

Code No: 07A60305

R07**Set No. 2****III B.Tech II Semester Examinations, APRIL 2011****PRINCIPLES OF MACHINE DESIGN****Mechatronics****Time: 3 hours****Max Marks: 80**

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Explain the following methods of reducing stress concentration.
 - i. Drilled holes
 - ii. Using large fillet radius
 - iii. Added grooves
- (b) A shaft is made of steel with ultimate tensile strength 700 MPa and yield point 420 MPa is subjected to a torque varying from 200N m anti-clockwise to 600 N m clockwise. Calculate the diameter of the shaft if the factor of safety is 2 and it is based on the yield point and the endurance strength in shear. [6+10]
2. Design a set of concentric springs for an air craft engine valve to exert a maximum force of 6000 N under a deflection of 40 mm. Allowable shear stress in the springs is 850 N/mm². Take $G=0.8 \times 10^5 \text{N/mm}^2$. [16]
3. (a) Explain the following terms in connection with riveted joints
 - i. Pitch
 - ii. Back pitch
 - iii. Diagonal pitch
 - iv. Margin.
- (b) A lever-loaded safety valve has a diameter of 100 mm and the blow off pressure is 1.6 MPa. The fulcrum of the lever is screwed into the cast iron body of the cover. Find the diameter of the threaded part of the fulcrum if the permissible tensile stress is limited to 50 MPa and the leverage ratio is 8. [6+10]
4. (a) What are the causes of failure of gear tooth?
- (b) Design a pair of spur gear with stub teeth to transmit 55kW from 175 mm pinion running at 2500 r.p.m. to a gear running at 1500 r.p.m. Both the gears are made of steel having B.H.N 260. Approximate the pitch by means of Lewis equation and then adjust the dimensions to keep within the limits set by the dynamic load and wear equation. [4+12]
5. (a) Design a rectangular sunk key for a shaft of 50mm diameter, transmitting 1200N-m torque. The shear and crushing stresses in the key are limited to 45 and 70MPa respectively.
- (b) Determine the inside and outside diameters of a hollow shaft, which will replace a solid shaft of diameter 50mm. Both the shafts are made of the same material. The hollow shaft should be equally strong in torsion, yet the weight should be half of the solid shaft. [6+10]

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6. (a) What are the factors to be considered while selecting the material for plain Bearing?
- (b) The thrust of propeller shaft in a marine engine is taken up by number of collars integral with the shaft which is 300mm in diameter. The thrust on the shaft is 200kN and the speed is 75r.p.m. Taking coefficient of friction constant and equal to 0.05 and assuming the bearing pressure as uniform and equal to 0.3N/mm^2 , find:
- Number of collars required,
 - Power lost in friction, and
 - Heat generated at the bearing in kJ/min. [4+12]
7. Design a V-belt drive actuated by an electric motor and driving a belt conveyor. The power supplied by the electric motor is 4kW and the angular speed at the input shaft is 150rad/sec. The speed ratio of the drive is to be approximately 2.8. The drive will be used for two shifts daily and subjected to a moderately varying load with a start up over load of 150%. [16]
8. (a) Discuss the failure theories related to Ductile Materials.
- (b) A short cast iron column of hollow circular cross-section with 250mm outside diameter and 150 mm inside diameter carries a vertical load of 'P' acting at a point 100mm from the axis of the column. The allowable stress is limited to 40 MPa in compression and 20 MPa in tension. Find the maximum load the column can carry. [6+10]

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R07**Set No. 4**

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1. (a) What do you understand by surge in springs and how can it be eliminated?
 (b) A rail wagon weighing 200kN is moving with a velocity of 2m/sec. It is to be brought to rest by two buffers with springs of 300 mm diameter. The maximum deflection of spring is 200 mm. Allowable shear stress in the spring = 600 N/mm². Design the spring. [6+10]
2. (a) Why the face of the pulley is crowned?
 (b) Design a flat belt drive to transmit 15kW at 720rpm to a driven machine operating at 360 rpm. Assume that the belt slips over pulley by 3%. [2+14]
3. Two parallel shafts are connected by a pair of steel helical gears. The power transmitted is 15kW at 4000rpm of the pinion. The safe static strength for the material is 100MPa. Gear ratio is 4:1 Stub teeth with 20° pressure angle in diameter plane have helix angle of 45°. Also calculate the necessary BHN with the standard point of wear. Check the design for dynamic load and suggest modification if necessary. Use 30 teeth on the pinion. [16]
4. (a) Explain the effect of the following factors on the type of fatigue failure.
 - i. Type of material
 - ii. Range of imposed stress
 - iii. Manner of loading.
 (b) Determine the size of a piston rod subjected to a total load of having cyclic fluctuations from 150 kN in compression to 25 kN in tension. The endurance limit is 360 MPa and yield strength is 400 MPa. Take impact factor = 1.25, factor of safety = 1.5, surface finish factor = 0.88 and stress concentration factor = 2.25. [6+10]
5. Determine the bolt size for the bracket shown in Figure 5. The design shear stress may be taken as 35 MPa. [16]

