DEPARTMENT OF MECHANICAL ENGINEERING

UABMCC01-DESIGN OF MACHINE ELEMENTS

QUESTION BANK

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Unit -1 STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS

Part-A

1. What are the steps in machine design process?
2. How will you classify machined design and explain it?
3. Enumerate the most commonly used engineering materials and state at least one important property and one application of each
4. Why are metals in their pure form unsuitable for industrial use?
5. Define 'mechanical property' of an engineering material.
6. What do you understand by the nominal size and basic size?
7. Define Interchangeability
8. Define Tolerance
9. Define Allowance
10. Define Fits
11. Define unilateral and bilateral tolerance.
12. What is meant by 'hole basis system' and 'shaft basic system'? Which one is preferred and why?
13. Discuss the Indian standard system of limits and fits.
14. What are the commonly used fits according to Indian standards?
15. What do you understand by preferred numbers?
16. How is the working stress calculated from the yield stress of a material?
17. What is meant by stress concentration?
18. For Ductile material, which of the strength is considered for designing a Component subjected to static loading
19. For Ductile material, which of the strength is considered for designing a Component subjected to fatigue loading
20. What is the force required to punch a hole of diameter 'd' in a metal of thickness 't' having ultimate shear strength as 'ζu'?

PART B

1. List down the factors that influence machine design?
2. How will you select materials based on Mechanical properties?
3. Write the equations for the following a) Direct Stress b)Bending stress c) Torsional Stress.
4. State any six mechanical properties give their definitions and one example of the material possessing the properties.
5. Differentiate Impact and Shock loading?
6. write down the equation for finding Principle Stresses?

7. Write the equation for a moment of inertia for 1.circular shaft 2. Rectangular shaft 3. Hollow shaft.
8. Write a bending moment equation.
9. What are assumption made in bending moment.
10. What is meant by stress concentration? Write the formulae.
11. Write soderberg equation for a machine component subjected to a. Combination of mean and variable torques b. Combination of mean and variable bending moments.
12. The load on a bolt consists of an axial pull of 15kN together with a transverse shear force of 10KN. Find the diameter of bolt required according to 1. Maximum strain energy theory and 2. Maximum distortion energy theory.
13. An electric motor weighing 500n is mounted on a short cantilever beam of uniform rectangular cross section. The weight of motor acts at a distance of 300mm from the support. The depth of the section is twice the width. Determine the cross section of the beam. The allowable stress in the beam 40N/mm^2
14. A cantilever of span 50mm carries a vertical downward load of 6KN at free end. Assume yield value of 350Mpa and FOS 3. Find the diameter considering the section is circular.
15. An unknown weight fall from a distance of 15mm on to a collar rigidly attached to the lower end of a vertical bar 2.5m and 500mm^2 cross section. The maximum instantaneous extension is 2mm. Find the corresponding stress and the value of the weight falling take E=2*10^{5}N/mm^2.

PART C

1. A bolt is subjected to a tensile load of 25KN and a shear load of 10KN. determine the diameter of the bolt according to 1.Max. Principal stress theory, 2.Max. Principal strain theory, 3. Max. shear stress theory, assume FOS=2.5 yield point stress in simple tension is 300N/mm^2 and poisson ratio is 0.25.
2. A steel member is subjected to a 3-D stress system and the resulting principal stress are 120 N/mm^2 tension 80 N/mm^2 and 40 N/mm^2 compression. If the proportional limit of the material is simple tension is 280N/mm^2 and its poisons ratio is 0.3 determine FOS
    1. Maximum principal stress theory; 2. Maximum shear stress theory; 3. Maximum principal strain theory
3. A Shaft is subjected to a bending moment vary from -200N-m & 500 N-m and twisting moment of 50 N-m to 175 N-m. The material used has ultimate stress 600mpa endurance stress 300 mpa, K_a=0.76, K_b=0.85, K_c=0.897, K_t=1.85, and Q=0.95. Find the diameter of the shaft by von mises hencky theory. Take FOS is 1.5.
4. A Simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4P. The span of the beam is 500mm and its cross section is circular with 60mm diameter. Taking for the beam material as ultimate stress of 700Mpa , yield stress of 500mpa , endurance limit of 330mpa for reversal bending and a FOS of 1.3.Calculate the maximum value of P.Take size factor of 0.85 and surface finish factor of 0.9.
5. The load on a bolt consists of an axial pull of 10kN together with a transverse shear force of 5KN. Find the diameter of bolt required according to 1. Maximum principal stress

theory; 2. Maximum shear stress theory; 3. Maximum principal strain theory; 4. Maximum strain energy theory and 5. Maximum distortion energy theory. assume FOS=3 yield point stress in simple tension is 450N/mm^2 and poisson ratio is 0.25.

