

**III B.Tech II Semester Regular/Supplementary Examinations, May/June - 2015  
DESIGN OF MACHINE MEMBERS-II****(Mechanical Engineering)****Time: 3 hours****Max. Marks: 75****Answer any FIVE Questions. All Questions carry equal marks****(Data books may be allowed)**

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- 1 a) Explain about classification of bearings. 5
- b) A rolling contact bearing is subjected to the following work cycle: (a) Radial load of 6000 N at 150 r.p.m. for 25% of the time; (b) Radial load of 7500 N at 600 r.p.m. for 20% of the time; and (c) Radial load of 2000 N at 300 r.p.m. for 55% of the time. The inner ring rotates and loads are steady. Select a bearing for an expected average life of 2500 hours. 10
- 2 a) Explain the various stresses induced in the connecting rod. 5
- b) Design a plain carbon steel centre crankshaft for a single acting four stroke single cylinder engine for the following data: Bore = 400 mm ; Stroke = 600 mm ; Engine speed = 200 r.p.m.; Mean effective pressure = 0.5 N/mm<sup>2</sup>; Maximum combustion pressure = 2.5 N/mm<sup>2</sup>; Weight of flywheel used as a pulley = 50 kN; Total belt pull = 6.5 kN. When the crank has turned through 35° from the top dead centre, the pressure on the piston is 1N/mm<sup>2</sup> and the torque on the crank is maximum. The ratio of the connecting rod length to the crank radius is 5. Assume any other data required for the design. 10
- 3 a) State the function of the following for an internal combustion engine piston: 4  
(a) Ribs ; (b) Piston rings ; (c) Piston skirt ; and (d) Piston pin
- b) A four stroke internal combustion engine has the following specifications: Brake power = 7.5 kW; Speed = 1000 r.p.m.; Indicated mean effective pressure = 0.35 N/mm<sup>2</sup>; Maximum gas pressure = 3.5 N/mm<sup>2</sup>; Mechanical efficiency = 80 %. Determine: 1) The dimensions of the cylinder, if the length of stroke is 1.4 times the bore of the cylinder; 2) Wall thickness of the cylinder, if the hoop stress is 35 MPa; 3) Thickness of the cylinder head and the size of studs when the permissible stresses for the cylinder head and stud materials are 45 MPa and 65 MPa respectively. 11
- 4 a) Derive the expression for  $h^2$  for rectangular section. 6
- b) A central horizontal section of a hook is symmetrical trapezium 90mm deep. The inner width being 90mm and outer being 45mm. The hook carries a load of 67.5KN the load line passes at a distance of 40mm from the inside edge of the section. The centre of curvature is in the load line. Calculate the extreme intensities of stress. Also plot the stress distribution across the section. 9
- 5 a) Why belts are provided with initial tension? Why slip is necessary is less in V-belt compared with flat belt? 5
- b) Design a wire rope for a lift which is to be used for maximum 100 KN for a building with a height of 400 m. The lift will attain a speed of 100 m/min in 6 sec. Assume load factor of 2. 10



- 6 Pair of helical gear with 17 teeth and 51 teeth of pinion and gear respectively transmits 2.5 KW power at 1750 rpm of the pinion. The normal pressure angle and helix angle are  $20^{\circ}$  and  $23^{\circ}$  respectively. The normal module and normal face width are 2 mm and 25 mm respectively. The gear and pinion are made from hardened steel. The surface and core hardness of pinion is 240 BHN and of gear 200 BHN. If expected pinion life is more than  $10^8$  cycles at 99% reliability find (a) the factor of safety in bending and (b) the factor of safety in wear. 15
- 7 a) How does the helix angle influence on the efficiency of square threaded screw? What do you understand by overhauling of screw? 5
- b) A vertical square threads screw of a 70 mm mean diameter and 10 mm pitch supports a vertical load of 50 kN. It passes through the boss of a spur gear wheel of 70 teeth which acts as a nut. In order to raise the load, the spur gear wheel is turned by means of a pinion having 20 teeth. The mechanical efficiency of pinion and gear wheel drive is 90%. The axial thrust on the screw is taken up by a collar bearing having a mean radius of 100 mm. The coefficient of friction for the screw and nut is 0.15 and that for collar bearing is 0.12. Find (a) Torque to be applied to the pinion shaft, (b) Maximum principal and shear stresses in the screw and (c) Height of nut, if the bearing pressure is limited to  $12 \text{ N/mm}^2$ . 10
- 8 a) What do you understand by leverage? Why levers are usually tapered? 5
- b) Design a cranked lever to be operated by two persons. The maximum lever arm length is 500 mm. The lever arm is made of 40C8 steel with ultimate stress of 580 MPa, yield stress of 380 MPa. Take a factor of safety of 5 for ultimate strength and 2.5 for yield strength. 10