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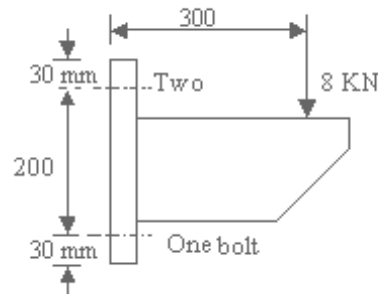


Figure 5

6. (a) What are the characteristics of a good bearing material ?
- (b) A ball bearing subjected to a radial load of 4000N is expected to have a satisfactory life of 12000 hours at 720r.p.m with a reliability of 95%. Calculate the dynamic load capacity of the bearing so that it can be selected from manufacturer's catalogue based on reliability of 95% in a system, what is the reliability of the complete system? [4+12]
7. (a) Draw the stress strain diagrams of
- Ductile materials and
 - Brittle materials.
- (b) Prove that according distortion energy theory the limiting value of shear stress under simple tension is 0.577 times strength. [4+12]
8. (a) Describe the design procedure of Sleeve & Cotter joint.
- (b) Design a cotter joint with two gibs to transmit an axial force of 130 kN. The permissible stresses are 165 M Pa in tension; 100 M Pa in shear and 180 M Pa in crushing. [6+10]

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R07**Set No. 1**

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1. (a) What is a spring and how they are classified?
 (b) Design a spring for spring loaded safely value for the following Conditions: Operating pressure 100N/cm^2 . Diameter of valve seat 100mm . Design shear stress for the spring is 400 N/mm^2 , $G=0.86 \times 10^5\text{ N/mm}^2$. The spring is to be kept in a casting of 120 mm inner diameter and 400 mm long. The spring should be at maximum lift of 6mm when the pressure is 107.5 N/cm^2 . [4+12]
2. Design a line shaft transmitting power to two machine tools. The power received by the shaft is 30kW at 300 rpm . The power absorbed by pulley P_1 is 12 kW and the remaining power is absorbed by pulley P_2 . The diameter of pulley P_1 is 300mm and its mass is 40Kg . The diameter and mass of pulley P_2 are 600mm and 75Kg respectively. Assume the belt tension ratio of 2 for both pulleys and the shaft material as 30C8 steel with $K_m = 2$ and $K_t = 1.5$. Draw the B.M and torque diagrams assuming maximum shear stress theory. [16]
3. (a) Define endurance strength and endurance limit.
 (b) A pulley is keyed to a shaft midway between two bearings. The shaft is made of cold drawn steel for which ultimate strength is 550MPa and the yield strength is 400MPa . The bending moment at the pulley varies from -150 N-m to 400N-m as the torque on the shaft varies from -50N-m to $+150\text{N-m}$. Obtain the diameter of the shaft for an indefinite life. The stress concentration factors for the keyway at the pulley in bending and in torsion are 1.6 and 1.3 respectively. Assume the following values :
 factor of safety = 1.5 load correction factor = 1.0 in bending and 0.6 in torsion
 Size factor = 0.85 and surface factor = 0.88. [4+12]
4. (a) State and prove the condition for maximum power transmission.
 (b) It is required to design a leather cross belt drive to contact 7.5kW , 1440 rpm electric motor to a compressor running at 480 rpm . The distance between the centers of the pulleys is twice the diameter of the bigger pulley. The belt should operate at 20m/s approximately and its thickness is 5mm . density of leather = 950kg/m^3 and allowable ultimate strength is 25MPa factor of safety is 4. [6+10]
5. (a) Show that the shear stress in case of an annular fillet weld subjected to torsion is given by $\tau = (2.83 T) / (\pi s d^2)$
 where T = Torque on cylindrical element; s = weld size and d = Diameter of cylindrical element welded to the flat surface.

