SHRI ANGALAMMAN COLLEGE OF
ENGINEERING AND TECHNOLOGY
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Department of Mechanical Engineering

ME 1302 DESIGN OF MACHINE ELEMENTS

UNIT-1 (STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS)

PART-A

1. Define ‘ Design’ and explain the design process
2. What is ‘innovative design”?
3. Explain a method of reducing cost of the final product from the design perspective.
4. What is ‘optimization’? What are the methods for optimization?
5. Define factor of safety. What factor dictate the selection of factor of safety?
6. Differentiate between hardness and toughness of materials.
7. Explain ‘ creep’, resilience’.
8. List the various types of loads and explain.
9. Distinguish between different types of variable stresses.
10. Explain endurance limit. What factors influence endurance strength?
11. Explain the effect of product reliability on endurance strength.
12. State the significance of S-N curve.
13. Define stress intensity factor, notch sensitivity and fatigue stress concentration factor.
14. Explain Goodman and Seidenberg diagrams
15. Differentiate between the use of Goodman diagram and Seidenberg diagram for designing.
16. Comment on the statement “ In curved beams maximum stress always occurs at the inner fiber “.
17. What is stress concentration? What are the methods to determine it? What are the methods to reduce it?
18. Explain how the maximum shear stress theory is used for biaxial and trysail stress cases.

PART-B

1. A bar of circular cross section is subject to alternating tensile forces varying from 200kN to 500kN. Material's ultimate tensile strength is 900Mpa, endurance limit is 700Mpa. Determine the diameter of the bar using safety factors of 3.5 related to ultimate strength and 4 related to ultimate strength and 4 related to endurance limit. Stress concentration factor us 1.65 use Goodman criteria**.**

2. A steel bar is subjected to a reversed axial load of 180kN. Find the diameter of the bar for a design factor of 2. Ultimate tensile strength 1070N/mm^2 yield strength 910N/mm^2 . Endurance limit in bending is half of ultimate tensile strength. Use the following data. Load factor 0.7, Surface finish factor 0.8, Size factor 0.85, and stress concentration factor 1.

3. A steel cantilever bean 180mm long has a diameter 'd' for a length of 125mm from the free end and '2d' for the remaining length. A fillet of radius 0.2d is provided at the junction of the two sections. A transverse load varying from 4N up and 135N down is acting in combination with an axial load that varies from- 110N to + 450N . Using a design factor of 2, calculate the diameter at the fillet section for infinite life. Ultimate strength 550Mpa, yield strength 470Mpa, Endurance limit 275Mpa. Size factor 0.85 surface factor 0.9 stress concentration factor for bending 1.44, for axial load 1.63 .

UNIT – 2 (DESIGN OF SHAFTS AND COUPLINGS)

PART-A

1. Explain the various types of shafts used in power transmission .
2. Obtain the expression for combined torque and bending moment on a shaft and also for axial load.
3. Write short notes on critical or whirling speed.
4. Write down the design procedure for variable load on a shaft.
5. Explain the various types of keys with simple and neat sketches.
6. Write down the design procedure of keys and splines.
7. Explain the various types of couplings with its applications.
8. Write down the step-by-step design procedure for muff of sleeve couplings.
9. Write down the step-by-step design procedure for clamp or split muff couplings.
10. Explain the various types of flange couplings with neat sketches.
11. Write down the design procedure for flange couplings.
12. Write short notes on bushed pin type flexible couplings.

PART- B

1. A hollow steel shaft of 800mm outside diameter is used to drive a propeller of a marine vessel. The shaft is mounted on bearings 6m apart, and it transmits 6000kW at 200rpm. The maximum axial thrust is 750kN and shaft weighs 75 kN. Determine
a)Maximum shear stress induced b) Angular twist of shaft between bearings.

2. A shaft is to transmit power from an electric motor to a machine through a pulley by means of a vertical belt drive with unit speed ratio. The pulley weighs 500N and is overhanging at a distance of 150mm, from the bearing. Diameter of pulley is 300mm

maximum power transmitted at 250rpm is 4.5kW. Co-efficient of friction between the belt and the pulley is 0.3 combined shock and fatigue factor in torsion is 1.5 and in bending is 2.0, permissible shear Stress for the shaft material is 45N/Sq. mm. Design the shaft.

3. A Shaft is subjected to reversal bending moment of 80Nm and variable torque that varies from + 10Nm to 50Nm during each cycle. Assuming that the shaft is made of C-40 steel. For a design factor of 2, determine the required diameter of shaft.

4. A shaft 30mm diameter is transmitting power at a maximum shear stress of 80N/mm^2. If a pulley is connected to the shaft by means of key, find the dimension of the key so that the stress in the key is not to exceed 50N/mm^2 and the length of key is 4 times of width the key.

5. A 50kW power at 250rpm is transmitted from 60mm diameter shaft by means of Kennedy key. The keys are made of C45 steel having strength of 370N/mm^2 and factor safety is 2.5. Design key.

