R13

SET - 1

III B. Tech II Semester Regular Examinations, April - 2016
DESIGN OF MACHINE MEMBERS– II
(Mechanical Engineering)

Time: 3 hours   Maximum Marks: 70

Note: 1. Question Paper consists of two parts (**Part-A** and **Part-B**)
2. Answering the question in **Part-A** is compulsory
3. Answer any **THREE** Questions from **Part-B**
Design Data book is allowed.

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PART –A

1	a)	Write a short note on classification of antifriction bearings.	[4M]
	b)	Explain the various types of stresses induced in the connecting rod.	[3M]
	c)	Explain the design procedure of studs size for the cylinder head.	[3M]
	d)	What are the various types of stresses induced in crane hooks?	[4M]
	e)	With the help of sketches, discuss about the various types of belt joints.	[4M]
	f)	State the application of various types of levers.	[4M]

PART -B

2   a)   Explain the following terms: [4M]
           i) Static load carrying capacity,   ii) Dynamic load carrying capacity

     b)   A journal bearing of 50mm diameter and 80mm long, has a bearing pressure of 6   [12M]
N/mm^2, the speed of the journal is 1000 rpm. 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 75^0C may be taken as 0.015 kg/m-s. The room temperature is 25^0C, Determine (i) the amount of artificial cooling required and (ii) the mass of the coolant oil required, if the difference between the outlet and inlet temperature of the oil is 10^0C. the specific heat of the oil is 1900 J/kg/^0C and heat dissipation coefficient is 500 $W/m^2/^0C$.

3   a)   Design a center crank shaft for a single acting four stroke engine for the following   [16M]
data:Bore = 200mm, stroke = 300mm, engine speed = 1000 rpm, length of connecting rod = 600mm, Maximum combustion pressure = 1 N/mm^2, the crank shaft carrying one fly wheel at one end of each journal. Weight of each flywheel = 2 kN, distance between flywheel and its nearest journal = 150 mm.
Maximum torque is experienced in the crank shaft when the crank angle is 30^0 from inner dead center position. Permissible stresses for crank shaft material are 70 N/mm^2 in bending, 40 N/mm^2 in shear, limiting bearing pressure is 8 N/mm^2. The length to diameter ratio 1.2 for both crank pin and journal. Assume required data.

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4   Design a cast iron piston for a single acting four stroke diesel engine with the   [16 M]
    following data
    Cylinder bore = 300mm
    Length of stroke = 250mm
    Speed = 600 rpm
    Brake mean effective pressure = 0.6 MPa
    Maximum gas pressure = 4MPa
    Fuel consumption = 0.25 kg per BP per h
    l/d ratio for bush in small end of connecting rod = 1.5
    Assume suitable data if required and state the assumptions made.

5   a)   Why Trapezoid cross-section is preferred for crank hook?   [6M]

    b)   A curved bar of rectangular section, initially unstressed, is subjected to bending   [10M]
         moment of 1400 N-m which tends to straighten the bar. The section is 4 cm wide by 5
         cm deep in the plane of bending, and the mean radius of curvature is 10 cm. Find the
         position of the neutral axis and magnitudes of the greatest bending stress and draw a
         diagram to show approximately how the stress varies across the section.

6   a)   A flat belt is required to transmit 30 kW from a pulley of 1.5m effective diameter   [8M]
         running at 300 rpm. The angle of contact is spread over 11/24 of the circumference.
         The coefficient of friction between the belt and pulley surface is 0.3. Determine taking
         centrifugal tension in to account, width of the belt required. It is given that the belt
         thickness is 9.5 mm. density of belt material is 100 kg/m^3 and the permissible working
         stress is 2.5 MPa.

    b)   The lead screw of lathe has ACME threads of 50mm outside diameter and 8 mm pitch.   [8M]
         The screw must exert an axial pressure of 2500N in order to drive the tool carriage.
         The thrust is carried on a collar 110mm outside diameter and 55mm inside diameter
         and lead screw rotates at 30r.p.m. Derive i)the power required to drive the screw, ii)
         the efficiency of the lead screw. Assume coefficient of friction of 0.15 for screw and
         0.12 for collar.

