the required properties of bearing materials?
12. What is a journal bearing?

UNIT -V (DESIGN OF BEARING AND FLYWHEELS)

PART-B

1. Design a journal bearing for a centrifugal pump with the following data:

      Diameter of the journal = 150mm

         Load on bearing = 40KN

         Speed of journal = 900rpm   (16)

2. Design a journal bearing for a centrifugal pump from the following data:

Load on the journal=20000N, Speed of the journal=900rpm, Type of oil is SAElO, for which the absolute viscosity at 55°C=0.017kg/m-s, Ambient temperature of oil = 15.5^0C, Maximum bearing pressure for the pump=1.5N/mm^2.Calculate also mass of the lubricating oil required for artificial cooling, If the rise of temperature, if the rise of temperature of oil be limited to 10^oC heat dissipation coefficient=1232W/m^2/^{o}C   (16)

3. A full journal bearing of 50mm diameter and 100mm long has a bearing pressure of l.4N/mm2• The speed of the journal is 900rpm and the ratio of journal diameter to the diametric clearance is 1000. The bearing is lubricated with oil, whose absolute viscosity at the operating temperature of 75°C may be taken as 0.011 kg/m-s. The room temperature is 35^0C.Find,

      (1) The amount of artificial cooling required.

      (2)The mass of lubricating oil required, if the difference between the outlet and

         inlet temperature of the oil is 10°C. Take specific heat of oil as 1850J/Kg/^{0}C.   (16)

4. A 150mm diameter shaft supporting a load of 10KN has a speed of 1500rpm.The shaft run in whose bearing length is 1.5 times the shaft diameter. If the diametric clearance of bearing is 0.15mm and the absolute viscosity of the oil at the operating temperature is 0.011 Kg/m-s.
Find the power wasted in friction.   (16)

5. The turning moment diagram of a multi-cylinder engine is drawn with a scale of (1 mm = 1˚) on the abscissa and (1 mm = 250 Nm)on the ordinate. The intercepted between the torque developed by the engine and the mean resisting torque of the machine, taken in order from one are -350,+800,-600,+900,

-550,+450,-650 mm2.The engine is running at a mean speed fluctuations is limited to 0.02.A rimmed flywheel made of grey cast iron FG 200 (Density=7100Kg/m^3) is provided. The spokes, shaft and hub are assumed to contribute 10% of the required moment of inertia. The rim has rectangular cross section and the ratio of width to thickness is 1.5.Determine the dimensions of the rim.　　(16)