Code No: R2032032 **R20** SET -1

III B. Tech II Semester Regular Examinations, July -2023
DESIGN OF MACHINE MEMBERS-II
(Mechanical Engineering)

Time: 3 hours Max. Marks: 70

Answer any **FIVE** Questions **ONE** Question from **Each unit**
All Questions Carry Equal Marks
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UNIT-I

1. a) Design a journal bearing for supporting a generator shaft of 75 mm diameter with a load of 12 kN running at 1,440 rpm. Also calculate maximum pressure, energy loss due to friction, the heat generation, and oil flow required for heat dissipation. [10M]
   b) What are rolling contact bearings? Discuss their advantages over sliding contact bearings [4M]

(OR)

2. a) What is the procedure followed in designing a journal bearing? [5M]
   b) A bearing has dynamic capacity of 50 kN. What equivalent load it can carry for the average life of 6000 hrs at 500 rpm? [5M]
   c) Write about AFBMA designation for roller bearings. Give at least 4 examples. [4M]

UNIT-II

3. a) A four-stroke petrol engine develops 10 kW at 1000 rpm. The mean effective pressure is 0.9 MPa, L/D ratio 1.2, and mechanical efficiency 80 percent. Calculate diameter and length of cylinder. [7M]
   b) Design a gudgeon pin for a piston of diameter 150 mm having maximum pressure 4 MPa. Safe bearing pressure is 12 MPa. Check the design in bending, if safe bending stress for the pin material is 100 MPa. [7M]

(OR)

4. A four-stroke IC engine develops 3 MPa maximum pressure in a cylinder of length 100 mm and diameter 75 mm. Use the following data to design I-section connecting rod. [14M]
   Mass of reciprocating parts = 1.5 kg;
   Density of rod material = 8,000 kg/m^3
   Length of rod / crank radius ratio (l / r) = 4
   Length to pin diameter ratio for small end is 1.8 with safe bearing pressure = 14 MPa
   Length to pin diameter ratio for big end is 1.4 with safe bearing pressure = 10 MPa
   Safe stress for bolt material = 65 MPa and for strap = 80 MPa
   Compressive yield stress = 300 MPa
   Assume any other data.

UNIT-III

5. A section of a C clamp is shown in figure 1. What force F can be applied if the maximum stress in the clamp is limited to 120 MPa? All the dimensions are in mm only. [14M]

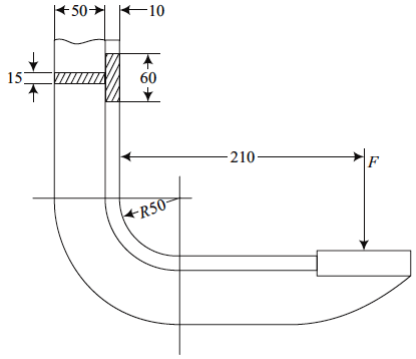

Figure 1

(OR)

6. A 150 kN capacity screw jack has been designed to have a triple start square threaded screw with a core diameter of 70 mm with pitch 10 mm. Determine the compressive stress in screw, the shearing stress at the threads if there are 14 threads in the unit, the bearing pressure and efficiency. Check also for the self-locking. Take coefficient of friction = 0.15. [14M]

UNIT-IV

7. Design a flat belt drive to transmit 20 kW from a motor pulley of diameter 100 mm running at 1440 rpm to a compressor shaft to run at 450 rpm. The centre distance between shafts is 1.2 m. the load factor may be taken as 1.2. [14M]

(OR)

8. A pair of helical gears consists of a pinion of 20 teeth and gear of 50 teeth. Helix angle for gears is 15° and normal pressure angle is 20°. If the normal module of gear teeth is 4 mm, calculate: transverse module, transverse pressure angle, addendum and dedendum circle diameters of both pinion and gear, and minimum widths of gears for smooth operation. [14M]

UNIT-V

9. A foot lever is 1.5 m from the centre of shaft to the point of application of 1000 N loads. Find: (a) Diameter of the shaft, (b) Dimensions of the key, and (c) Dimensions of rectangular arm of the foot lever at 75 mm from the centre of shaft assuming width of the arm as 2.5 times thickness. The allowable tensile stress may be taken as 75MPaand allowable shear stress as 68MPa. [14M]

(OR)

10. Select a wire rope to lift 10 kN of debris from a mine shaft of 600 m deep. The weight of the bucket is 3 kN. The maximum velocity of 20 m/s is attained in 5 seconds. [14M]

