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QUESTION BANK (DESCRIPTIVE)

Subject with Code : Design of Machine Elements-II (20ME0320) **Course & Branch**: B.Tech - ME
Year & Sem: III-B.Tech & II SEM **Regulation:** R20

UNIT I

DESIGN OF MECHANICAL SPRINGS

1.	(a)Classify springs according to their shapes. Draw neat sketches indicating in each case whether stresses are induced by bending or by torsion.	L4	CO1	4M
	(b)Design a spring for a balance to measure 0 to 1000 N over a scale of length 80 mm. The spring is to be enclosed in a casing of 25 mm diameter. The approximate number of turns is 30. The modulus of rigidity is 85 kN/mm^2. Also calculate the maximum shear stress induced.	L6	CO1	8M
2.	(a) Explain what you understand by A.M. Wahl's factor and state its importance in the design of helical springs.	L2	CO1	4M
	(b) A mechanism used in printing machinery consists of a tension spring assembled with a preload of 30 N. The wire diameter of spring is 2 mm with a spring index of 6. The spring has 18 active coils. The spring wire is hard drawn and oil tempered having following material properties: Design shear stress = 680 MPa, Modulus of rigidity = 80 kN/mm^2. Determine: (i) The initial torsional shear stress in the wire. (ii) Spring rate. (iii) The force to cause the body of the spring to its yield strength.	L5	CO1	8M
3.	(a)What is the function of a spring?	L1	CO1	3M
	(b) A helical spring is made from a wire of 6 mm diameter and has outside diameter of 75 mm. If the permissible shear stress is 350 MPa and modulus of rigidity 84 kN/mm^2, find the axial load which the spring can carry and the deflection per active turn.	L5	CO1	9M

4.	A compression spring made of alloy steel of coil diameter 75 mm and spring index 6.0, number of active coil 20 is subjected to a load of 1.2 kN. Calculate: (i) The maximum stress developed in the coil. (ii) The deflection produced. (iii) The spring rate.	L5	CO1	12M
5.	It is required to design a helical compression spring with plain ends, made of cold drawn plain carbon steel, for carrying a maximum pure static force of 1000 N. The ultimate tensile strength and modulus of rigidity for spring material are 1430 N/mm^2 and 85 N/mm^2 respectively. The spring rate is 48 N/mm. If spring index is 5, Determine: (i) Wire diameter. (ii) Total number of coils. (iii) Free length and (iv) Pitch.	L5	CO1	12M
6.	Design a helical compression spring for a maximum load of 1000 N for a deflection of 25 mm using the value of spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm^2.	L2	CO1	12M
7.	A bumper consisting of two helical steel springs of circular section brings to rest, a railway wagon of mass 1500 kg and moving at 1.2 m/s. While doing so, the springs are compressed by 150 mm. The mean diameter of the coils is 6 times the wire diameter. The permissible shear stress is 400 MPa. Determine: (i) Maximum force on each spring. (ii) Wire diameter of the spring. (iii) Mean diameter of the coils and (iv) Number of active coils. Take G = 0.84 x 105MPa.	L5	CO1	12M
8.	Design a close coiled helical compression spring for a service load ranging from 2250 N to 2750 N. The axial deflection of the spring for the load range is 6 mm. Assume a spring index of 5. The permissible shear stress intensity is 420 MPa and modulus of rigidity, G = 84 kN/mm^2.	L6	CO1	12M

9.	Design and draw a valve spring of a petrol engine for the following operating conditions : Spring load when the valve is open = 400 N Spring load when the valve is closed = 250 N Maximum inside diameter of spring = 25 mm Length of the spring when the valve is open= 40 mm Length of the spring when the valve is closed= 50 mm Maximum permissible shear stress = 400 MPa	L6	CO1	12M
10.	A semi-elliptical laminated vehicle spring to carry a load of 6000 N is to consist of seven leaves 65 mm wide, two of the leaves extending the full length of the spring. The spring is to be 1.1 m in length and attached to the axle by two U-bolts 80 mm apart. The bolts hold the central portion of the spring so rigidly that they may be considered equivalent to a band having a width equal to the distance between the bolts. Assume a design stress for spring material as 350 MPa. Determine: (i) Thickness of leaves. (ii) Deflection of spring. (iii) Diameter of eye. (iv) Length of leaves. (v)Radius to which leaves should be initially bent.	L5	CO1	12M