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- 1 a) Define the following terms as applied to rolling contact bearings:(a) Basic static load rating (b) Static equivalent load (c) Basic dynamic load rating 5
- b) A full journal bearing of 50 mm diameter and 100 mm long has a bearing pressure of 1.4 N/mm<sup>2</sup>. The speed of the journal is 900 r.p.m. and the ratio of journal diameter to the diametral 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 35°C. Find : 1. The amount of artificial cooling required, and 2. The mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10°C. Take specific heat of the oil as 1850 J / kg / °C. 10
- 2 Determine the dimensions of an I-section connecting rod for a petrol engine from the following data: Diameter of the piston = 110 mm; Mass of the reciprocating parts = 2 kg; Length of the connecting rod from centre to centre = 325 mm; Stroke length = 150 mm; R.P.M. = 1500 with possible overspeed of 2500; Compression ratio = 4 : 1; Maximum explosion pressure = 2.5 N/mm<sup>2</sup>. 15
- 3 a) Explain the various types of cylinder liners. 5
- b) A four stroke diesel engine has the following specifications: Brake power = 5 kW; Speed = 1200 r.p.m. ; Indicated mean effective pressure = 0.35 N / mm<sup>2</sup> ; Mechanical efficiency = 80 %. Determine: 1) bore and length of the cylinder; 2) thickness of the cylinder head and 3) size of studs for the cylinder head.
- 4 Determine (i) location of neutral axis, (ii) maximum and minimum stresses when a curved beam of trapezoidal section of bottom width 30 mm, top width 20 mm and height 40 mm is subjected to pure bending moment of + 600 Nm. The bottom width is towards the centre of curvature. The radius of curvature is 50 mm and beam is curved in a plane parallel to depth. Also plot the variation of stresses across the section. 15
- 5 a) State the advantages and disadvantages of the chain drive over belt and rope drive. 5
- b) Determine the percentage increase in power capacity made possible in changing over from a flat belt drive to a V-belt drive. The diameter of the flat pulley is same as the pitch diameter of the grooved pulley. The pulley rotates at the same speed as the grooved pulley. The coefficient of friction for the grooved and flat belt is same and is 0.3. The V-belt pulley groove angle is 60°. The belts are of the same material and have same cross-sectional area. In each case, the angle of wrap is 150°. 10



- 6 A pair of  $20^\circ$  full-depth involute tooth spur gears is to transmit 30 kW at a speed of 250 r.p.m. of the pinion. The velocity ratio is 1 : 4. The pinion is made of cast steel having an allowable static stress, 100 MPa, while the gear is made of cast iron having allowable static stress, 55 MPa. The pinion has 20 teeth and its face width is 12.5 times the module. Determine the module, face width and pitch diameters of both the pinion and gear from the standpoint of strength only taking velocity factor into consideration. Assume suitable values of velocity factor and Lewis factor. 15
- 7 a) What is self locking property of threads and where it is necessary? 5
- b) Design a screw jack for lifting a load of 50 kN through a height of 0.4 m. The screw is made of steel and nut of bronze. The following allowable stresses may be assumed. 10  
For steel : Compressive stress = 80 MPa ; Shear stress = 45 MPa  
For bronze: Tensile stress = 40 MPa ; Bearing stress = 15 MPa, Shear stress = 25 MPa.  
The coefficient of friction between the steel and bronze pair is 0.12. The dimensions of the swivel base may be assumed proportionately. The screw should have square threads. Design the screw, nut.
- 8 Design a lever for a safety valve. The lever loaded safety valve exerted a force of 3 kN on the lever. The distance between the fulcrum and dead weight is 1000 mm. The distance between fulcrum and the pin connecting the valve spindle to the lever is 200 mm. Assuming the lever material as steel having ultimate strength of 380 MPa, determine the dimensions. Take factor of safety as 4. The bearing pressure is 20 MPa. 15