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UNIT-I

1. a) What is meant by hydrodynamic lubrication? [4M]
   b) A 75 mm long full journal bearing of diameter 75 mm supports a load of 12 kN on a journal turning at 1800 rpm. Assuming a D/c ratio of 1000, and an oil having viscosity 0.01 kg/ms, Determine the coefficient of friction by using the McKee equation and the Raimondi and Boyd curve. Also determine the amount of heat generated and surface temperature of the bearing. [10M]

(OR)

2. A shaft with two supports is loaded in such a way that the axial thrust on each bearing is 500 N and the radial thrust is 2000 N and 1000 N respectively at left and right hand bearing. The shaft rotates at 1440 rpm. The bearing is to be selected on the basis of 3 hours per day for 10 years. The shaft diameter is 40 mm. Select the suitable ball bearings at each end. Assume any missing data. [14M]

UNIT-II

3. Explain the procedure to design centre crankshaft when it is at top dead centre position. [14M]

(OR)

4. A four-stroke single cylinder vertical engine has cylinder diameter 100 mm and stroke 150 mm. The length of connecting rod is four times the crank radius. Crank pin length to diameter ratio can be taken 0.85. Maximum gas pressure is 2.8 MPa. The power developed by engine is transmitted through a heavy pulley of width 200 m min the center weighing 30 kN and horizontal belt giving total pull of 20 kN. Gas pressure at maximum torque position when crank is at 33° is 1.6 MPa. Safe bending stress 65 MPa and bearing pressure 12 MPa. Design a crank shaft. [14M]

UNIT-III

5. Determine the maximum compressive and tensile stresses in the critical section of a crane hook lifting a load of 50 kN. The dimensions of the hook are shown in figure 1. The line of application of the load is at a distance of 8 cm from the inner fibre. Rounding-off of the corners of the cross-section is not to be taken into account. [14M]

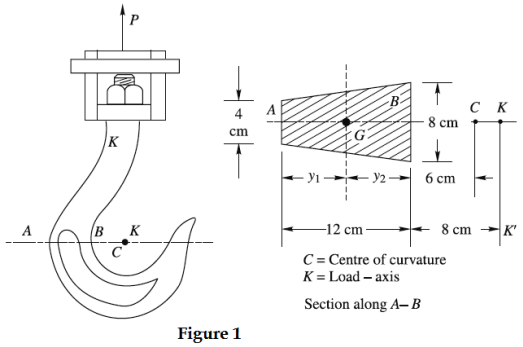

Figure 1

(OR)

6. a) A 24 mm bolt is tightened to develop an initial axial force of 40 kN. Determine the necessary tightening torque to be appliedto the nut and the maximum shear stress in the body of thebolt. [7M]

   b) Find the torque required on the turnbuckle to tighten to a tension of 8 kN. It is being used in packing machinery. Single start square threaded screw having nominal diameter 40 mm with 7 mm pitch is used. Take coefficient of friction between the screws and nuts as 0.15. [7M]

UNIT-IV

7. Design a chain drive to actuate a compressor from a 10 kW electric motor at 960 rpm. The compressor speed is to be 350 rpm. Minimum center distance should be 0.5m.Motor is mounted on an auxiliary bed. Compressor is to work for 8 hours/day. [14M]

(OR)

8. A pair of helical gears consists of 24 teeth pinion meshing with 72 teeth gear. Normal pressure angle is 20°, and helix angle is 24°. The pinion rotates at 720 rpm. Normal module of gear is 5 mm and face width is 50 mm. Both, pinion and gear are made of steel with ultimate strength of 600 MPa. Gears are heat treated to a surface hardness of 360 BHN. What power can be transmitted by gears if service factor is 1.4 and factor of safety is 2? Assume that velocity factor accounts for the dynamic load. [14M]

UNIT-V

9. a) A cranked lever has the following dimensions : [8M]
   Length of the handle = 500 mm
   Length of the lever arm = 600 mm
   Overhang of the journal = 250 mm
   If the lever is operated by a single person exerting a maximum force of 750 N at a distance of 1/3rd length of the handle from its free end, find :
   1. Diameter of the handle,
   2. Cross-section of the lever arm, and
   3. Diameter of the journal.