UNIT II

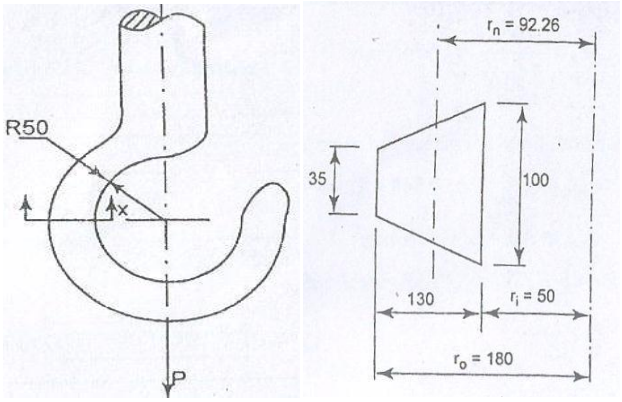
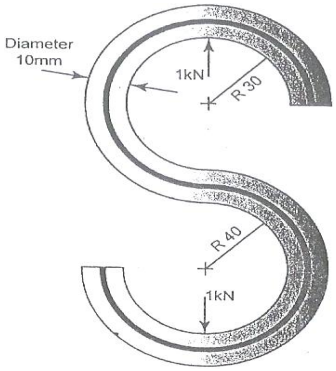
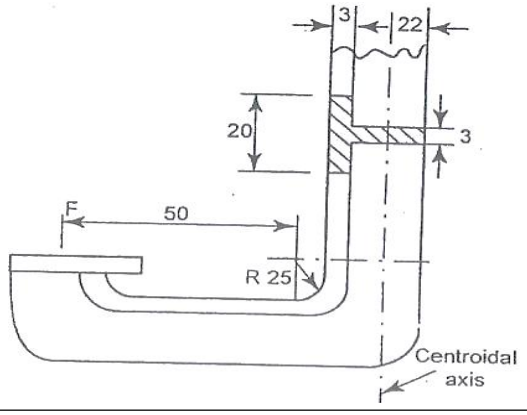
DESIGN OF SLIDING CONTACT & ROLLING CONTACT BEARINGS

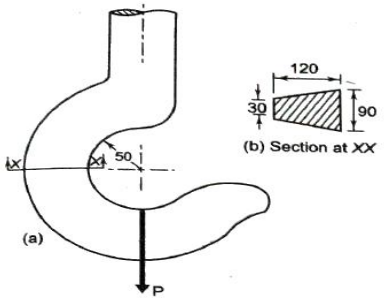
1.	Design a journal bearing for a centrifugal pump with the following data. Diameter of journal =150mm Load on bearing =40kN Speed of journal =900 RPM	L6	CO2	12M
2.	Design a journal bearing for centrifugal pump from the following data: Load on the journal = 20 kN Speed of the journal = 900 rpm Type of oil SAE 10 for which absolute viscosity at 55°C = 17 centipoises Ambient temperature of oil = 15.5°C Maximum bearing pressure for the pump = 1.5 N/mm^2 Calculate also the mass of the lubricating oil required for artificial cooling to rise in temperature of the oil limited to 10°C. Heat dissipation coefficient = 12.2 $kN/m^2/°C$	L5	CO2	12M
3.	A 75mm journal bearing 100mm long is subjected to 2.5kN at 600rpm. If the room temperature is 240C, what viscosity of oil should be used to limit the bearing surface temperature at 550C ,D/C=1000.	L5	CO2	12M
4.	Following data is given for 3600 hydrodynamic bearings: journal diameter =100 mm, radial clearance =0.12mm, radial load =50kN, bearing length =100 mm, journal speed =1440rpm and viscosity of lubricant = 16CP. Calculate (i) minimum film thickness (ii) coefficient of friction and (iii) power lost in friction.	L5	CO2	12M
5.	Design a journal bearing for centrifugal pump for the following data: Load on the journal = 12kN, Diameter of the journal =75mm, Speed=1440 rpm, Atmosphere temperature =16^0C Operating temperature=60^0C, Absolute viscosity of oil at 60^0C = 23 centipoise	L6	CO2	12M

