

III B.Tech II Semester Supplementary Examinations, Apr/May 2008
DESIGN OF MACHINE MEMBERS-II

(Common to Mechanical Engineering and Production Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) A 100 mm long and 60 mm diameter journal bearing supports a load of 2500 N at 600 rpm. If the room temperature is 20°C , what should be the viscosity of oil to limit the bearing surface temperature to 60°C ? Diametral clearance = 0.06 mm. Energy dissipation coefficient based on the projected area of the bearing = $210 \text{ W/m}^2 \text{ }^{\circ}\text{C}$. [8]
(b) A 250×250 mm bearing carries a load of 108 kN. The bearing rotates at 1500 rpm. The clearance ratio is 670. For full journal bearing the power lost in friction is 14.36 kW. Find the viscosity of the oil. [8]
2. (a) What do you understand by static load capacity of a bearing? [2]
(b) The operating schedule of a ball bearing is as follows.
Radial load of 1650 N at 2000 rpm for 5% of lifetime
Radial load of 1140 N at 3300 rpm for 15% of time
Radial load of 560 N at 1750 rpm for 35% of time and
Radial load of 445 N at 2200 rpm for 45% of time
The inner ring rotates and loads are steady. The life is to be 10 years at 2 hours per day operation. Select a suitable ball bearing. [14]
3. Check the suitability of I-section $15\text{mm} \times 12\text{mm} \times 3\text{mm}$ for designing the connecting rod in the case of single cylinder motor cycle engine of 40 mm bore and 50 mm stroke wherein the maximum pressure produced is 3.6 Mpa and in which the connecting rod is 4 times crank. [16]
4. What are the stresses to which an over hanging shaft is subjected to? How would you proceed to design such a crank shaft. [16]
5. A solenoid brake is to be actuated by a helical compression spring of free length 350mm and is to exert a maximum force of 10kN when compressed by 80mm. The outside diameter of the spring should not exceed 180mm. What is the wire diameter, coil diameter and number of coils? [16]
6. (a) State the advantages and disadvantages of flat belts. [4]
(b) A 18 kW, 900 r.p.m. motor drives a centrifugal pump at 290 r.p.m. by means of a leather belt. The pulleys are of cast iron and are 1.2 meter center distance. The pulleys of diameter less than 150 mm should not be used. The coefficient of friction between the leather belt and the cast iron pulley is 0.35, and the mass of the belt is 9 kg/m width/m length. The maximum permissible tension per mm width of the belt is 10 N. The drive is to be designed for 20% overload. [12]

7. (a) Explain the procedure of evaluating module and face width of the gear drive. [4]
- (b) A pair of 4 diametral pitch, 20° full depth involute. Spur gears with a face width of 60mm is made of steel having 400 HB. The pinion has 28 teeth and runs at 1200 rpm. The gear ratio is 4. What power can be transmitted as indicated by the Lewis equation? Check for dynamic and wear loads. Assume $\sigma_o = 210$ MPa and $\sigma_{es} = 70$ Mpa. [12]
8. Design screw jack to lift a load of 50 kN with a possible eccentricity of 4 mm. The following data are given: [16]
Allowable compressive stress in the screw material = 100 N/mm^2 , ultimate tensile stress in the tommy bar material = 480 N/mm^2 , coefficient of friction in threads = 0.14, coefficient of collar friction = 0.2.

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1. (a) What are the desirable properties of bearing materials? [4]
(b) A hydrodynamic full journal bearing is to carry a load of 25 kN at a speed of 3000 rpm. The journal diameter is 150 mm and the length of bearing is 75 mm. SAE 30 oil is used with an average operating temperature of 55°C. If the radial clearance is 0.075 mm, calculate the power loss, the side leakage and the minimum film thickness. [12]
2. (a) A roller bearing is selected to withstand a radial load of 40 kN and life of 1200 hrs at 600 rpm. What load rating would you look for in searching from manufacturers catalogue if it specifies load at speed 500 rpm and life 3000 hrs [8]
(b) Select a suitable rolling bearing for a 55 mm diameter shaft. The bearing should be capable of withstanding 3 kN radial and 1.5 kN axial load at 750 rpm. The bearing is to have a desired rated life of 2000 hrs at a reliability of 94% . There is a light shock load and inner ring rotates. [8]
3. Enumerate the design procedure for the connecting rod section considering it as a simple compression or tension member subjected to fluctuating load [16]
4. The over hung crank of an engine having a cylinder diameter of 250 mm and stroke 400 mm. The connecting rod is 5 times crank, the maximum explosion pressure in the cylinder is 1.7 Mp and engine runs at 200 rpm. Assuming a suitable stress for the material design the over hung crank. Also calculate the maximum stress in the crank arm when the crank is at 30° to the I.D.C position and the gas pressure is 0.8 Mpa. Take modulus of section for rectangular section as $0.269bt^2$. [16]
5. (a) Give important functions of a spring. [6]
(b) A helical valve spring is to be designed for an operating load range of approximately 90 to 135 N. The deflection of the spring for the load range is 7.5 mm. Assume a spring index of 10, permissible shear stress for the material of the spring = 480 MPa and its modulus of rigidity = 80 kN/mm². Design the spring. Wahl's factor = $(4C-1)/(4C-4) + 0.615/C$, where C = spring index. [10]
6. An open belt connects two flat pulleys. The pulley diameters are 300 mm and 450 mm and the corresponding angles of lap are 160° and 210°. The smaller pulley runs at 200 r.p.m. The coefficient of friction between the belt and pulley is 0.25. It is found that the belt is on the point of slipping when 3 kW is transmitted. To increase the power transmitted two alternatives are suggested, namely [16]

