

III B.Tech II Semester Supplementary Examinations, Aug/Sep 2007
DESIGN OF MACHINE MEMBERS-II
(Common to Mechanical Engineering, Production Engineering and
Automobile Engineering)

Time: 3 hours

Max Marks: 80

Answer any FIVE Questions
All Questions carry equal marks

1. (a) Name the various bearing materials and name the important requirements of bearing materials for efficient operation. [6]
(b) Design a full journal bearing of 100 mm long supports a radial load of 5 kN. The shaft rotates at 500 rpm. The diametral clearance is 0.1 mm. The room temperature is 25°C and temperature of the surface of the bearing is to be limited to 55°C . The bearing is well ventilated and no artificial cooling is to be used. Select a suitable oil to satisfy above requirements. [10]
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. Following data refers to 4-stroke cycle diesel engine cylinder [16]
Cylinder bore = 0.15 m
Stroke = 0.1875 m
Speed = 1200 rpm
Maximum gas pressure = 5.6 Mpa Determine
(a) The dimensions of an I-section connecting rod of forged steel with an elastic limit compressive stress of 350 Mpa. The ratio of length of connecting rod to the length of crank is 4 and factor of safety is 5 [10]
(b) The wrist pin and crank pin dimensions on the basis of the bearing pressure of 10.5 Mpa and 6.5 Mpa. [6]
4. Design a center crankshaft for a single acting 175×175 mm air compressor working at 360-rpm .The maximum pressure on the cylinder is 70N/sq.mm. Select suitable material and factor of safety [16]
5. Design and draw a valve spring of a petrol engine for the following operating conditions: [16]
Spring load when the valve is open = 400 N
Spring load when the valve is closed = 250 N

Maximum inside diameter of spring = 25 mm
Length of the spring when the valve is open = 40 mm
Length of the spring when the valve is closed = 50 mm
Maximum permissible shear stress = 400 Mpa

6. A 8mm thick leather open belt connects two flat pulleys. The smaller pulley is 300 mm diameter and runs at 200 r.p.m. The angle of lap of this pulley is 160° and the coefficient of friction between the belt and the pulley is 0.25. The belt is on the point of slipping when 3kW is transmitted. The safe working stress in the belt material is 1.6 N/mm^2 . Design the drive for 20% overload capacity. [16]
7. Design a cast iron spur gear drive for a crane hoist to transmit 3.75 kW at 1440 rpm. Maximum gear ratio in the gear box is 4. Each gear is expected to work 2 hours/day for 10 years. Determine the minimum centre distance, required face width and module of the gear. [16]
8. A machine slide weighing 3 kN is elevated by a double start Acme threaded screw at the rate of 0.84 m/min. If coefficient of friction is 0.12, calculate the power to drive the slide. The end of the screw carries a thrust collar of 32 mm inside diameter and 58 mm outside diameter. Pitch of the screw thread is 7 mm and outside diameter is 44 mm. If the screw is of C45 steel, is it strong enough to sustain the load? [16]

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1. (a) Explain wedge film and squeeze film journal bearings. [4]
- (b) The load on a 100 mm full hydrodynamic journal bearing is 9000 N. Speed of the journal is 320 rpm. consider $L/D = 1$, $C/D = 0.0011$. The operating temperature = $65^{\circ}C$ and minimum oil film thickness = 0.022 mm. [12]
 - i. Select an oil that will closely accord with the stated conditions. For these selected oil, determine
 - ii. the friction loss
 - iii. the hydrodynamic oil flow through the bearing
 - iv. the amount of leakage
 - v. the temperature rise of oil passes through the bearing and
 - vi. maximum oil pressure
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. The following data refer to a 4-stroke single cylinder vertical engine [16]