7   a)   A pair of parallel helical gears consists of a 20 teeth pinion meshing with a 100 teeth   [8M]
         gear. The pinion rotates at 720 rpm. The normal pressure angle is 20^0, while the helix
         angle is 25^0, the face width is 40 mm and the normal module is 4 mm. the pinion as
         well as gear is made of steel 40C8 (S_{ut} = 600 N/mm^2) and heat treated to a surface
         hardness of 300 BHN. The service factor and the factor of safety are 1.5 and 2
         respectively. Assume that the velocity factor accounts for the dynamic load and
         calculate the power transmitting capacity of gears.

    b)   A cranked lever has the following dimensions: Length of the handle = 300 mm,   [8M]
         Length of the lever arm = 400mm, overhang of the journal = 100 mm. if the lever is
         operated by a single person exerting a maximum force of 400 N at a distance of 1/3 rd
         length of the handle from its free end, find i) diameter of the handle ii) cross section of
         the lever arm   iii) diameter of the journal.
         The permissible bending stress for the lever material may be taken as 50 MPa and
         shear stress for shaft material as 40 Mpa.

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PART –A

1 a) Define the following terms related to rolling contact bearings: [4M]
       i) Bearing life   ii) Reliability.
   b) Explain the design procedure of a connecting rod big end cap bolts.   [3M]
   c) Explain the various types of cylinder liners.   [4M]
   d) Derive an expression for radius of neutral axis of a rectangular cross- section curved   [4M]
       beam.
   e) Classify the wire ropes, based on the direction of twist.   [3M]
   f) Define the following   [4M]
       i) Normal pitch   ii) Axial pitch

PART -B

2 a) State any four advantages of Rolling contact bearings over sliding contact bearings.   [4M]
   b) Design a full hydrodynamic journal bearing with the following specifications for   [12M]
       machine tool application
       Journal diameter = 75mm
       Radial load = 10 kN
       Journal speed = 1440 rpm
       Minimum oil film thickness = 22.5 microns
       Inlet temperature = 40^0C
       Bearing material = Babbitt
       Determine the length of the bearing and select a suitable oil.

3   Design an overhung crank shaft for a 300 X 350 mm single cylinder vertical engine   [16M]
       using following data:
       Maximum gas pressure = 2.5 MPa
       (L/r) ratio = 4.5
       Weight of flywheel cum belt pulley = 10 kN
       Total belt pull = 5 kN
       Width of hub for flywheel cum belt pulley = 150 mm
       The torque on the crank shaft is maximum when the crank turns through 35^0 from the
       top dead center and at this position the gas pressure inside the cylinder is 1MPa. The
       belts are in the horizontal direction. Assume suitable data.

4   Design a cast iron piston for a single acting four stroke engine for the following data: [16M]
       Cylinder bore = 100mm, stroke = 125mm, maximum gas pressure = 5 N/mm^2,
       Induced mean effective pressure = 0.75 N/mm^2, mechanical efficiency = 80%, fuel
       consumption = 0.15 kg per BP per hour, higher calorific value = 42 X 10^3 kJ/kg,
       speed = 2000 rpm, assume suitable data if required and state the assumptions made.

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5   a)   What are the applications of curved beams?   [2M]

     b)   A C-Clamp is subjected to a maximum load of W as shown in fig. if the maximum   [14M]
tensile stress in the clamp is limited to 140 MPa, find the value of load W.
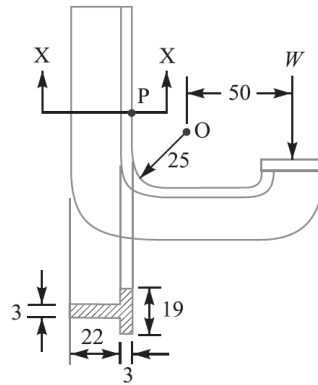
Section of X-X

All dimensions in mm.

6   a)   It is required to select a flat open belt drive for a compressor running at 720 rpm,   [8M]
which is driven by a 25 kW, 1440 rpm motor space is available for a center distance
of 3m.

     b)   A power screw having double start square threads of 25 mm nominal diameter and 5   [8M]
mm pitch is acted upon by an axial load of 10 kN. The outer and inner diameters of
screw collar are 50mm and 20 mm respectively. The coefficient of thread friction and
collar friction may be assumed as 0.2 and 0.15 respectively. The screw rotates at 12
rpm. Assuming uniform wear condition at the collar and allowable thread bearing
pressure of 5.8 N/mm^2. Find
i) The torque required to rotate the screw
ii) The stresses in the screw and

7   a)   A pair of straight teeth spur gears is to transmit 20 kW when the pinion rotates at 300   [8M]
rpm. The velocity ratio is 1:3. The allowable static stresses for the pinion and gear
materials are 120 MPa and 100 MPa respectively. The pinion has 15 teeth and its
face width is 14 times the module. Determine i) Module   ii) face width   iii) pitch
circle diameters of both the pinion and gear from the stand point of strength only,
taking into consideration the effect of the dynamic loading. The tooth form factor can
be taken as $y = 0.154 \dfrac{0.912}{no.of\ teeth}$ and the velocity factor $C_v = \dfrac{3}{3+v}$ where v is
expressed in m/sec

     b)   State the applications of hand and foot levers. Discuss the procedure for designing a   [8M]
hand or foot lever.