<table>
<tr><td>6.</td><td>A 70mm machine shaft is to be supported at the ends. It operates continuously for 8hrs per day,320 days per year for 8 years. The load and speed cycle for one of the bearings are given below. Select the bearing.
<table>
<tr><th>S.No</th><th>Fraction of cycle</th><th>Radial load,N</th><th>Thrust load,N</th><th>Speed, rpm</th><th>X</th><th>Y</th><th>Z</th></tr>
<tr><td>1</td><td>0.25</td><td>3500</td><td>1000</td><td>600</td><td>0.56</td><td>1.2</td><td>1.5</td></tr>
<tr><td>2</td><td>0.25</td><td>3000</td><td>1000</td><td>800</td><td>0.56</td><td>1.2</td><td>1.5</td></tr>
<tr><td>3</td><td>0.5</td><td>4000</td><td>2000</td><td>900</td><td>0.56</td><td>1.4</td><td>1.5</td></tr>
</table></td><td>L6</td><td>CO2</td><td>12M</td></tr>
<tr><td>7.</td><td>Select a suitable spherical roller bearing from SKF series 222C to support a radial load of 4kN and axial load of 2kN. Minimum life required is 10000 hrs at 1000 rpm. For this select bearing find
(i) The expected life under the given loads
(ii) The equivalent load that can be supported with a probability of survival of 95% with 10000 hours.</td><td>L6</td><td>CO2</td><td>12M</td></tr>
<tr><td>8.</td><td>The radial load on a roller bearing varies as follows a load of 50 kN is acting 20% of time at 500 rpm and a load of 40kN is acting 50% of the time at 600 rpm. In the remaining time the load varies from 40kN to 10kN linearly at 700 rpm. Select a roller bearing from NU22 series for a life of at least 4000 hours. The operating temperature is 175^{o}C.</td><td>L5</td><td>CO2</td><td>12M</td></tr>
<tr><td>9.</td><td>The ball bearing for the drilling machine spindle is rotating at 3000rpm. It is subjected to radial load of 2500N and an axial load of 1500N. It is to work 50 hours per week for one year. Design a suitable bearing if the diameter of the spindle is 40mm.</td><td>L6</td><td>CO2</td><td>12M</td></tr>
<tr><td>10</td><td>A 30BC03 deep groove ball bearing is to operate at 1600rpm and carries 8kN radial load and 6kN thrust load. The bearing is subjected to a light shock load. Determine the rating life of the bearing.</td><td>L5</td><td>CO2</td><td>12M</td></tr>
</table>

UNIT III

DESIGN OF CURVED BEAMS & DESIGN OF POWER TRANSMISSION SYSTEMS

1.	(a). Differentiate the straight and curved beams?	L2	CO3	2M
	(b). A crane hook has a section, which for the purpose of analysis is considered trapezoidal as shown in fig. it is made of plain carbon steel with an yield strength of 350Mpa in tension. Determine the load capacity of the hook for a factor of safety 3. 	L5	CO3	10M
2.	An open S link shown in fig. is made of steel rod of diameter 12mm. Determine the maximum tensile and shear stress. 	L5	CO3	12M
3.	A C- clamp is to bear the force' F' applied on to it. It has a T-section as shown in fig. if the maximum tensile strength in the clamp is limited to 130MPa. Find 'F'. 	L5	CO3	12M

4.	The horizontal section of crane hook is symmetrical trapezium 120 mm deep, the inner width being 90 mm and outer width being 30 mm. The hook is made of plain carbon steel $45C8$ (σ_{yt}= 380 N/mm^2) and the factor of safety is 3.5. Determine the load carrying capacity of the hook. Also draw the crane hook and show the location at which maximum stress is acting.  	L4	CO3	12M
5.	(a) List the materials used for belts? How are wire ropes designated?	L1	CO3	6M
	(b) Mention the materials used for Sheeve and its characteristics.	L1	CO3	6M
6.	An open belt connects two flat pulleys. Pulley diameters are 300 mm and 450mm and the corresponding angles of cap are 160^0 and 210^0 . the smaller pulley runs at 200rpm, μ=0.25. it is found that the belt is on the point of slipping when 3kw is transmitted. To increase the power transmitted two alternatives are suggested., namely (i) increase the initial tension by10% and (ii) increasing μ by 10% by the application of a suitable dressing to the belt. Which of these two methods would be more effective ? find the percentage increase in power possible in each case.	L4	CO4	12M
7.	Design a horizontal belt drive for a centrifugal blower, the belt driven at 600rpm by a 15kw, 1750rpm electric motor. The centre distance is twice the diameter of the larger pulley. The density of the belt material=1500kg/m3 maximum allowable stress =4MPa. μ1=0.5 (motor pulley), μ2=0.4 (blower pulley); peripheral velocity of the belt=20m/s. Determine the following: i. Pulley diameters ii. Belt length iii. Cross sectional area of the belt iv. Minimum initial tension for operation without slip	L6	CO4	12M

