R10

Set No: 1

III B.Tech. II Semester Supplementary Examinations, January -2014
**DESIGN OF MACHINE MEMBERS-II**
(Mechanical Engineering)

Time: 3 Hours   **Max Marks: 75**

Answer any FIVE Questions
All Questions carry equal marks
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(Assume suitable data if necessary)

1. A full journal bearing of 50mm diameter and 100mm long has a bearing pressure of 1.4 N/mm^2. The speed of the journal is 900r.p.m. and the ratio of journal diameter to the diametral clearance is1000. The bearing is lubricated with oil whose absolute viscosity at the operating temperature of 75^{0}C may be taken as 0.0111 kg/m-s. The room is 35^{0}C. Find
   (a) The amount of artificial cooling required, and
   (b) The mass of the lubricating oil required, if the difference between the outlet and inlet temperature of the oil is 10^{0}C Take specific heat of the oil as 1850J/kg/^{0}C.   [15M]

2. Design a connecting rod of I cross section for an automobile diesel engine of the following specifications.   [15M]
   Diameter of cylinder=100mm
   Stroke length =125mm
   Maximum combustion pressure =2.8MPa
   Maximum engine speed=2000rpm
   Weight of the reciprocating parts =1.1kg
   Length of connecting rod between centers=31.5cm
   Assume an allowable crushing stress =3000kg/cm^2

3. Design an aluminum alloy piston for a single acting four stroke engine for the following data:
Cylinder bore	= 400mm
Stroke	= 375mm
Maximum gas pressure	= 9 M Pa
Break mean effective pressure	= 2MPa
Fuel consumption	= 0.22kg/kW/hr
Speed	=50rev/min. [15M]

4. A ring is made of a 5 cm diameter round bar as shown in figure . Calculate the stresses at point A and B.   [15M]

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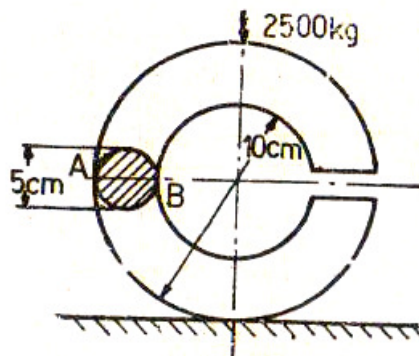
5. (a) What are the merits and demerits of straight and curved arms of a pulley?

(b) A V belt drive is used to transmit 80kW at a motor speed of 100 rpm, the driven pulley speed being 600 rpm. Approximate center distance is 1.110m, μ is 0.3, angle of groove is 40degree and V_{max}=25m/sec. Neglecting the centrifugal tension. Calculate the size and number of belts. Also check the induced stress and find the induced stress and find the life of the belt assuming allowable endurance strength is 9MPa. [3+12M]

6. (a) What are the causes of failure of gear tooth?

(b) Design a pair of spur gear with stub teeth to transmit 55kW from 175 mm pinion running at 2500 rpm. to a gear running at 1500 rpm. Both the gears are made of steel having B.H.N 260. Approximate the pitch by means of Lewis equation and then adjust the dimensions to keep within the limits set by the dynamic load and wear equation. [3+12M]

7. A vertical two start square threaded screw of 100 mm mean diameter and 20mm pitch supports a vertical load of 18 k N. The nut of the screw is fitted in the hub of a gear wheel having 80 teeth which meshes with a pinion of 20 teeth. The mechanical efficiency of the pinion and gear wheel drive is 90 percent. The axial thrust on the screw is taken by a collar bearing 250 mm outside diameter and 100 mm inside diameter. Assuming uniform pressure conditions, find, minimum diameter of pinion shaft and height of nut, when coefficient of friction for the vertical screw and nut is 0.15 and that for the collar bearing is 0.20. The permissible shear stress in the shaft material is 56 M Pa and allowable bearing pressure is 1.4 N/mm^2. [15M]

8. Design a foot brake lever from the following data: [15M]

Length of the lever from the center of gravity of the spindle to the point of application of load is 1m, Maximum load on the foot plate is 800N, over hang from the nearest bearing is 100mm, permissible tensile and shear stress is 70M Pa.

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(Assume suitable data if necessary)

1. A shaft is mounted on two roller bearings, which are 350mm apart .The shaft carries a bevel gear at the middle. At a shaft speed of 900 rpm; the gear forces are: radial load =10kN,and the thrust load=3.5kN.Determine the rated dynamic Capacity of the bearing, for a desired life of 10,00 hours .The service factor is 0.67,and radial load factor is 0.67.