   The permissible bending stress for the lever material may be taken as 75 MPa and shear stress for shaft material as 50 MPa.

   b) Write the procedure for designing a hand lever. [6M]

(OR)

10. Select a wire rope for a vertical mine hoist to lift a load of 50 kN from a depth of 300 metres. A rope speed of 500 metres / min is to be attained in 10 seconds. [14M]

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UNIT-I

1. A hydrodynamic journal bearing is to support a radial load of 3 kN. The shaft of diameter 50 mm rotates at 1440 rpm and journal have L/D ratio of 1. If the radial clearance is 0.05 mm and oil of viscosity 25 cP is used, find pressure, coefficient of friction, minimum oil film thickness, flow requirement and temperature rise. How much power is lost in friction? [14M]

(OR)

2. a) Describe parameters used in selecting rolling contact bearings. [4M]
   b) A ball bearing has a life of 2 million revolutions with 90 per cent reliability. Calculate its life with 95 per cent reliability. How much is reduction in life with this increased reliability. [5M]
   c) What is the approximate friction power loss in a single radial ball bearing having a bore diameter of 50 mm and subjected to a radial load of 20 kN? The shaft rotates at 500 rpm. [5M

UNIT-II

3. a) Design a cylinder head for an engine having cylinder diameter 80 mm and maximum gas pressure 4 MPa. Also calculate bolt diameter, number of bolts, and pitch. Assume safe tensile strength for the head 40 MPa and for bolts 60 MPa. [10M]
   b) What is the function and construction of a gudgeon pin? What are the different methods to fix it in a piston? [4M]

(OR)

4. Design a connecting rod for four stroke petrol engine with the following data. Piston diameter = 0.1 m , stroke = 0.14 m, length of the connecting rod from centre to centre = 0.315 m, weight of reciprocating parts = 20 N, speed = 1500 rpm with possible over speed of 2500 compression ratio = 4:1, probable maximum explosion pressure = 2.5 MPa. [14M]

UNIT-III

5. A ring is made from a 75 mm diameter bar. The inside diameter of the ring is 100 mm. For the load shown in figure 1, calculate the maximum shear stress in the bar, and specify its location. [14M]

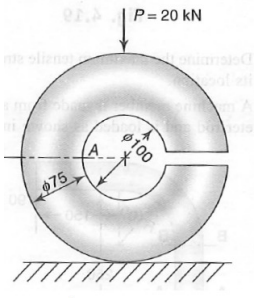

Figure 1

(OR)

6. A 30 mm single start ACME power screw of 6 mm pitch has a thrust bearing of 40 mm mean diameter. The thread and bearing coefficients of friction are 0.15 and 0.1 respectively. (a)Estimate the torque required to raise a load of 200 kN. (b)If the screw rotates at 2 Hz, determine the combined efficiency. (c)Thread is lubricated to reduce the friction. Dose this result in overhauling? [14M]

UNIT-IV

7. Design an open flat belt drive to connect horizontal shafts at 4 m distance. Velocity ratio is 3. Speed of smaller pulley is 960 rpm. Nominal power transmission is 20kW under very light shock. [14M]

(OR)

8. A cast steel pinion is to drive a cast iron gear. The gear ratio is 6. The power to be transmitted is 20 kW at 900 rpm of pinion having 16 number of teeth. Design pair and check for wear and dynamic load. [14M]

UNIT-V

9. For operating the exhaust valve of petrol engine, the maximum load required on the valve is 600N. The rocker arm oscillates around a pin whose center line is 275mm away from the valve axis. The two arms of the rocker are equal and make an included angle of 165^0.Desing the rocker arm with the fulcrum if the tensile stress is 75MPa and the bearing pressure is 7.5 N/mm^2. Assume the cross section of the rocker arm as rectangular. [14M]

(OR)

10. A workshop crane is lifting a load of 25 kN through a wire rope and a hook. The weight of the hook along with other components is 15 kN. The rope drum diameter may be taken as 30 times the diameter of the rope. The load is to be lifted with an acceleration of 1 m/s^2. Calculate the diameter of the wire rope. Take a factor of safety of 6 and Young's modulus for the wire rope 80 GPa. The ultimate stress may be taken as 1800 MPa. The cross-sectional area of the wire rope may be taken as 0.4 times the square of the wire rope diameter. [14M]