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- 1 a) State any four objectives of lubrication. Give the factors that form and maintain thick oil film in hydrodynamic journal bearings. 6
- b) Following data refer to a  $360^\circ$  hydrodynamic journal bearing Load = 3.2 kN, speed = 1490 rpm, diameter = 50 mm, length = 50 mm, radial clearance = 0.05 mm, Viscosity = 25 cP. Assume heat generated is carried away by oil flow. Calculate coefficient of friction, power lost in friction, minimum oil film thickness, flow and temperature rise. 9
- 2 Design a plain carbon steel centre crank shaft for single acting four stroke single cylinder engine for the following specifications. Bore = 140 mm, stroke = 200 mm, mean effective pressure = 1.02 MPa, maximum combustion pressure = 3.5 MPa, weight of the flywheel = 2800 N, total belt pull = 4 KN, engine speed = 300 rpm when the crank has turned  $30^\circ$  from the top dead centre the pressure on the piston is 1.25 MPa and the torque is maximum. Assume any other data and design the crankshaft. 15
- 3 Design a cast iron piston for a four stroke single cylinder semi diesel engine running at 700 rpm. The maximum explosion pressure on the cylinder head is about 4 MPa. The mean effective pressure is about 0.75 MPa. The diameter and the stroke of the piston are 250 mm and 375 mm respectively. The connecting rod length is 700 mm. The piston is to have at least 3 sealing rings and two oil rings. Heat conducted through the piston crown is approximately 4.5 to 5% of the total heat produced. The temperature at the centre and edges may be assumed as  $320^\circ\text{C}$  and  $150^\circ\text{C}$  respectively. 15
- 4 a) What are the assumptions made in derivation of stresses in a curved bar which is subjected to bending moments. 5
- b) Derive the expression for Winkler-Bach formula. 10
- 5 a) State the advantages and disadvantages of the chain drive over belt and rope drive. 4
- b) An exhaust fan fitted with 900 mm diameter pulley is driven by a flat belt from a 30 kW, 950 r.p.m. squirrel cage motor. The pulley on the motor shaft is 250 mm in diameter and the centre distance between the fan and motor is 2.25 m. The belt is 100 mm wide with a coefficient of friction of 0.25. If the allowable stress in the belt material is not to exceed 2 MPa, determine the necessary thickness of the belt and its total length. Take centrifugal force effect into consideration for density of belt being  $950\text{ kg/m}^3$ . 11



- 6 a) What is a herringbone gear? List the assumptions made in Lewis equation. 5
- b) The following data is given for a spur gear. Number of teeth on pinion = 30, number of teeth on gear = 60, speed of pinion = 1440 rpm, pressure angle =  $20^{\circ}$  involute type, module = 3 mm, face width = 32 mm, both gears are made of steel with ultimate strength 560 MPa. Determine (a) the rated power on the basis of bending failure if the factor of safety is 1.5, (b) the factor of safety on the basis of dynamic failure. 10
- 7 a) In what way the power screws differ from threaded fasteners? Which thread forms are used for power screw? Why? 4
- b) Design a screw jack to lift a maximum load of 50 KN through a height of 200 mm with ground clearance of 300 mm. The allowable bearing pressure between nut and screw is  $16 \text{ N/mm}^2$ . The coefficient of friction of threads and collars may be taken as 0.14. Select the suitable material and stresses. Assume the data wherever necessary. 11
- 8 Design a cranked lever to be operated by two persons. The maximum lever arm length is 500 mm. The lever arm is made of 40C8 steel with ultimate stress of 580 MPa, yield stress of 380 MPa. Take a factor of safety of 5 for ultimate strength and 2.5 for yield strength. 15