- (a) increasing the initial tension by 10%, and
- (b) increasing the coefficient of friction by 10% by the application of a suitable dressing to the belt. Which of these two methods would be more effective? Find the percentage increase in power possible in each case and also design the system.
7. A pair of cast steel annealed spur gears with cast teeth transmits 18.75kW and 60 rev/min of the pinion. The pitch diameter of the pinion is approximately 0.23m and the velocity ratio is 2.5. Determine the module and face of the gears; also the correct pitch diameters and tooth numbers. Check for dynamic load. [16]
8. (a) Explain the advantages and disadvantages of ball screws. [4]
- (b) The following data refer to a screw jack:
Load = 40 kN, cup supported on ball bearing, eccentricity of load, $c = 6\text{mm}$, maximum lift = 300 mm, 50 mm acme threads, $p = 12$, 0.45% carbon steel screw, coefficient of friction = 0.12. Determine the torque and stresses developed in the screw, neglect buckling effect. [12]

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1. (a) Differentiate between hydrostatic and hydrodynamic bearing.
(b) Design a hydrodynamic full journal bearing for a centrifugal pump of 200mm diameter of 200 mm $\times$ 200 mm to support a load of 20 kN. Speed of the journal is 1500 rpm. [4+12]
2. (a) What are the commonly used non-metallic bearing materials? [2]
(b) The radial load on a roller bearing varies as follows. A load of 50 kN is acting 20% of time at 500 rpm and a load of 40 kN is acting 50% of time at 600 rpm. In the remaining time, the load is varying from 40 kN to 10 kN linearly at 700 rpm. Select a roller bearing from NU22 series for a life of at least 4000 hours. The operating temperature is 175°C. [14]
3. Enumerate the design procedure for the connecting rod section considering it as a simple compression or tension member subjected to fluctuating load [16]
4. What are the stresses to which an over hanging shaft is subjected to? How would you proceed to design such a crank shaft. [16]
5. (a) Classify various types of springs with sketches and give their applications. [8]
(b) A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 Mpa and modulus of rigidity 84kN/mm², find the axial load which the spring can carry and the deflection per active turn. [8]
6. (a) Prove that the centrifugal tension must be $1/3^{rd}$ of the maximum tension for maximum power transmission. [6]
(b) Design a cross belt drive having 1.5 m center distance between the two pulleys. The diameter of bigger and smaller pulleys are 'D' and 'd' respectively. The smaller pulley rotates at 1000 r.p.m. and the bigger pulley at 500 r.p.m. The flat belt is 6 mm thick and transmits 7.5 kW power at belt speed of 13 m/s approximately. The coefficient of belt friction is 0.3 and the density of belt material is 950 kg/m³. The permissible tensile stress for the belt material is 1.75 MPa. [10]
7. A pair of cast steel annealed spur gears with cast teeth transmits 18.75kW and 60 rev/min of the pinion. The pitch diameter of the pinion is approximately 0.23m and the velocity ratio is 2.5. Determine the module and face of the gears; also the correct pitch diameters and tooth numbers. Check for dynamic load. [16]

8. (a) What are the advantages of power screws? [4]
- (b) What are the important factors to be consider while designing milling machine tool beds? Briefly discuss. [12]

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1. (a) What is a babbit alloy?
(b) Design a journal bearing for centrifugal pump for the following data. [4+12]
Load on the journal = 12 kN
Diameter of the journal = 75 mm
Speed = 1440 rpm
Atmosphere temperature = $16^{\circ}C$
Operating temperature of oil = $60^{\circ}C$
Absolute viscosity of oil at $60^{\circ}C$ = 23 centipoise
2. (a) What do you understand by static load capacity of a bearing? [2]
(b) The operating schedule of a ball bearing is as follows.
Radial load of 1650 N at 2000 rpm for 5% of lifetime
Radial load of 1140 N at 3300 rpm for 15% of time
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The inner ring rotates and loads are steady. The life is to be 10 years at 2 hours per day operation. Select a suitable ball bearing. [14]
3. Enumerate the design procedure for the connecting rod section considering it as a simple compression or tension member subjected to fluctuating load [16]
4. What are the stresses to which an over hanging shaft is subjected to? How would you proceed to design such a crank shaft. [16]
5. (a) Classify various types of springs with sketches and give their applications. [8]
(b) A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 Mpa and modulus of rigidity $84kN/mm^2$, find the axial load which the spring can carry and the deflection per active turn. [8]
6. (a) Design a cast iron pulley of 630mm diameter to transmit 10kW at a speed of 500 r.p.m. The center plane of the pulley overhangs the nearer bearing by 300mm. The belt ends are parallel and horizontal and the belt tension ratio is 2:1. [8]
(b) Design a belt pulley to transmit 10kW at 180 r.p.m. The velocity of the belt is not to exceed 500 meter / minute and the maximum tension is not to exceed 15 N/mm width. The tension on the slack side is one half that on the tight side. Calculate all the dimensions of the pulley. Sketch neatly the sectional elevation and end view showing all leading dimensions. [8]

7. (a) Explain the methods of improving the wear strength of a gear drive. [2]
- (b) A compressor running 300 rpm is driven by a 15kW, 1200 rpm motor through a 20° full depth involute gears. The centre distance is 375 mm. Choosing suitable materials for the pinion and the gear, design the drive. Assume medium shock conditions. [14]
8. (a) Discuss the important points to be taken into account while selecting a proper material for various elements of machine tools. [6]
- (b) Discuss the various types of power threads. Discuss their relative advantages and disadvantages. [10]

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