

VALLIAMMAI ENGINEERING COLLEGE

*DEPARTMENT OF MECHANICAL
ENGINEERING*

QUESTION BANK

Subject code/Name: ME 2303- DESIGN OF MACHINE ELEMENTS

Year/Sem: III / V

**UNIT- I (STEADY STRESSES AND VARIABLE STRESSES IN MACHINE MEMBERS)
PART-A (2 marks)**

1. Define: Factor of safety
2. Define endurance limit.
3. What is impact load?
4. What are the various phases of design process?
5. What are the different types of loads that can act on machine components?
6. What are the factors affecting endurance strength. What are the types of variable stresses?
7. Differentiate between repeated stress and reversed stress.
8. What are the types of fracture?
9. Distinguish between brittle fracture and ductile fracture.
10. Define stress concentration and stress concentration factor.
11. Explain size factor in endurance strength. Size factor is used to consider the effect of the size
12. Explain Griffith theory. (Or) State the condition for crack growth.
13. What are the modes of fracture?

ME2303- DESIGN OF MACHINE ELEMENTS

14. What are the factors to be considered in the selection of materials for a machine element?
15. What are various theories of failure?
16. List out the factors involved in arriving at factor of safety
17. Give some methods of reducing stress concentration.
18. Explain notch sensitivity.
19. What are the factors that affect notch sensitivity?
20. What is an S-N Curve?

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. $E=200\text{GPa}$.
(8)
- (b) Explain with mathematical expressions. Maximum shear theory 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 poisson's ratio is 0.3. Determine the factor of safety according to (a) Maximum principal stress theory (b) Maximum principal strain theory (c) Maximum shear stress theory.
(16)

ME2303- DESIGN OF MACHINE ELEMENTS

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/mm², Poisson's ratio is 0.25.
(16)

5. Taking stress concentration into 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 with a fillet radius of 6mm.
(16)

6. A circular bar is simply supported with a span of 0.5m and is subjected to a concentrated cyclic load at its midspan. The load varies from a minimum value of 20KN 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 factors of 0.85 and 0.89 respectively for size effect and surface finish. Take the following values for material properties. Ultimate strength = 650N/mm², Yield strength = 450N/mm²

Endurance strength = 350N/mm²
(16)

7. The bending stress in a machine part fluctuates between a tensile stress of 280N/mm² 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 -500Nm. 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. Define the term critical speed.
2. Factor is considered to design a shaft?
3. What is a shaft?
4. What are the types of shafts?
5. What is key?
6. What is key?
7. What are the types of keys?
8. How are sunk key designed?
9. What is the main use of woodruff keys?
10. List the various failures occurred in sunk keys.
11. What is simple torsion?
12. What is simple bending moment?
13. What are the types of rigidity?
14. What are the different measures followed to control the lateral deflection?
15. Define the term critical speed?
16. What is the function of a coupling between two shafts?
17. Under what circumstances flexible couplings are used?
18. What are the purposes in machinery for which couplings are used?
19. What are the types of Rigid coupling?
20. What are the types of Flexible coupling?

PART-B

1. A line shaft rotating at 200rpm is to transmit 20KW power. the allowable shear stress for the shaft material is 42N/mm^2 . 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/cm^2 and shear stress is 3920kg/cm^2 . 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. $G=80\text{XI}03\text{N/mm}^2$. 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 of C45 steel and the coupling is of C.I. Design the coupling. (16)

9. A solid circular shaft subjected to bending moment of 3000Nm and torque of 10000 Nm shaft is made of 45C8 steel having ultimate tensile stress of 700MPa and ultimate shear stress 500Mpa /. assuming factor of safety as 6, determine the dia of the shaft.

10. design a cast iron flange coupling for mild steel shaft transmitting 90KW at 250 rpm. the allowable shear stress in engine shaft is 40Mpa and angle of twist not to exceed 1 degree in the length of 20 diameter. the allowable shear stress in the coupling bolts is 30Mpa.

UNIT-III (DESIGN OF FASTNERS AND WELDED

JOINTS) PART-A (2 marks)

- 1 How is a bolt designated?
2. What factors influence the amount of initial tension?
3. What is bolt of uniform strength?
4. What stresses act on screw fastenings?
- 5.State the two types of eccentric welded connections.
6. What are the different applications of screwed fasteners?
7. What are the advantages of screwed fasteners?
8. Define pitch.
9. Define lead.
10. What are the different types of metric thread?
11. Define welding.
12. What are the types of welded joints?
- 13 . What are the two types of stresses are induced in eccentric loading of loaded joint?
- 14.Define butt and lap joint
- 15.When will the edge preparation need?
- 16.What are the two types of fillet weld?
- 17 .State the two types of eccentric welded connections.
18. What are the practical applications of welded joints?
- 19.What is Tee-joint?
- 20.What is corner joint?

PART-B

1. 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 $\sigma_y = 300\text{MPa}$.
(16)

2. A steam of effective diameter 300mm is subjected to a steam pressure of

1.5N/mm^2 . 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 of 350mm and the maximum steam pressure acting on the cylinder cover is 5N/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 100mm 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)

7. 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/mm² and shear stress for C.I as 14N/mm². Assume maximum torque is 30% higher than mean torque.