                                                                                                              [15M]

2. (a) Under what forces the big end bolt and caps are designed?
    (b) The following data refer to a 4-stroke cycle, single cylinder diesel engine
                Suction pressure=0.095MPa
                Cylinder diameter =200mm
                Stroke=200mm
                Ratio of compression=15
                Engine speed =7450rpm
                Equivalent mass of reciprocating parts 2N/sq.mm of piston area
                Ratio of connecting rod length to crank length is 4
    Design Nickel steel connecting rod of I section choosing the suitable values for the
    permissible stresses for the material.   [3+12M]

3. (a) What are the requirements of a piston material?
    (b) Design a CI piston for a single acting 4Stroke petrol engine of the following
                specifications :
                Cylinder bore   = 100mm
                Stroke Length   =120mm
                Maximum gas pressure   = 5MPa
                Break mean effective Pressure   =0.65MPa
                Fuel Consumption   = 0.17kg/bhp/min
                Speed   =220rpm   [3+12M]

4. A bar of rectangular cross-section, with a width of 60mm and a thickness of 40mm, is bent in the shape of a horse shoe having a mean radius of 70 mm. Two Equal and opposite forces of 10kN each are applied at a distance of 12 cm from the centre line of the middle section so that they tend to straighten the rod. Find the maximum tensile and compressive stresses and construct a diagram showing the variation of the normal stresses over the central section.   [15M]

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5. (a) State and prove the condition for maximum power transmission.
   (b) It is required to design leather cross belt drive to contact 7.5kW, 1440 rpm electric motor to a compressor running at 480 rpm. The distance between the centers of the pulleys is twice the diameter of the bigger pulley. The belt should operate at 20m/s approximately and its thickness is 5mm. density of leather =950 kg/m^3 and allowable ultimate strength is 25MPa. Factor of safety is 4. [3+12M]

6. (a) Explain why helical gears are capable of transmitting greater power at high speed as compared to the spur gear.
   (b) A pair of spur gears has pinion made of material with 80MPa safe static bending stresses, gear made of material with safe static bending stresses of 55MPa.The module and face width of the teeth are 5mm and 60mm respectively. The pinion rotates at 60rpm.The number of teeth on pinions and gear is 20 and 80 respectively. Find the capacity in kW of the gear drive. The error is limited to e=16+1.25(m+0.25√d) microns. B.H.N. of the pinion material is 250. [3+12M]

7. A screw jack is to lift a load of 80 kN through a height of 400 mm. The elastic strength of screw material in tension and compression is 200 M Pa and in shear 120 MPa. The material for nut is phosphor-bronze for which the elastic limit may be taken as 100 MPa intension, 90 M Pa in compression and 80 M Pa in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm^2. Design and draw the screw jack. The design should include the design of 1.screw, 2. nut, 3. handle and cup, and 4. body. [15M]

8. Design a cranked lever for the following dimensions:
   Length of the handle is 320mm, length of the lever arm is 450mm, and overhang of the journal is 120mm.The lever is operated by a single person exerting a maximum force of 400N at a distance of 1/3rd length of the handle from its free ends. The permissible stress may be taken as 50MPa for lever material and 40MPa for shaft material. [3+12M]

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Time: 3 Hours   **Max Marks: 75**

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(Assume suitable data if necessary)

1. (a) Distinguish between 'Hydrodynamic lubrication" and "Hydrostatic bearings"
   (b) A shaft rotating at constant speed is subjected to variable load. The bearings supporting the shaft are subjected to stationary equivalent radial load of 3kN for 10% of time, 2kN for 20% of time ,1kN for 30% of time and no load for remaining time of cycle. If the total life excepted for the bearing is 20×10^6 revolutions at 95% reliability, calculate dynamic load rating of the ball bearing.   [3+12M]

2. Design and give a neat drawing of high speed petrol engine connecting rod, given: [15M]

Piston diameter	= 100mm.
Stroke length	= 138mm
Weight of reciprocating parts per cylinder	= 1.8kg
Length of the connecting rod	= 310mm
Rated rpm of the engine	=1500
Compression ratio	=4:1
Maximum explosion pressure	=2.45MPa
Speed	=2500 rpm
Bearing pressure for big end	=7MPa
Bearing pressure for small end	=14MPa

   Connecting rod should of I –section and be made of forged steel, the proportions being depth h=5t,width=4t,where t is the flange and web thickness.

3. Design a piston, piston rings and gudgeon pin for a single four stroke engine for the following given data:

Cylinder bore	= 100mm
Stroke	= 125mm
Maximum gas pressure	= 5MPa
b.m.e.p	= 0.6MPa
Fuel consumption	= 0.15kg/brake kW/hr
Speed	= 1500rpm [15M]

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4. A chain link is subjected to a pull of 200 kN as shown in fig. It is compressed of steel 2.5cm diameter and has a mean radius of 3cm. Its semi-circular ends are connected by straight pieces 2.5 cm long. Estimate the maximum compressive stress in the link and tensile stress at the same section. [15M]
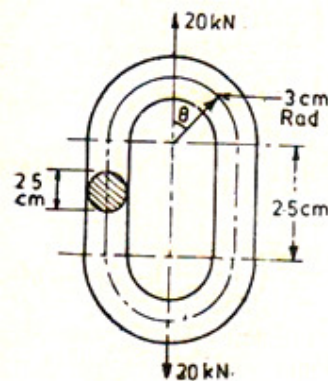
5. The following data relate to an overhang flat belt drive:

        Power transmitted   =22 kW
        Rev/min   =300
        Angle of contact   =165degree
        The coefficient of fiction between the belt and the pulley   = 0.3
        Distance of centre of pulley from centre of nearest bearing =0.25m
        Take into account centrifugal tension, but neglecting weight of CI pulley, find:

