R16

SET - 1

III B. Tech I Semester Regular/Supplementary Examinations, March – 2021
DESIGN OF MACHINE MEMBERS– II
(Mechanical Engineering)

Time: 3 hours
Max. Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B)**
2. Answer **ALL** the question in **Part-A**
3. Answer any **FOUR** Questions from **Part-B**
4. **Data Book allowed**

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PART –A **(14 Marks)**

1. a) Explain the basic difference between sliding bearings and rolling bearings. [2M]

   b) Mention the design criteria for the piston crown in an IC engine. [2M]

   c) How do curved beams differ from straight beams? [2M]

   d) In what way is a trapezoidal thread better than a square thread in power screws? [3M]

   e) What is meant by beam strength of a spur gear? [3M]

   f) Write down the designation of a steel wire rope and explain the features. [2M]

PART –B **(56 Marks)**

2. a) The coefficient of friction in a sliding bearing is given as 0.0019. The shaft measures [7M] 75 mm in length and diameter. The bearing pressure is specified as 1.8 MPa and the speed of the journal is 1440 rpm. Determine the heat generated in the bearing. If the bearing is operating without any artificial cooling, find the maximum temperature that the bearing can withstand.

   b) A single row ball bearing carries a radial load of 8 kN and an axial thrust of 3.5 kN. [7M] The radial load factor and the axial load factor are given as 0.56 and 1.48 respectively. Desired reliability is 90 percent. The mounting of the bearing is such that the inner ring is stationary. The shaft rotates at 500 rpm and the expected life is 2500 operating hours. Find the dynamic load capacity of the bearing required for the application.

3. a) The main dimensions of a connecting rod of an IC engine have to be determined [7M] based on the following data: Length of connecting rod=300 mm; cylinder bore=100mm; maximum gas pressure inside the cylinder = 4.5 MPa; specified factor of safety = 5. Draw the I-cross section of the connecting rod at the mid section. Compressive yield stress may be taken as 330 MPa.

   b) Draw the schematic line diagram of a piston under load. Explain the principle of [7M] dimensioning the piston pin. Mention the materials used and the permissible stresses.

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4. a) Draw a representative sketch of a curved beam under the action of bending moment. [7M]
   Explain the bending stress distribution across the cross section as compared to that of
   a straight beam.
   b) Draw the sketch of a typical example of a curved beam from practice. Explain the [7M]
   concept of eccentricity 'e' in a circular cross section.

5. a) An open belt of density 970 kg/mm^3 has a cross section of 300 mm x 10 mm. The [7M]
   driving and smaller pulley has a diameter of 315 mm. The input power is 30 kW at
   970 rpm. The angle of wrap on the larger pulley is 205^0. The coefficient of friction
   between the belt and both pulleys is 0.35. If the maximum allowable stress in the belt
   should not exceed 3 MPa, verify if the belt is safe in tension.
   b) Write a note on the various stresses occurring in a power screw and nut. Explain the [7M]
   need for a friction collar in the body of a power screw.

6. a) What are the advantages of helical gears over spur gears? Explain the concept of [7M]
   virtual number of teeth with the help of a sketch.
   b) A spur gear pair with a module of 6 mm has transmission ratio of 4. The number of [7M]
   teeth on the pinion is 16 of 20^0 pressure angle, full depth and involute profile. Face
   width of the teeth may be taken as 10 times module. Taking the permissible bending
   stress as 105 MPa, calculate the power that the gear pair can transmit based on the
   beam strength of the teeth.

7. a) A single steel wire rope of 6 x 37 constructions lifts a load of 20 kN. The factor of [7M]
   safety is specified as 6. Find the diameter of the rope. A wire rope catalogue can be
   used. What are the other forces to be considered in the rope for an exact analysis?
   b) What is a bell crank lever? What are its applications? Explain with a sketch and a [7M]
   force analysis.

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PART –A   (14 Marks)

1. a) What is meant by bearing modulus in sliding bearings?   [2M]

    b) Write a short note on cylinder liners of IC engines.   [2M]

    c) Explain the difference between centroidal axis and neutral axis in curved beams.   [2M]

    d) Draw a neat line sketch of a wire rope pulley and mark the parts.   [3M]

    e) Mention the different threads shapes used in power screws. How are they different from thread screws?   [3M]

    f) Explain the term, mechanical advantage in levers. Give an example.   [2M]

PART –B   (56 Marks)

2. a) Write down the expression for Sommerfeld number and explain its merits. Explain how the coefficient of friction is obtained with the help of Sommerfeld number?   [7M]

    b) What is rating life of a rolling bearing? A deep groove ball bearing with a dynamic load capacity of 62784 N carries a radial load of 5000 N and an axial load of 1500 N. Assuming the radial and axial load factors as 0.56 and 1.71 respectively, estimate the life of the bearing in operating hours. The speed of the shaft on which the bearing is mounted is 1000 rpm. Expected reliability is 90%.   [7M]