8. Design a knuckle joint to transmit 150KN. the design stress may be taken as 75 Mpa in tension, 60Mpa in shear and 150Mpa in compression

9. A bracket carrying a load of 20 KN is to be welded .calculate size of the the weld if the working shear stress is not to exceed 70N/mm²

10. A steel plate subjected to a force of 5KN and fixed to a channel by means three identical bolts are made up of plain carbon steel 45C8 the factor of safety is 3. specify the size of bolts.

UNIT -IV (DESIGN OF SPRINGS AND LEVERS)

PART-A (2 marks)

1. What is a spring?
2. State any two functions of springs.
3. What are the various types of springs?
4. Classify the helical springs.
5. Define: Leaf springs
6. Define: Belleville Springs
7. What is spring index (C)?
8. What is pitch?
9. What is solid length?
10. What are the requirements of spring while designing?
11. What are the end conditions of spring?
12. What is buckling of springs?
13. What is surge in springs?
14. What is a laminated leaf spring?
15. What semi - elliptical leaf springs?
16. What is nipping of laminated leaf spring?
17. What are the various application of springs?
18. Define free length.
19. Define spring index.
20. Define spring rate (stiffness).

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/mm² and a modulus of rigidity of 0.8×10^5 N/mm² 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 0.8×10^5 N/mm² (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/mm² 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 spring 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/mm² (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/mm². (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, $E = 2.1 \times 10^5$ 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 overall 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, $E=2.1 \times 10^5 \text{MPa}$.
(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/mm²
Maximum number of leaves = 10 Span of spring = 1000mm Permissible deflection = 80mm Young's modulus of the spring = 200N/mm²
(16)

9. Design a cantilever leaf spring to absorb 600N-m energy without exceeding a deflection of 150mm and a stress of 800N/mm². The length of the spring is 600mm. The material of the spring is steel. Take, $E=200 \text{KN/mm}^2$
(16)

10. A knuckle joint is to transmit a force of 140kN. Allowable stresses in tension, shear and compression are 75N/mm², 65N/mm² and 140N/mm² respectively. Design the joint.
(16)

UNIT-V (DESIGN OF BEARING AND FLYWHEELS)

PART-A (2 marks)

1. What is bearing?
2. Classify the types of bearings.
3. What are the required properties of bearing materials?

4. What is a journal bearing?
5. What are the types of journal bearings depending upon the nature of contact?
6. What are the types of journal bearing depending upon the nature of lubrication?
7. What is known as self – acting bearing?
8. What is flywheel?
9. What is the function of flywheel?
10. Define the term 'fluctuation of speed' and 'fluctuation of energy'.
11. State the type of stresses induced in a rim flywheel?
12. What are the stresses induced in flywheel arms?
13. How does the function of flywheel differ from that of governor?
14. What is the nature of contact involved in a ball bearing element?
15. Define antifriction bearing?
16. What are the types of rolling contact bearing?
17. State the components of rolling contact bearings?
18. What are the several types of radial ball bearing?
19. What are the types of thrust ball bearings?
20. What is load rating?

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 SAE10, for which the absolute viscosity at 55°C=0.017kg/m-s, Ambient temperature of oil = 15.50C, Maximum bearing pressure for the pump=1.5N/mm². 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°C heat dissipation coefficient=1232W/m²/°CA (16)

3. A full journal bearing of 50mm diameter and 100mm long has a bearing pressure of 1.4N/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 350C. 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/0C. (16)

4. A 150mm diameter shaft supporting a load of 10KN has a speed of 1500rpm. The shaft runs 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, 11-550,+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/m³) 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.

6. The load on the journal bearing is 150 kn due to turbine shaft of 300mm

diameter running at 1800 rpm. determine the following (1) length of the bearing if the allowable bearing is 1.6 N/mm^2 . (2) amount of heat to be removed by the lubricant per minute if the bearing temperature is 60°C and viscosity of the oil is 60°C is 0.02 kg/ms and the bearing clearance is 0.25mm

7. Design a mild steel connecting rod with an I section for a cylinder IC engine from the following data. diameter of the piston is 0.104m ; weight of the reciprocating parts is 18.2N ; length of the connecting rod center to center is 0.314m ; stroke length is 0.14m ; speed of the engine is 1500 rpm ; maximum explosion pressure is 2.28 Mpa . Assume that the maximum thrust takes place at TDC during explosion stroke. Assume also any missing data

8. The connecting rod of a petrol engine is to be designed for the following data.

piston diameter 80mm

stroke 120mm

weight of the reciprocating parts 15N

length of the connecting rod 240mm

maximum speed 2800rpm

explosion pressure corresponding to 10° of crank angle is 3Mpa

factor of safety 6

If the connecting rod is to be made of 40Cr1 steel, find the dimensions of the I section connecting rod

9. A single row deep groove bearing No.6002 is subjected to an axial thrust load of 1000N and a radial load of 2200N . find the expected life that 50% of the bearings will complete under this condition

10. Following data is given for 360° hydrodynamic bearing:

journal bearing = 100mm

radial clearance = 0.12mm

radial load = 50KN

bearing length = 100mm

journal speed = 1440rpm

viscosity of lubricant = 16CP calculate 1. minimum film thickness 2. coefficient of friction 3. power lost in friction