6. Two shafts 80mm diameter is to be connected by means of two cast iron flange couplings. The allowable shearing stress of the bolt materials is 45N/mm^2 While that of the shaft materials is 55n/mm^2 . Find the size of the bolts to be used. Check the bolts for the induced crushing stress.

7. Design a bushed pin type of flexible coupling for connecting a motor and
pump shaft for the following data
Power = 20kW;
speed = 1000rpm
Shaft diameter = 50mm;
Bearing pressure for rubber bush = 0.3N/mm^2

8. Design a muff coupling to connect two shafts transmitting 40kW at 150rpm. The allowable shear and crushing stresses for the shaft and key are 37N/mm^2 and 96.25N/mm^2 respectively. The permissible shear stress for the muff is 17.5N/mm^2 . Assume that the maximum torque transmitted is 20% more than the mean torque. Take the width and depth of the parallel key is 22mm and 14mm respectively.

UNIT- 3 (DESIGN OF FASTNERS AND WELDED JOINTS)

PART-A

1. What are the various types of screwed fasteners used in machine construction?
2. Compare square thread with trapezoidal thread.
3. List out the application areas of square, buttress and trapezoidal threads.
4. Draw the bolt-deformation diagram and explain.
5. State how a bolt of uniform strength is produced.
6. What is a self-locking screw?
7. Define. Welding and what are the main types of welding?
8. What are the important general applications, advantages and limitations of welding?
9. Explain the different types welded joints with neat sketches.
10. Write down the design procedure for longitudinal and transverse fillet weld.
11. Write down the design procedure for eccentrically loaded welded joints.
12. Write short notes on stress concentration factor.
13. Describe welding specification with its elements and sketches.

PART-B

1. A bolted joint is used to connect two components. The combined stiffness of the two components is twice the bolt stiffness. Initial tightening load tightening load is 5kN. The external force of 10kN creates further tension in the bolt. The bolt is made of plain carbon steel 30C8 for Which yield strength in tension is 400N/mm^2. Using a factor of safety of safety of 3 and assuming coarse threads, select a suitable bolt size.

2. A rectangular steel plate 100mm wide is welded to a vertical plate to form a cantilever with an overlap of 50mm and an overhang of 150mm. It carries a vertical downward load of 60kN at free end. Fillet weld is done three sides of the plate for a permissible stress is 140N/mm^2. Determine the size of the weld.

UNIT-4 (DESIGN OF SPRINGS AND LEVERS)

PART-A

1. What are the various functions of springs?
2. Describe the classification of springs.
3. Obtain the expression for stiffness of helical springs.
4. Write a short note on end conditions of springs.
5. Explain buckling and surge in springs.
6. Differentiate between springs in series and parallel.
7. Describe some important materials used in spring manufacturing.
8. Explain briefly the different groups of springs according to service conditions.
9. State the step-by-step procedure involved in design of helical springs.
10. Explain the design procedure of Belleville springs.

11Obtain the expression for stiffness of helical torsion springs.

12. Obtain the expression for stiffness of maximum stress and deflection in leaf spring and also for cantilever and simply supported springs.
13. Obtain the expression for the deflection semi-elliptical leaf springs.
14. Explain the nipping of leaf springs and how it is calculated?
15. What are the materials used in leaf springs?
16. Write down the step-by-step procedure of design procedure for leaf springs.
17. Classify levers and explain any two briefly.
18. Explain the various steps to be followed for designing levers.

19.. Write short notes on design of hand lever.

PART-B

1. Design a helical compression spring for a load range of 2.0 to 2.5kN and deflection for this range being 5.0mm. Spring index is Modulus of rigidity is 84kN/mm^2. permissible shear stress is 400N/mm^2.

2. A helical spring is made from a wire of 6mm diameter and is of outside diameter 70mm. The spring has 6 numbers of active coils. If the permissible stress in shear is 300N/mm^2 and the modulus of rigidity is 80kN/mm^2. Find the axial load which the spring can take and the deflection produced**.**

3. Two close coiled helical springs are arranged concentrically one inside the other. Both spring have the same number of effective coils and same overall length, but the mean coil diameter of the outer spring is two and half times of the inner spring, which is made of bronze. The outer spring is made of steel. The springs are designed to act together when a

force is applied, so that both suffer change in length and each carries twice the force. Determine ratio of the wire diameters and the ratio of stresses induced in wires, if the modulus of rigidity 3of steel is twice that of bronze**.**

4. A relief must blow off at a pressure of 1.5Mpa and should lift by 5mm for a 7% increase in pressure. The valve diameter is 60mm. Take the spring index as 6.Maximum allowable shear stress of the spring material is 650N/mm^2 . The diameters of the available spring wires in mm are 13, 14, 15, 16 and 18 . Modulus of rigidity is 81370N/mm^2 . Consider Wahl's correction factor. Take inactive number of turns as 1. Design the valve spring.

5. A helical spring is subjected to a load varying from 450N to 1050N having spring index of 6 and the design factor of safety is 1.2. The compression of the spring at the maximum load is 30mm. Design the helical compression spring. Take yield stress in shear as 120N/mm^2 endurance stress in shear as 360N/mm^2 and the modulus of rigidity for the spring material as 75* 10^3 N/mm^2.