Code No: R32035

**R10**

**Set No. 4**

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- 1 a) State the types of journal bearing failure 4
- b) Following data refer to a  $360^\circ$  hydrodynamic journal bearing radial load = 10 kN, journal speed = 1440 rpm, unit bearing pressure = 900 kPa, clearance ratio = 800, lubricant viscosity = 30 Ns/m<sup>2</sup>. Assuming that total heat generated in the bearing is carried by the total oil flow in the bearing, determine (i) dimensions of bearing (ii) coefficient of friction (iii) power lost in friction (iv) total oil flow (v) side leakage (vi) temperature 11
- 2 Design a connecting rod for four stroke petrol engine with the following data Piston diameter = 0.10 m, stroke = 0.14 m, length of the connecting rod from centre to centre = 0.315 m weight of reciprocating parts = 18.2 N speed = 1500 rpm with possible over speed of 2500 compression ratio = 4:1 probable maximum explosion pressure = 2.45 MPa. 15
- 3 Design an aluminum alloy trunk type piston for a single acting two stroke engine for the following specifications. Cylinder bore = 75 mm, stroke = 100mm, maximum gas pressure = 4 MPa, break mean effective pressure = 0.9 MPa, fuel consumption = 0.2 kg/KW/h, speed = 900 rpm. Assume any other data if required. 15
- 4 a) Derive the expression for  $h^2$  for trapezoidal section. 6
- b) Determine the location of neutral axis, minimum and maximum stresses, ratio of minimum and maximum stress when a curved beam of rectangular section of width 10mm and depth 20mm is subjected to pure bending moment +50Nm. The beam is curved in a plane parallel to the depth. The mean radius of curvature is 25mm. Also plot the variation of stresses across the section. 9
- 5 a) How do you classify wire rope? List the advantages of rope drive over belt drive 4
- b) A V-belt is to transmit 14.7 KW to a compressor. The motor speed is 1150 rpm and the compressor pulley runs at 400 rpm. Determine the size and number of belts required. 11
- 6 a) Explain the different causes of gear tooth failures and suggest possible remedies to avoid such failures. 15
- b) A spur gear made of bronze drives a mild steel pinion with angular velocity ratio of 3.5. The pressure angle is  $14.5^\circ$ . It transmits 5 kW at 1800 r.p.m. of pinion. Considering only strength, design the smallest diameter gears and find also necessary face width. The number of teeth should not be less than 15 teeth on either gear. The elastic strength of bronze may be taken as 84 MPa and of steel as 105MPa. Lewis factor for  $14.5^\circ$  pressure angle may be taken as  $y = 0.124 - (0.684/\text{No. of teeth})$

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Code No: **R32035**

**R10**

**Set No. 4**

- 7 a) What are differential and compound screws? Explain with sketches. What advantages are offered by them? 5
- b) The lead screw of a lathe has ACME threads of 50 mm outside diameter and 8 mm pitch. 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 lead screw rotates at 30 rpm. Determine the power required to drive the screw. Assume the coefficient of friction of 0.15 for screw and 0.12 for the collar. 10
- 8 Design a lever for a safety valve. The lever loaded safety valve exerted a force of 3 KN on the lever. The distance between the fulcrum and dead weight is 1000 mm. The distance between fulcrum and the pin connecting the valve spindle to the lever is 200 mm. Assuming the lever material as steel having ultimate strength of 380 MPa, determine the dimensions. Take factor of safety as 4. The bearing pressure is 20 MPa. 15

2 of 2