6. A pulley is keyed to a shaft midway between two anti-friction bearings. The bending moment at the pulley varies from – 170 N-m to 510 N-m and the torsional moment in the shaft varies from 55 N-m to 165 N-m. The frequency of the variation of the loads is the same as the shaft speed. The shaft is made of cold drawn steel having an ultimate strength of 540 MPa and a yield strength of 400 MPa. Determine the required diameter for an indefinite life. The stress concentration factor for the keyway in bending and torsion may be taken as 1.6 and 1.3 respectively. The factor of safety is 1.5. Take size factor = 0.85 and surface finish factor = 0.88.

Unit-II DESIGN OF SHAFTS AND COUPLINGS

Part-A

1. What is an axle.
2. How the shafts are formed?
3. Discuss the various types of shafts

4. the standard sizes of transmissions shafts.
5. What types of stresses are induced in shafts?
6. How the shaft is designed when it is subjected to twisting moment only?
7. Define equivalent twisting moment
8. Define equivalent bending moment.
9. When the shaft is subjected to fluctuating loads, what will be the equivalent twisting moment and equivalent bending moment?
10. What do you understand by torsional rigidity.
11. Under what circumstances are hollow shafts preferred over solid shafts?
12. Give any two examples where hollow shafts are used. How they are generally manufactured?
13. What is a key?
14. State the functions of key.
15. How are the keys classified?
16. What are the considerations in the design of dimensions of formed and parallel key having rectangular cross-section?
17. Write short note on the splined shaft covering the points of application, different types and method of manufacture.
18. What is the effect of keyway cut into the shaft?
19. Discuss the function of a coupling. Give at least three practical applications.
20. Why are two universal joints often used when there is angular misalignment between two shafts?

PART-B

1. Draw neat sketches of different types of keys and state their applications.
2. What are flexible couplings and what are their applications? Illustrate your answer with suitable examples and sketches.
3. Distinguish clearly, giving examples between pin, axle and shaft.
4. A line shaft rotating at200rpm is to transmit 20kw. The shaft may be assumed to be made of mild steel with allowable shear stress 42mpa. Determine the diameter of shaft neglecting bending moment.
5. Write the equation for both shaft and hollow subjected to twisting moment.
6. A solid shaft is transmitting 1MW at 240rpm. Determine the diameter of shaft if maximum torque transmitting exceeds the mean torque by 20%. Take maximum shear stress as 60Mpa.
7. A hollow shaft has greater strength and stiffness than solid shaft of equal weight. Explain.
8. How does the working of a clamp coupling differ from that of a muff coupling? Explain.
9. A pair of wheels of a railway wagon carries a load of 50 KN on each axle box, acting at a distance of 100mm outside the wheel base. The gauge of the rail 1.m. Find the diameter of the axle between wheels if the stress is not to exceed 100Mpa.
10. A solid circular shaft is subject to a bending moment of 3000Nm and a torque of 10000Nm, the shaft is C45 steel having ultimate strength of 700Mpa a ultimate shear stress of 500Mpa. Assume factor of safety as 6. Find the diameter.

11. A solid shaft is to transmit 1000kw and 120rpm. Find the shaft diameter if the shear stress is 80N/mm^2. If the shaft is made hollow with internal diameter is 0.6 times the outer diameter. Find the percentage of saving in material.
12. A solid shaft is to transmit 500kw and 60rpm. Find the shaft diameter if the shear stress is 70N/mm^2. If the shaft is made hollow with internal diameter is 0.4 times the outer diameter. Find the percentage of saving in material.
13. What is a coupling and requirement of a good coupling.
14. A solid circular shaft is subject to a bending moment of 2500Nm and a torque of 8000Nm, the shaft is C45 steel having ultimate strength of 500Mpa a ultimate shear stress of 300Mpa. Assume factor of safety as 4. Find the diameter of the shaft.
15. A pair of wheels of a railway wagon carries a load of 30 KN on each axle box, acting at a distance of 80mm outside the wheel base. The gauge of the rail 2.m. Find the diameter of the axle between wheels if the stress is not to exceed 80N/mm^2.