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UNIT-I

1. a) What is SAE designation of oils? How this designation helps in choosing the oil for a particular operations. Give examples. [4M]
   b) A journal bearing is 150 mm long and 50 mm diameter. It supports a radial load of 8 kN. If the radial clearance is 0.075 mm and bearing dissipates I kW in friction. Determine the oil viscosity at operating temperature. [7M]
   c) Enumerate the design procedure of a journal bearing based on the Raimondi and Boyd curves. [3M]

(OR)

2. A shaft shown in figure 1 is supported between two bearings 0.5 m apart. It carries a pulley weighing 1200 N. The tensions in the belts in horizontal direction are 2500 N and 1250 N on tight and slack side respectively. Select the proper ball bearings for shaft diameter of 50 mm. There is an axial thrust of 2000 N. Life of bearing should be 6000 hours at 300 rpm. Assume the missing data if any. [14M]

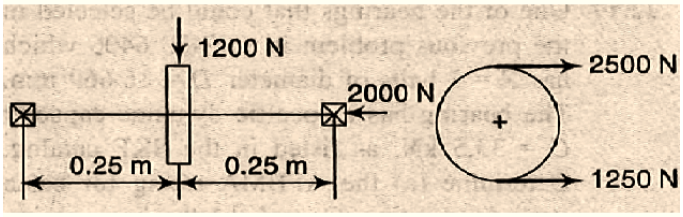

Figure 1

UNIT-II

3. Design a cast iron piston for a single acting four stroke engine for the following data: [14M]
   Cylinder bore = 100mm, stroke = 125mm, speed = 2000 rpm,
   Maximum gas pressure = 5 MPa, Mechanical efficiency = 80%,
   Induced mean effective pressure = 0.75 MPa,
   Fuel consumption = 0.15 kg per BP per hour,
   Higher calorific value = 42 X 10^3 kJ/kg,
   Assume suitable data if required.

(OR)

4. a) A diesel engine has cylinder diameter of 120 mm and maximum gas pressure 4 MPa. Length to diameter ratio for the gudgeon pin is 1.6 and safe bearing pressure is 15 MPa. Determine the size of the pin and outside diameter of small end of a connecting rod, if safe tensile strength of rod is 80 MPa. [9M]
   b) Describe the design procedure to design a center crank shaft. [5M]

UNIT-III

5. A crane hook has a trapezoidal section of sides 90 mm and 25 mm and depth of 116 mm with an inner radius of curvature as 65 mm. Determine the maximum fibre stresses developed in the hook while lifting a load of 90 kN. [14M]

(OR)

6. A screw jack with 60 mm diameter and 9 mm pitch double threaded square screw is used to raise a load of 5 kN. The coefficient of friction is 0.12. Determine the screw pitch, lead, diameters, helix angle and efficiency. Also calculate the nominal value of torsional, axial, thread bearing and thread shear stress under starting condition. [14M]

UNIT-IV

7. A 7.5 kW motor running at 1800 rpm is used to drive a pump set which operates 24 hours per day. The centre distance is approximately 500 mm and only 200 mm and 300 mm pulley are available in the stock. Select a suitable V-belt drive and estimate the life of the belt. [14M]

(OR)

8. A pair of spur gears with 20° full depth involute teeth needs to be designed. Input shaft rotates at 1000 rpm and receives 6 kW power. Speed reduction of output shaft is by 5 times. Pinion and gear are made of steel with ultimate strength of 450 MPa. Estimate the module of the gear teeth. Determine static and dynamic loads. Specify the surface hardness of gear teeth assuming that strength in bending is the same as strength in wear. Assume any other relevant data. [14M]

UNIT-V

9. A lever loaded safety valve is 75 mm in diameter. It is required to blow off at 1.25 MPa. Design the mild steel lever of rectangular cross-section if the permissible stresses are 70 MPa in tension, 50 MPa in shear and 25 MPa in bearing. The pin is made of the same material as that of the lever. The distance from the fulcrum to the dead weight of the lever is 1m and the distance between the fulcrum pin and the valve spindle link pin is 80 mm. [14M]

(OR)

10. a) A rope drive is required to transmit 750 kW from a pulley of 1 m diameter running at 450 rpm. The safe pull in each rope is 2 kN and the mass of the rope is 1 kg / m length. The angle of lap and the groove angle is 150° and 45° respectively. Find the number of ropes required for the drive if the coefficient of friction between the rope and the pulley is 0.3. [10M]

    b) Under what circumstances a fibre rope and a wire rope is used? What are the advantages of a wire rope over fibre rope? [4M]