(i) diameter of pulley
(ii) width of 8mm thick leather belt.
(iii)Diameter of shaft (d) size of key
(iv)Dimensions of four elliptical arms having major axis is 0.6 minor axis, permissible stresses:

        Shaft and key   = 42MPa
        Arms   =14MPa
        Pulley   =4.9MPa
        Belt   =2.1MPa   [15M]

6. What is the herringbone gear? Where are they used?
A helical cast steel gear with 30° helix angle has to transmit 35kW at 2000 rpm. If the gear has 25 teeth, find the necessary module, pitch diameters and face width for 20° full-depth involute teeth. The static stress for cast steel may be taken as 100MPa. The face width may be taken as 3 times the normal pitch. The tooth form factor is given by expression y= $0.154-0.912 / T_E$, where T_E represents the equivalent number of teeth. The velocity factor is given by Cv = 6/ (6+V) where V is the peripheral speed of the gear in m/s. [3+12m]

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7. A vertical square threads screw of a 70 mm mean diameter and 10 mm pitch supports a vertical load of 50 k N. 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 N/mm^2.   [15M]

8. A lever loaded safety valve is 70mm in diameter and is to be designed for a boiler to blow-off at pressure of 1N/mm^2 gauge. Design a suitable mild steel lever of rectangular cross section using the following permissible stresses. Tensile stress 70 MPa, Shear stress is 50 MPa, bearing pressure intensity 25N/mm^2. The pin is also made of mild steel. The distance from the fulcrum to the weight of the lever is 880mm and the distance between the fulcrum and the pin connecting the valves spindle links to the lever is 80mm. [15M]

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(Assume suitable data if necessary)

1. A 407 radial ball bearing, with inner race rotation, has a 12 seconds work cycle as mentioned below:

   For 3 seconds   For 9 seconds
   F_r=5kN F_r=3.5kN
   F_a=2kN F_a=0
   Speed =900 rpm   Speed =1200 rpm
   Light shock   steady load
   If the basic dynamic capacity of the bearing is 42500 N, determine the expected average life of the bearing .Take X=0.56and Y=1.43.   [15M]

2. Design a centre crank shaft for a single acting four stroke single cylinder engine for the following given data:
   Piston diameter   = 400mm
   Stoke   = 600 mm
   Speed   = 200 rev/min
   I.M.E.P   = 0.5Mpa
   Maximum combustion Pressure = 2.5Mpa
   Gas pressure at the maximum torque =1 MPa at 35^0 crank angle
   Ratio of length of connecting rod to crank radius =5
   Weight of flywheel used as a pulley =5.0kN
   Total belt pull = 6.5kN
   Assume any other missing data.   [15M]

3. (a) What are the various types liners?
   (b) Design a Al. piston for a single acting 4 Stroke petrol engine of the following specifications :

   Cylinder bore   = 100mm
   Stroke Length   =120mm
   Maximum gas pressure   = 5MPa
   Break mean effective Pressure =0.65MPa
   Fuel Consumption   = 0.17kg/bhp/min
   Speed   =220rpm
   Assume suitable data if necessary   [3+12M]

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4. A crane hook carries a load of 6 kN, the line of the load being at a horizontal distance of 3.25 cm from the inside edge of a horizontal section through the centre of curvature, the centre of curvature being 4 cm from the same edge. The horizontal section is a trapezium whose parallel sides are 1.5 cm and 3 cm and perpendicular distance apart by 3.25 cm. Find the greatest tensile and compressive stresses in the hook. [15M]

5. An overhung cast iron pulley transmits 7.5kW at 300 rpm. The diameter of the pulley is 500mm and angle of lap is 180°. Find: i) diameter of the pulley. The density of cast iron is 7200 kg/m^3. ii) Width of the belt, if the coefficient of fiction between the belt and the pulley is 0.25 iii) diameter of the shaft, if the distance of the pulley center line from the nearest bearing is300mm. iv) Dimensions of the key for securing the pulley on to the shaft. v) Size of the arms 6 in number the section may be taken as elliptical, the major axis twice the minor axis length. The following stresses may be taken for design purposes: [15M]

        Shaft and key: tension-80MPa, Shear -50MPa
        Belt   : tension-2.5MPa
        Pulley rim   : tension-4.5MPa
        Pulley arms   : tension-15MPa

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

7. (a) Differentiate between the Differential screw and compound screw
   (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 (i) the power required to drive the screw; and (ii) the efficiency of the lead screw. Assume a coefficient of friction of 0.15 for the screw and 0.12 for the collar. [5+10M]

8. A vertical lever PQR of length 1m is attached by a fulcrum pin at R and to a horizontal rod at Q .An operating force of 700N is applied horizontally at P. The distance of the horizontal rod Q from the fulcrum pin R is 140mm. If the permissible stresses are 52.5MPa in Tension and compression and 32MPa in shear. Find the diameter of the pins, tie rod at Q and thickness of the lever. The bearing pressure on the pins may be taken as 22N/mm^2. [15M]

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