PART-C

1. Find the diameter of a solid shaft to transmit 20KN at 200rpm. The ultimate shear stress for the steel may be taken as 360Mpa and FOS 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 and outside diameter is 0.5.
2. A hollow steel shaft transmits 600 kW at 500 rpm. The maximum shear stress is 62.4 Mpa. Find the outside and inside diameter of the shaft, if the outer diameter is twice of inside diameter, assuming that the maximum torque is 20% greater than the mean torque.
3. Determine the dimension of flange coupling that connect a motor and a pump shaft. The power to be transmitted a 4KW at a shaft speed of 1200 rpm. Select suitable material for the parts of the couplings and list the dimensions.
4. Design of muff coupling for a shaft to transmit 35kw at 350rpm the safe shear stress for the steel shaft is 50N/mm^2 and for cast iron muff. It is 15N/mm^2 the allowable shear and crushing stress for the material are 2N/mm^2 and 120N/mm^2 respectively.
5. A rigid type of coupling is used to connect two shafts transmitting 15 KW at 200 rpm. The shafts, keys and bolts are made of C45 steel and the coupling is of Cast iron. Design the couplings.
6. Determine the dimension of flange coupling that connect a motor and a pump shaft. The power to be transmitted a 2KW at a shaft speed of 960rpm. Select suitable material for the parts of the couplings and list the dimensions.

Unit –III DESIGN OF TEMPORARY AND PERMANENT JOINTS

PART-A

1. What is meant by welding?
2. Write any two types of joints.
3. Sketch the Lap joint.
4. Sketch the Butt joint.

5. What do you understand by the single start threads.
6. What do you understand double start threads?
7. State three conditions where tap bolts are used.
8. What are the different stresses setups in a bolt due to initial tightening?
9. What is threaded joint?
10. What is a stud?
11. How is a bolt designated? Give examples.
12. How do you design a bolt with uniform strength?
13. What is the meaning of bolt M24 x 2?
14. What is purpose of cotter joint?
15. Which type of thread would you suggest for the following? a. Lead screw for a lathe b. Fastening of a bracket to a wall c. Screw jack.
16. Why reinforcement is normally required in welded joints?
17. What are the advantages of welded joints compared with riveted joints?
18. What are the limitations of rived joint.
19. What is the minimum size for fillet weld
20. Name the possible modes of failure of riveted joint.

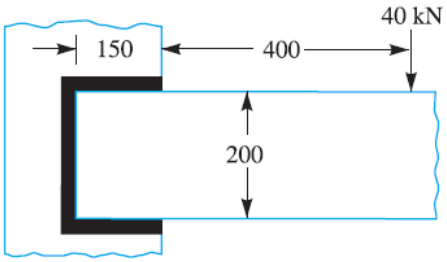
PART-B

1. Explain in detail any two types of joints.
2. Explain in detail a)single start thread b) Double start thread.
3. Explain with neat sketch any three types of welding.
4. A Plate 60mm wide and 10mm thick is welded to another plate by two parallel fillet welds . Determine the safe load that the weld joint can carry the allowable working stress is shear for the weld material is $75N/mm^2$
5. What do you mean by efficiency of a riveted joint? The efficiency of a riveted joint is always less than 100% give your comment.
6. Sketch a)Lap joint and b)Butt joint.
7. What are the reasons of replacing riveted joint by welded joint in modern equipment?
8. A Plate 40mm wide and 15 mm thick is welded to another plate by two parallel fillet welds . Determine the safe load that the weld joint can carry the allowable working stress is shear for the weld material is $100N/mm^2$.
9. A plate of 80mm wide and 6mm thickness is to be welded to a another plate by means of a double parallel fillet. The plate is subjected to a static load of 60KN. Find the length of weld if the permissible shear stress in the weld does not exceed 45Mpa.
10. Distinguish between cotter joint and knuckle joint.
11. A plate 150mm wide and 15 mm thick is to be welded to another plate by means of parallel fillet welds. The plates are subjected to a load of 80KN. Find the length of the welds so that the maximum stress does not exceed 46Mpa.
12. What is a cotter joint? Explain with the help of a neat sketch, how a cotter joint is made?

13. Write the types of fillet weld with its formula?
14. Write down the expression for strength of parallel fillet weld in terms of permissible shear stress, leg of weld and length of welded joint.
15. A 75mm diameter solid shaft is welded to a flat plate by 6mm fillet weld. determine the maximum torque that the welded joints can sustain if the permissible shear stress intensity in the weld material is not to exceed 80Mpa.