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SET - 3

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*****

PART –A

1 a) What are the commonly used materials for sliding contact bearings?   [3M]
   b) Explain the various types of crank shafts.   [3M]
   c) Explain the function of piston rings.   [4M]
   d) Draw the distribution of stresses in curved beams across the cross section.   [4M]
   e) Differentiate between differential screw and compound screw.   [4M]
   f) Define i) Module, ii) Face width.   [4M]

PART -B

2 a) Distinguish between "Hydrodynamic bearings" and "Hydrostatic bearings".   [4M]

   b) A single row deep groove ball bearing is subjected to a radial load of 8 kN and a [12M]
      axial load of 3 kN. The shaft rotates at 1200 rpm. The expected life of the bearing is
      20000 hours. The minimum acceptable diameter of the shaft is 75mm. select a
      suitable ball bearing for this application.

3   The following data is given for the connecting rod of a diesel engine: Cylinder bore = [16M]
     85 mm, Length of connecting rod = 350 mm, Maximum gas pressure = 3 MPa, factor
     of safety against the buckling failure = 5, l/d ratio for piston pin bearing = 1.5, l/d
     ratio for crank pin bearing = 1.25, Allowable bearing pressure for piston pin bearing
     = 13 MPa, Allowable bearing pressure for crankpin bearing = 11 MPa, stroke length
     = 140mm, mass of reciprocating parts = 1.5kg, engine speed = 2000 rpm, allowable
     stress in the bolts as 90 N/mm^2 and in cap as 95 N/mm^2, density of connecting rod =
     7800 kg/m^3 calculate:
     a) Dimensions of the cross section of connecting rod
     b) Dimensions of small and big end bearings
     c) Nominal diameter of bolts for the cap
     d) Thickness of cap and
     e) Magnitude of whipping stress.

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4   A cylinder of a four stroke diesel engine has the following specifications: [16M]
Brake power = 5 kW
Speed = 600 rpm
Indicated mean effective pressure = 0.5 MPa
Make suitable assumptions and calculate
a) Bore and length of the cylinder liner
b) Thickness of the cylinder liner
c) Thickness of the cylinder head
d) Size, number and pitch of studs.

5   a)   Derive an expression for radius of neutral axis of a 'I' cross- section curved beam.   [6M]
   b)   A central horizontal section of a hook is symmetrical trapezium 60 mm deep, the   [10M]
inner width being 60 mm and the outer width being 30 mm. Estimate the extreme
intensities of stresses when the hook carries a load of 20 kN. the load line passes at
40 mm from the inside edge of the section and the center of curvature lies in the load
line.

6   a)   It is required to select a V belt drive to connect a 15 kW, 2880 rpm normal torque A   [8M]
C Motor to a centrifugal pump, running at approximately 2400 rpm, for a service of
18 hours per day. The center distance should be approximately 400mm. assume that
the pitch diameter of the driving pulley is 125mm

   b)   A vertical two start square threaded screw of a 100 mm diameter and 20mm pitch   [8M]
supports a vertical load of 18kN. The axial thrust on the screw is taken by a collar
bearing of 250mm outside diameter and 100 mm inside diameter. Find the force
required at the end of a lever of 400 mm long in order to lift and lower the load. The
coefficient of friction for the vertical screw and net is 0.15 and that for collar bearing
is 0.20.

7   a)   A pair of helical gears is to transmit 15 kW. The teeth are 20^0 stub in diametral plane   [10M]
and have a helix angle of 45^0. The pinion runs at 10000 rpm and has 80mm pitch
diameter. The gear has 320 mm pitch diameter. if the gears are made of cast steel
having allowable static strength of 100 MPa, determine a suitable module and face
width from static strength considerations and check the gears for wear, given σ_{es} =
618 MPa

   b)   A foot lever is 1m from the center of the shaft to the point of application of 800N   [6M]
load. Find i) diameter of the shaft ii) dimensions of the rectangular arm of the foot
lever at 60 mm from the center of the shaft assuming width of the arm as three times
the thickness. The allowable tensile stress may be taken as 73 MPa and allowable
shear stress as 70 MPa.