3. a) The maximum gas pressure inside an IC engine cylinder is 1.5 MPa. The cylinder crown is fixed to the cylinder body by means of 6 studs on a pitch circle of 200 mm diameter. The internal diameter of the cylinder is 120 mm. If the yield strength of the bolt material is 380 N/sq.mm and the specified factor of safety is 3, determine the size of the bolt required for the purpose by using simple analysis, neglecting the elasticity of the bolts and the joint.   [7M]

    b) Draw a line sketch of a crankshaft of a four cylinder SI engine. Explain the criteria for designing a crankshaft.   [7M]

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4. a) Draw a line sketch of a crane hook and describe the steps in calculating the stresses across the cross section. [7M]
    b) Considering a circular cross section for a curved beam, draw the section and the various radii required to illustrate the condition after applying the bending moment on the beam. Write the expressions for the stresses in the extreme fibres. [7M]

5. a) How are V-belts different from flat belts? Describe the design procedure for finding the number of V-belts required for transmitting power. [7M]
    b) A triple-threaded square screw has a nominal diameter of 50 mm and a pitch of 8 mm. A friction collar with OD of 100 mm and ID of 65 mm is used in the power for creating additional friction. The coefficients of friction at the thread surface and the collar are both 0.15. The power screw is used for lifting a load of 15 kN. Applying uniform wear theory for the collar, calculate: (i) the torque required to lift the load (ii) the torque required to lower the load (iii) check self-locking condition. Calculate also the manual effort required at the end of a handle with a turning radius of 400 mm. [7M]

6. a) A pinion with 29 teeth rotating at 970 rpm is paired with a gear wheel with 50 teeth. The teeth are 20 degree, full width, involute profile of module 6 mm. The gears are made of steel having an ultimate strength of 600 N/mm^2. The surface hardness on the pinion is 350 BHN and on the gear it is 280 BHN. Calculate the following:
    (i) Beam strength of the gears (using the velocity factor)
    (ii) Wear strength of the gears. [7M]
    b) Explain the method of Buckingham for calculating the dynamic load on a gear pair. How does this method differ from the velocity factor method? [7M]

7. a) Draw a sketch of safety valve using a lever. Explain the design of the lever showing clearly the force analysis. [7M]
    b) How is a steel wire rope wound and unwound on drum with grooves? Explain with the help of a sketch. Mention the special features in construction of the rope drum. [7M]

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PART –A   (14 Marks)

1. a) Mention the merits of the Sommerfeld number method of sliding bearing   [2M]
        calculation.
    b) Make a simple line sketch to show how the wrist pin is assembled inside the piston   [2M]
        of an IC engine.
    c) Explain why there will be a shift of the neutral axis from the centroidal axis in a   [2M]
        curved beam subjected to bending.
    d) What is a ball screw and what is its merit?   [3M]
    e) Write a note on wear strength of a helical gear.   [3M]
    f) Draw a sketch of a bell crank lever and explain the force analysis. [2M]

PART –B   (56 Marks)

2. a) A full journal bearing operates under an axial load of 25 kN. The length and   [7M]
        diameter of the journal are 150 mm and 100 mm respectively. The radial clearance
        is 0.05 mm. The journal rotates at a speed of 300 rpm. If the viscosity of the oil
        used at the operating temperature is 0.01 kg/ms, find the coefficient of friction in
        the bearing and power loss due to friction. Use McKee's equation.
    b) A deep groove ball bearing of basic design no. SKF 6312 has a dynamic load   [7M]
        capacity of 81900 N. If this bearing is expected to carry a pure radial load of
        37800 N, find the loading ratio and estimate the nominal life of the bearing in
        millions of revolutions. If the rotational speed of the bearing is 500 rpm, find the
        bearing life in number of operating hours. Find the reduction in service life when
        the radial load is increased by 10000 N.

3. a) Mention the criteria of design of an IC engine piston. Draw a line sketch of a   [7M]
        piston and name the important parts.
    b) For an IC engine the following data are available: Length of connecting   [7M]
        rod=350mm; cylinder bore = 110 mm; maximum gas pressure inside the
        cylinder=5 MPa; specified factor of safety = 5. Draw the I-cross section of the
        connecting rod at the mid section. Compressive yield stress may be taken as
        350 MPa.

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4. a) Draw neat sketches showing the bending stress distribution across the cross [7M] sections of (i) a straight beam of rectangular cross section, and (ii) a curved beam of circular cross section.

    b) Give examples of practical applications of curved beams. Supply line sketches for [7M] illustration.