PART-C

1. A plate of 100mm wide and 10mm thickness is to be welded to a another plate by means of a double parallel fillet. The plate is subjected to a static load of 80KN. Find the length of weld if the permissible shear stress in the weld does not exceed 55Mpa.
2. With a neat sketch explain the types of welding.
3. A plate 100mm 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 50KN. Find the length of the welds so that the maximum stress does not exceed 56Mpa.
4. With a neat sketch explain the types of joints.
5. A 50mm diameter solid shaft is welded to a flat plate by 8mm fillet weld. determine the maximum torque that the welded joints can sustain if the permissible shear stress intensity in the weld material is not to exceed 70Mpa.
6. A bracket, as shown in Fig. 10.39, carries a load of 40 KN. Calculate the size of weld, if the allowable shear stress is not to exceed 80 MPa.



All dimensions in mm.

Unit-IV DESIGN OF ENERGY STORING ELEMENTS

Part-A

1. What is the function of a spring?
2. In which type of spring the behaviour is non-linear?
3. Discuss the materials for the springs.
4. Discuss the practical applications for the springs.
5. The extension springs are in considerably less use than the compression springs. Why?
6. Explain one method of avoiding the tendency of a compression spring to buckle.

7. What do you understand by full length and graduated leaves of a leaf spring?
8. What is the effect of increase in wire diameter on the allowable stress value?
9. What are constant widths and constant strength springs?
10. What is meant by coefficient of fluctuation of energy with reference to flywheels?
11. What are the applications of concentric spring?
12. Two springs of stiffness K_1 and K_2 are connected in series. What is the stiffness of connection?
13. What are the different styles of end for helical compression spring?
14. How do you eliminate the surge in springs?
15. What is purpose of leaf spring that is used in automobiles?
16. What type of stresses is produced in a disc flywheel?
17. What is the main function of a flywheel in an engine?
18. Define 'Coefficient of fluctuation of speed'.
19. Define 'coefficient of steadiness of speed'.
20. Discuss the various types of stresses induced in a flywheel rim.

PART-B

1. Explain in detail classification of springs
2. Write the functions of a spring.
3. In what way does a flywheel differ from that of a governor? Illustrate your answer with suitable examples.
4. When two concentric springs of stiffness 100 N/mm and 50 N/mm respectively are subjected to an axial load of 750 N, what will be the deflection of each spring?
5. Discuss the materials and practical applications for the various types of springs.
6. Explain the advantages, disadvantages and limitation of leaf springs.
7. A helical spring made of C50 steel has an outside diameter of 80mm and a wire diameter of 12mm. The spring has to support a maximum axial load of 1KN. Determine the maximum shear stress and total deflection. If the spring have 10.5 coils with ends grand flat. Determine the FOS. take $G=0.89*10^2 KN/mm^2$.
8. A helical spring is made from a wire of 10mm diameter and its outer diameter 95mm.The spring has 8 number of turns of active coils. If he permissible shear stress is $450N/mm^2$ and the modulus of rigidity is $86KN/mm^2$. Find the axial load in which the spring deflection produced.
9. Design a cantilever leaf spring to absorb 500N-m energy without exceeding a deflection of 250mm and a stress of $900N/mm^2$. The length of the spring is 500mm. The material of the spring is cast iron.
10. What is nipping in a leaf spring? Discuss its role. List the materials commonly used for the manufacture of the leaf springs.
11. Write the expression for determining the stress and deflection in full length and graduated leaves.
12. Explain in detail the types of leaf spring.
13. A leaf spring for a small trailer is to support a load of 8KN. The spring has 8 graduated leaves and 2 extra full length leaves of spring steel of 380MPa. The overall length is 1m

and central band is 80mm wide. Taking the ratio of total depth of leaves to width as 3. design the spring.

14. 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.
15. A semi elliptical spring is 2 m long carries a load of 6KN. The spring consists of 8 leaves with 2 full length leaves. All leaves are 40mm wide. Find the thickness of leaves. Also find the maximum stress induced for a deflection of 50mm.