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Code No: RT32033 $\boxed{R13}$ SET - 4

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*****

PART –A

1 a) Define the terms: [4M]
i) Bearing characteristic number ii) Bearing modulus

b) What are the various types of stresses induced in the crank shaft?   [4M]

c) Explain the properties required for the piston materials.   [4M]

d) What are the assumptions made in Winkler-Bach Theory?   [4M]

e) Name the type of stresses induced in the wire ropes.   [3M]

f) Explain about herring bone gear.   [3M]

PART -B

2 a) Explain the various types of lubrication.   [4M]

b) Select a single row deep groove ball bearing for a radial load of 4000N and an axial load   [12M]
of 5000N, operating at a speed of 1600rpm for an average life of 5 years at 10 hours per
day. Assume uniform and steady load.

3   Design a connecting rod for an IC engine running at 1800 rpm and developing a   [16M]
maximum pressure of 3.15 N/mm^2. The diameter of the piston is 100mm, mass of the
reciprocating parts per cylinder 2.25kg, length of connecting rod 380 mm, stroke of
piston 190 mm and compression ratio 6:1.take factor of safety of 6 for the design. Take
length to diameter ratio for big end bearing as 1.3 and small end bearing as 2 and the
corresponding bearing pressure as 10 N/mm^2 and 15 N/mm^2. The density of rod material
may be taken as 8000 kg/m^3 and the allowable stress in the bolts as 60 N/mm^2 and in cap
as 80 N/mm^2. Assume I cross section for the connecting rod. The elastic limit of
compressive stress is 350 MPa and rankine constant 1/7500. Draw a neat dimensioned
sketch.

4   A four stroke diesel engine has the following specifications   [16M]
Brake power = 5 kW, Speed = 1200 rpm, indicated mean effective pressure = 0.35
N/mm^2, Mechanical efficiency = 80%. Determine
i) Bore and length of the cylinder ii) Thickness of the liner
iii) Thickness of the cylinder head iv) Size, number and pitch of studs.

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5   a)   Define curved beam? What is the difference with respect to straight beam   [4M]

    b)   A crane hook has a trapezoidal section at A-A as shown in fig. find the maximum stress at points P and Q   [12M]

Section at A-A
All dimensions in mm.
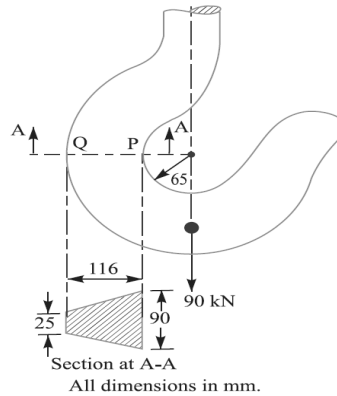
6   a)   Design a chain drive to actuate a compressor from a 15 kW electric motor running at 1000 rpm. The compressor speed being 350 rpm. The minimum center distance is 500 mm. the compressor operates 16 hours per day. The chain tension may be adjusted by shifting the motor on sliders   [8M]

    b)   A nominal diameter of a triple threaded square screw is 50mm, while the pitch is 8 mm. it is used with a collar having an outer diameter of 100mm and inner diameter as 65mm. the coefficient of friction at the thread surface as well as at the collar surface can be taken as 0.15.the screw is used to raise a load of 15 kN. using the uniform wear theory for collar friction, calculate
i)Torque required to raise the load   ii)Torque required to lower the load and
iii)The force required to raise the load, if applied at a radius of 500 mm   [8M]

7   a)   Design a pair of spur gears with 20^0 full-depth involute teeth consisting of a 20 teeth pinion meshing with a 50 teeth gear. The pinion shaft is connected to a 22.5 kW, 1450 rpm electric motor. The starting torque of the motor can be taken as 150% of the rated torque. The material for the pinion is plain carbon steel Fe410 (S_{ut} = 410 N/mm^2), while the gear is made of grey cast iron FG200 (S_{ut} = 200 N/mm^2). The factor of safety is 1.5. design the gears based on the Lewis equation and using velocity factor to account for the dynamic load   [10M]

    b)   A right angled bell crank lever is to be designed to raise a load of 5 kN at the short arm end. The lengths of short and long arms are 100 and 450 mm respectively. The lever and the pins are made of steel 30C8 (S_{ut} = 400 N/mm^2). And the factor of safety is 5.the permissible bearing pressure on the pin is 10 N/mm^2. The lever has a rectangular cross section and the ratio of width to thickness is 3:1. The length to diameter ratio of the fulcrum pin is 1.25:1. Calculate i) the diameter and length of the fulcrum pin ii) the dimensions of the cross section of the lever   [6M]

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