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- (b) A double riveted lap joint is made between 15-mm thick plates. The rivet diameter and pitch are 25 mm and 75 mm respectively. If the ultimate stresses are 400 MPa in tension, 320 MPa in shear and 640 MPa in crushing, find the minimum force per pitch which will rupture the joint.
If the above joint is subjected to a load such that the factor of safety is two, find out the actual stresses developed in the plates and the rivets. [6+10]
6. (a) How will you designate the following varieties of materials according to BIS system: Grey cast iron with an ultimate tensile strength of 300 N/mm². Plain carbon steel with a minimum tensile strength of 320 N/mm².
- (b) The principal stresses induced at a point in a machine component made of steel 50C4 ($S_{Yt} = 460$ N/mm²) are as follows:
Maximum principal stress = 200 N/mm² and
Minimum principal stress = 150 N/mm².
Calculate the factor of safety by
- maximum shear stress theory and
 - distortion energy theory. [4+12]
7. (a) Why do we prefer taper roller bearings to cylindrical roller bearings?
- (b) Determine the bearing characteristic number, coefficient of friction, heat generated and dissipated for a journal bearing with the following data: Load=3500N; Speed=1200r.p.m; Journal diameter =50mm; $l/d=1.0$; $c/r=0.001$; Oil viscosity=128cP at the operating temperature 55°C. [4+12]
8. A single stage helical gear reducer is to receive power from a 1440 r.p.m, 25kW induction motor. The gear tooth profile is involute full depth with 20° normal pressure angle. The helix angle is 23°, number of teeth on pinion is 20 and the gear ratio is 3. Both the gears are made of steel with allowable beam stress of 90MPa and hardness 250B.H.N.
- Design the gears for 20% overload carrying capacity from the standpoint of bending strength and wear.
 - If the incremental dynamic load of 8kN is estimated in tangential plane, what will be the safe power transmitted by the pair at the same speed. [16]

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1. A concentric spring for an air craft engine valve is to exert a maximum force of 5kN under an axial deflection of 40mm. Both the springs have same free length, same solid length and are subjected to equal maximum shear stress of 500N/mm^2 . If the spring index for both the springs is 6, find
 - (a) The load shared by each spring
 - (b) The main dimensions of both the springs, and
 - (c) The number of active coils of each spring. Assume $G=0.8 \times 10^5 \text{N/mm}^2$ and diametral clearance to be equal to the difference between the wire diameters. [16]
2. (a) Explain the effect of the following factors on the type of fatigue failure
 - i. Manner of loading
 - ii. Range of imposed stress
 - iii. Type of material.
 (b) A simply supported shaft between bearings carries a steady load of 10 kN at the center. The length of shaft between bearings is 0.45 m. Neglecting the effect of stress concentration, find the minimum diameter of shaft. Given that Endurance limit = 600 MPa, Surface finish factor = 0.87, Size factor = 0.85, and Factor of safety = 1.6. [6+10]
3. (a) Why dynamic load is induced in the gear teeth? Explain the procedure of designing the dynamic load using Buckingham equation.
 (b) Design a pair of spur pinion and gear made of cast steel and CI respectively. The diameter of pinion is 140mm and it transmits 30kW at 1250rpm. The gear ratio 3:1 and teeth are 20^0 full depth involute. [8+8]
4. (a) Differentiate the following
 - i. Strength from Stress
 - ii. Brittle fracture from ductile fracture
 - iii. Resilience from Toughness.
 (b) Discuss the important phases of Design. [6+10]
5. (a) What is meant by creep of a belt and what is its effect?

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- (b) Determine the number of manila ropes required to transmit 200kW at a speed of 12m/s. Use the following particulars of the drive.
 Diameter of the rope = 30mm
 Mass of the rope = 0.65kg/meter length
 Breaking load = 70kN
 Coefficient of friction = 0.15
 Pulley groove angle = 45°
 Angle of arc of contact = 165°
 Factor of safety = 25. [4+12]
6. (a) What theory is commonly used for design of a shaft? Explain why?
 (b) Two round steel rods 5cm diameter are connected by a sleeve and cotter joint. Design and draw the joint. Assume tensile stress in rods 80Mpa, shearing stress in cotter 70MPa and crushing stress in cotter 60MPa. [4+12]
7. A ball bearing is operating on a work cycle consisting of three parts-a radial load of 3000N at 1440rpm for one quarter cycle, a radial load of 5000N at 720rpm for one half cycle, and radial load of 2500N at 1440rpm for the remaining cycle. The expected life of the bearing is 1000hr. Calculate the dynamic load carrying capacity of the bearing. [16]
8. A rectangular steel plate is welded as a cantilever to a vertical column and supports a single concentrated load 70 kN as shown in Figure 8. Find the size of weld required if the allowable shear stress is not to exceed 140 MPa. [16]

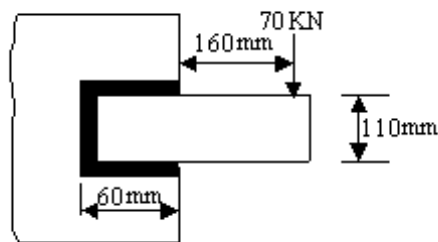


Figure 8