Piston diameter = 125mm
 Stroke=150mm
 Speed of the engine=1200 r.p.m
 Weight of the reciprocating parts = 45N
 Design stress for the material used = 80N/sq.mm
 Design bearing stress=10N/sq.mm
 Design stress for bolts=35N/sq.mm
 Design a suitable connecting rod and check for stresses due to inertia.
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) Discuss the phenomenon of surge in spring, and how do you eliminate surge in spring? [8]
- (b) With the aid of a diagram explain the modified soderberg line method for various stresses in a spring. [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/m^3 . The permissible tensile stress for the belt material is 1.75 MPa. [10]
7. A pair of gears is to be designed to transmit 30kW for a pinion speed of 1000 rpm and a speed ratio of 1:5. Design the gear pair. [16]
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 various types of lubrication methods for journal bearings? [4]
 (b) Design a suitable journal bearing for a centrifugal pump from the following available data: [12]
 Load on the bearing = 13.5 kN
 Diameter of the journal = 75 mm
 Speed = 1440 rpm
 Bearing characteristic number at the working temperature of $75^{\circ}C = 30$
 Permissible bearing pressure intensity = 0.7 N/mm² to 1.4 N/mm²
 Average atmospheric temperature = $30^{\circ}C$
 Calculate the cooling requirements, if any
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. 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) Derive an expression for deflection of a helical spring. [6]
 (b) Design a compression helical spring to carry a load of 500 N with a deflection of 25 mm. The spring index may be taken as 8. Assume the following values for the spring material: [10]
 Permissible shear = 350 MPa
 Modulus of rigidity = 84 kN/mm²
 Wahl's factor = $[(4C-1) / (4C - 4)] + [0.615 / C]$, where C = spring index.
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. What should be the module, face width and number of teeth on each gear of a pair of spur gears, a C45 steel pinion driving a cast iron gear, if they are to transmit 18.75 kW at 700 rev/min of the 0.18m pinion in continuous service? The velocity ratio is 3, the teeth are 20° full depth and the load is smooth. Determine the outside and root diameters. [16]
8. (a) Enumerate the differences between differential screw, ball screw and compound screw. [6]
- (b) Explain step by step procedure to design a lathe machine bed. [10]

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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) What is equivalent static load. [2]
(b) The radial reaction on a bearing is 9000 N. It also carries a thrust of 5000 N. The speed of the shaft is 1000 rpm. The outer ring stationary. Expected average life of bearing is about 25,000 hours. The load on the bearing is smooth, the service is 8 hours/day. Select, [14]
 - i. Suitable roller bearing
 - ii. What is the rated 90% life of selected bearing?
 - iii. Compute the probability of the selected bearing surviving 25,000 hours
3. (a) Why I-section is selected for high-speed I.C engines? [4]
(b) A double acting steam engine has the following specifications
Cylinder bore = 500 mm
Piston stroke = 750 mm
Maximum pressure on piston = 175 N/sq.cm
Connecting rod length = 1400 mm
Select the suitable material and design the connecting rod. [12]
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. Design a helical spring for a spring loaded safety valve (Ramsbottom safety valve) for the following conditions: Diameter of valve seat = 65 mm; operating pressure = 0.7 N/mm²; Maximum pressure when the valve blows off freely = 0.75 N/mm²; Maximum lift of the valve when the pressure rises from 0.7 to 0.75 N/mm² = 3.5 mm; Maximum allowable stress = 550 MPa; Modulus of rigidity = 84 kN/mm²; Spring index = 6. Draw a neat sketch of the free spring showing the main dimensions. [16]
6. (a) Prove that the centrifugal tension must be 1/3rd 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/m^3 . The permissible tensile stress for the belt material is 1.75 MPa. [10]
7. Design the teeth for a pair of cast iron spur gears with cast teeth to transmit 26kW. The pinion runs at 50 rev/min and the velocity ratio is to be 2.5. Decide upon a suitable grade of cast iron and find the module, face, and diameters, and centre distance for the gears. Check for dynamic load. [16]
8. The lead screw of a lathe has 50 x 8 threads. The screw must exert an axial pressure of 2500 N in order to drive the tool carriage. The thrust is carried on a collar 110 mm outside diameter and 55 mm inside diameter and the screw rotates at 30 rpm. Determine: [16]
- (a) the power required to drive the screw and
- (b) the efficiency of the lead screw. Assume a coefficient of friction of 0.15 for the screw and 0.12 for the collar.