5. a) For a V-belt drive the following details are given: Driving motor power = 15 hp; [7M] motor speed = 1440 rpm; reduction ratio = 2:1; maximum centre distance between the pulleys is 1200 mm; for continuous duty; Using standard design tables and assuming any missing data, calculate: (i) corrected design power (ii) pulley diameters (iii) length of belt along pitch line (iv) actual centre distance.

    b) The lead screw of a lathe machine with single-start trapezoidal threads of 60 mm [7M] nominal diameter and a standard pitch of 9 mm. The axial thrust on the screw during movement is estimated as 5 kN. A thrust collar of diameters 100mmx75mm is provided. The coefficients of friction in the screw threads and the friction collar are 0.15 and 0.2 respectively. The lead screw rotates at 50 rpm. Determine: (i) the efficiency of the lead screw and (ii) the power required to drive the lead screw.

6. a) In a spur gear transmission, the pinion and the gear have 19 and 46 teeth [7M] respectively. The gears have 20^0 FD, involute profile. The pinion and the gear are made of plain carbon steel with S_u of 600 MPa. Estimate the module of the gear set and find the centre distance. Assume a factor of safety of 3 for both pinion and gear. For the initial check, assume that the pitch line velocity is less than 10 m/s and the service factor is 1.5.

    b) A helical gear set of normal module 6 mm has 18 teeth on the pinion and 43 teeth [7M] on the gear. The normal pressure angle and the helix angle are given as 20^0 and 25^0 respectively. Calculate: (i) the pitch circle diameters of the pinion and the gear, (ii) centre distance, (iii) transverse module, (iv) axial pitch, and (v) transverse pressure angle.

7. a) Draw a neat sketch to show the application of a bell crank lever. Show how the [7M] force analysis is done.

    b) Discuss the various stresses occurring a steel wire rope wound on hoisting drum of [7M] a crane in the process of lifting a load.

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SET - 4

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      2. Answer **ALL** the question in **Part-A**
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PART –A   (14 Marks)

1. a) Write a note on the dynamic load capacity of a rolling bearing.   [2M]

    b) Draw a simple sketch to show a wet liner inside an IC engine cylinder.   [2M]

    c) Explain the term eccentricity in the design of curved beams.   [2M]

    d) Explain the terms, compound screw and differential screw.   [3M]

    e) Explain the difference between pressure angle and helix angle in a helical gear. [3M]

    f) Draw a simple sketch to describe 6 x 37 (H) x 12 mm x 120 m steel wire rope. [2M]

PART –B   (56 Marks)

2. a) Explain in detail how McKee and Lasche equations are useful in sliding   [7M]
       bearing design? When is artificial cooling required for sliding bearing?

    b) A ball bearing is mounted on a shaft rotating at 500 rpm. The radial load on the [7M]
       bearing is estimated as 8 kN. If the desired life of the bearing is 3000 operating
       hours, calculate the dynamic load capacity of the bearing. When an additional
       axial load of 2 kN acts on the bearing, calculate the reduction in the service of
       the bearing.

3. a) Discuss the design procedure for determining the sizes of the small and the big [7M]
       end bearings in a connecting rod.

    b) An IC engine piston is made of cast iron for a cylinder with a bore of 100 mm [7M]
       diameter. The maximum gas pressure inside the cylinder is 6 MPa. Estimate
       the piston crown thickness based on mechanical strength. Write down the
       formula for validating the crown thickness by the heat conduction method.

4. a) What is normal cross section used in crane hooks? Draw a line sketch to show [7M]
       the shift between the CA and NA in the section after applying a bending beam.
       Write down the formulas for obtaining extreme fibre stresses in the beam.

    b) Draw the sketch of an L-shaped wall bracket using bent rods; mark the forces [7M]
       acting on the bracket when a load is placed on the bracket. Mark the section
       which is most stressed and distribution bending stress across the cross section.

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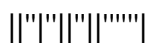
5. a) A 1000 rpm motor is connected to a blower through an open double-ply belt, 10 mm thick and 300 mm wide. The pulleys used in the transmission are 315 mm (driver) and 800 mm (driven). The centers of the pulleys are 1200 mm apart. The pulley material is cast iron and the coefficient of friction between the belt and the pulley is 0.35. The permissible stress in the belt is 2.5 N/mm^2 and the belt weighs 970 kg/m^3. Calculate the maximum kW power that the belt can transmit. [7M]

   b) Compare and contrast flat belts and V-belts in power transmission. What is the effect of the groove angle in the calculations and selection of V-belts? [7M]

6. a) Details of a helical gear set are as follows: [7M]
      Normal module=5 mm; normal pressure angle=20^0; power transmitted=5 kW; speed = 970 rpm; number of teeth = 19/40.
      Determine the tooth force components and the centre distance.

   b) Describe the Buckingham methods for checking the dynamic load and wear strength of a spur gear set. Explain the various terms clearly in your description. [7M]

7. a) Draw sketches of different types of leavers and brackets you are familiar with. Show the forces acting on them to maintain equilibrium. [7M]

   b) Describe the construction of a pressure relief valve using suitable lever or levers. Draw a sketch to show the valve and the force plan and to illustrate how equilibrium is maintained? [7M]

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