6.A torsion spring is wound from a round wire into coil mean diameter 40mm. The torsion moment applied on the spring is 6N-m. Assume the spring index as 8. The Permissible stress in the spring in the spring is 530N/mm^2 and E= 2.6 * 10^{5}N/mm^2. What must be the diameter of wire and the corresponding deflection in degrees? Take number of effective coils as 9.

7.A semi elliptic leaf spring consists of two extra full-length leaves and seven graduated length leaves, including the master leaf. Each leaf is 7mm thick and 58mm wide. The centre-to-centre distance between the two eyes is 1.2m. The leaves are pre-stressed in such a way that when the load is maximum, stress induced in all leaves are equal to 370N/mm^2 Determine the maximum force that the spring can withstand.

8. A semi-elliptical spring has 12 leaves with two full-length leaves extending 600mm. It is 75mm wide and is made of 8mm thick. Design a helical spring, with mean coil diameter 95mm, which will have approximately the same values of induced stress and deflection for any load.

9.Design a leaf spring for a truck to the following specifications :
Maximum load on the spring – 125kN
Number of springs – 3
Material for spring – Chromium vanadium steel
Permissible tensile stress – 620N/mm^2
Maximum number of leaves – 8
Span of spring – 1010cm
Permissible deflection – 80mm
Young's modules of the spring – 210kN/mm^2.

10. A leaf spring for a small trailer is to support a load of 10kN. The spring has 6 graduated leaves and 2 extra full-length leaves of spring steel of safe stress 360Mpa. The overall length is 1.2m and the central band is wide. Taking the ratio of total depth of leaves to width as 3, design the spring.

UNIT-5 (DESIGN OF BEARINGS AND FLYWHEELS)

PART-A

1. Compare rolling contact bearing with the sliding contact bearing.
2. Write short notes on standard dimensions and designation of bearing.
3. Obtain the life of the bearing for various types of machines.
4. Discuss the selection of bearings for a given application.
5. Explain briefly topper roller bearings with its types.
6. Explain the different types of bearings with its neat sketches.
7. Write short notes on bearing materials.
8. Explain each type of journal bearing.
9. Give the complete picture about hydrodynamic and hydrostatic theory of lubrication.

10 Explain the different terminologies in design aspect of journal bearing.

11. Write short notes on heating of bearings.
12. Write down the design procedure of journal bearings.
13. Define the following terms:
    a) Fluctuation of speed. B) . Co-efficient of fluctuation speed c) Stresses in flywheel rim
14. Write down the design procedure of flywheel shaft, hub and key
15. Describe with neat sketches the types of components of roller contact bearings.
16. Give a clear picture about the radial bearings.

PART-B

1. A 25BC02 deep groove ball bearing is to operate at 1300rpm and carries 6000N radial load and 4500N thrust load. The bearing is subjected to a light shock load. Determine the rating life of the bearing.

2. Select a bearing for a 45mm diameter shaft rotates at 500rpm. Due to a bevel gear mounted on the shaft, the bearing will have to withstand a 4500N radial load and a 2500N thrust load. The life of the bearing expected to be least 6000hr.

3. Design journal bearing for 20MW, 200rpm stem turbine, which is supported by two bearings. Take the atmosp0heric temperature as 23$_0$C and operating temperature of oil is 70$_0$ C. Assume viscosity of oil as 20 centistokes

4. An internal combustion engine develops 60Kw at 250rpm with explosions per minute. The done during power stroke is 1.5 times the work done during one cycle. If the revolution of speed is to be limited within 0.6% of the mean speed, design suitable cast iron flywheel. Select suitable materials and specify stress value.

5. Design a cast iron flywheel for a four-stroke engine to develop 150 kW brake power at 200rpm. The work done during the power stroke is 1.4 times the average work done during the whole cycle. The mean diameter of the flywheel may be taken as 2.5 meter. The total fluctuation of speed is to be speed is to be limited to 5% of the mean.

6. Design a rim type cast flywheel for a four-stroke engine to the following specifications. Power = 85kW, Speed = 220rpm. Work done during power stroke is 35 higher than average work during a whole cycle. The fluctuation of speed = _+ or-2.5%. Allowable shear stress for shaft = 50N/mm$_2$. Maximum torque for shaft is 25% higher than mean torque.

7. An internal combustion engine develops 50kW at 200rpm with 100 explosions per minute. The work done during power stroke is 1.4 times done during one cycle. If the revolution of speed is to be limited within 0.5% of the mean speed, design suitable cast iron flywheel. Select suitable materials and specify stress value.

8. Assuming the relevant data, design the flywheel needs for a single cylinder internal combustion engine working on the four-stroke cycle, which develops 75kW at 360rpm.

9. Design a rim type cast flywheel for a four-stroke engine to the following specifications. Power = 75 kW, Speed = 250rpm. Work done power stroke is 30 higher than average work during a whole cycle. The fluctuation of speed = _+_ 2.5%. Allowable shear stress for shaft = 45 N/mm^2. Maximum torque for shaft is 25% higher than mean torque.