PART-C

1. A gas engine valve spring is to have a mean diameter 37.5mm. The maximum load it will have to sustain is 450N with a corresponding deflection of 12.5 mm. The spring is to be made of tempered wire. Since the material is subjected to a repeated loading and fatigue must be considered a low working stress of 300N/mm^2 will be used. Find the size for wire and number of coils used. Take rigidity modulus as $0.8*10^5$ N/mm^2.
2. A helical spring is made from a wire of 8mm diameter and its outer diameter 75mm.The spring has 6 number of turns of active coils. If he permissible shear stress is 350N/mm^2 and the modulus of rigidity is 84KN/mm^2. Find the axial load which the spring can take and deflection produced.
3. A helical valve spring is to be designed for an operating range 90N to 135 N. the deflection of the spring for this load range is 7.5mm. Assuming a spring index of 10, a permissible shear stress of 480 N/mm^2 for the material and the modulus of rigidity of $0.8*10^5$N/mm^2. determine the dimension of the spring.
4. A semi elliptical leaf spring consisting of two extra full length leaves and 6 graduated length leaves including the master leaves. Each leaf is 7.5mm thick and 50mm wide. The centre to centre distance between the two eyes is 1m.The leaves are pre stressed in such a way that when the load is maximum, the stress induced in all leaves equal to 350N/mm^2. Determine the maximum force that force can withstand.
5. An automatic semi elliptical spring is 1.5 m long carries a load of 8000N. The spring consists of 10 leaves with 2 full length leaves. All leaves are 50mm wide. Find the thickness of leaves. Also find the maximum stress induced for a deflection of 60mm.
6. Design a leaf spring for a truck to the following specifications.
   Maximum load on the spring 140KN, No. of springs 4, Material: Chromium vanadium stress, Permissible tensile stress is 600N/mm^2, Maximum number of leaves 10, Span of the spring 1000mm, Permissible deflection 80mm, Young's modulus 200KN/mm^2.

Unit-V DESIIGN OF BEARINGS AND MISCELLANEOUS ELEMENTS

Part-A

1. What are journal bearings?
2. What are the classification of journal bearing.
3. What is meant by hydrodynamic lubrication?
4. Differentiate radial and thrust bearing.
5. List the important physical characteristics of a good bearing material.
6. What is the procedure followed in designing a journal bearing?
7. For a journal bearing the maximum operating temperature must be less than 80˚C. Why?

8. State the merits of hydrostatic bearings.
9. What is a quill bearing?
10. State the disadvantages of trust ball bearing.
11. What is meant by life of anti-friction bearings?
12. Differentiate the rated life of bearing with its average life.
13. What is the advantage of Telfon which is used for bearings?
14. Name the material that is used for to make ball bearings.
15. Why is piston end of a connecting rod kept smaller than the crank pin end?
16. Explain the various stresses induced in the connecting rod.
17. Under what force, the big end bolts and caps are designed?
18. List the various types of crankshafts.
19. At what angle of the crank, the twisting moment is maximum in the crankshaft?

PART-B

1. Explain in details a) Radial bearing
2. Explain in details b) Thrust bearing.
3. With a neat sketch explain a)sliding contact
4. With a neat sketch explain b) Rolling contact.
5. What are assumptions in bearings.
6. Write the design procedure for journal bearing.
7. Write the design procedure for rolling contact bearing.
8. Explain in detail any four material properties of the bearing.
9. What are the methods and materials used in the manufacture of crankshafts?
10. What are materials used for the bearings explain in detail.
11. Write a short notes on lubricants and explain its properties in detail.
12. Design a journal bearing for the following data
    Diameter of the journal (D)=200mm.
    Load on the bearing (W)=10KN.
    Speed (N)=1400rpm.
13. Design a journal bearing for 10KW, 1440rpm pelton turbine, which is supported by two bearings. Take the atmospheric temperature as 30^0C and operating temperature of oil as 80^0C. Viscosity of oil as 28 Ns/m^2.
14. Explain wedge film and squeeze film journal bearings.
15. List any four advantages of rolling contact bearings over sliding contact bearings.

PART-C

1. Design a journal bearing for a centrifugal pump with the following data
    Diameter of the journal (D)=150mm.
    Load on the bearing (W)=40KN.
    Speed (N)=900rpm.

2. Explain in detail the types of bearings with neat sketch.
3. Design a journal bearing for 12MW, 1000rpm steam turbine, which is supported by two bearings. Take the atmospheric temperature as 16^0C and operating temperature of oil as 60^0C. Assume viscosity of oil as 23 centipoise.
4. Explain in details the various material properties of a bearing.
5. Design a journal bearing for the following data
   Diameter of the journal (D)=300mm.
   Load on the bearing (W)=20KN.
   Speed (N)=1200rpm.
6. Design a journal bearing for 8MW, 1200rpm water turbine, which is supported by two bearings. Take the atmospheric temperature as 28^0C and operating temperature of oil as 70^0C. Viscosity of oil as 28 Ns/m^2.

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