8.	Two shafts whose centres are 1 metre apart are connected by a V-belt drive. The driving pulley is supplied with 95 Kw power and has an effective diameter of 300 mm. It runs at 1000 r.p.m. while the driven pulley runs at 375 r.p.m. The angle of groove on the pulleys is 40°. Permissible tension in 400 mm2 cross-sectional area belt is 2.1 Mpa. The material of the belt has density of 1100 kg / m3. The driven pulley is overhung, the distance of the centre from the nearest bearing being 200 mm. The coefficient of friction between belt and pulley rim is 0.28. Estimate: 1. The number of belts required. 2. Diameter of driven pulley shaft, if permissible shear stress is 42 Mpa.	L5	CO4	12M
9.	A belt drive consists of two V-belts in parallel, on grooved pulleys of the same size. The angle of the groove is 30°. The cross-sectional area of each belt is 750 mm^2 and $\mu = 0.12$. The density of the belt material is 1.2 Mg/ m^3 and the maximum safe stress in the material is 7 Mpa. Calculate the power that can be transmitted between pulleys of 300 mm diameter rotating at 1500 r.p.m. Find also the shaft speed in r.p.m. at which the power transmitted would be a maximum.	L5	CO4	12M
10.	A rope drive is to transmit 250 kW from a pulley of 1.2 m diameter, running at a speed of 300 r.p.m. The angle of lap may be taken as π radians. The groove half angle is 22.5°. The ropes to be used are 50 mm in diameter. The mass of the rope is 1.3 kg per metre length and each rope has a maximum pull of 2.2 kN, the coefficient of friction between rope and pulley is 0.3. Determine the number of ropes required. If the overhang of the pulley is 0.5 m, suggest suitable size for the pulley shaft if it is made of steel with a shear stress of 40 Mpa.	L5	CO4	12M

UNIT IV
SPUR AND HELICAL GEARS

1.	In a spur gear drive for a rock crusher, the gears are made of case hardened alloy steel. The pinion is transmitting 18 kW at 1200 rpm with a gear ratio of 3.5. The gear is to work 8 hours/day for 3 years. Design the drive.	L6	CO5	12M
2.	A compressor running at 300 rpm is driven by 15kW, 1200rpm motor through 20^0 full depth involute gears. The centre distance is 375mm. choose the suitable materials for the pinion and gear, design the drive.	L5	CO5	12M
3.	A pair of straight spur gears is required to reduce the speed of shaft from 500 to 100 rpm while continuously running 12hr per day. The pinion is of 40C8 steel and has 20 teeth. The wheel is of cast iron of grade FG200 and has 100 teeth. The gears are of 8mm module, 100 mm face width and 20^0 pressure angle. Calculate power rating.	L5	CO5	12M
4.	A bronze spur pinion rotating at 600 r.p.m. drives a cast iron spur gear at a transmission ratio of 4:1. The allowable static stresses for the bronze pinion and cast iron gear are 84 MPa and 105 MPa respectively. The pinion has 16 standard 20° full depth involute teeth of module 8 mm. The face width of both the gears is 90 mm. Find the power that can be transmitted from the standpoint of strength.	L5	CO5	12M
5.	A pair of gears is to be designed to transmit 30kW for a pinion speed of 1000 rpm and a speed ratio of 5. Design the gear train.	L6	CO5	12M
6.	A helical gear set used in a paper pulping machine connects the driving motor to the blade shaft. A power of 20kW is transmitted by the motor at 1600rpm while the blade shaft runs at 400rpm. Due to space restrictions the center distance between the gears is kept at 500mm. choosing suitable materials for the gears design the 20^0 full depth involute helical gears with a helix angle of 25^0.	L5	CO5	12M
7.	A Pair of parallel helical gears consists of 23 teeth pinion meshing with a 46 gear teeth. The helix angle is 24^o and the normal pressure angle is 21^o. Calculate: (i) transverse module (ii) transverse pressure angle (iii) The Axial pitch (iv) the pitch circle diameters of the pinion and the gear (v) the centre distance (vi) the addendum and the dedendum circle diameters of the pinion.	L5	CO5	12M

8.	A compressor running at 350 rpm is driven by 5 kW, 1400 rpm motor through 20^0 full depth spur gears. The motor pinion is to be of C30 forged steel hardened and tempered, and the driven gear is to be of cast iron grade 35. Assuming medium shock condition, design the gear drive completely. Take minimum number of teeth is 18 for the pinion. The gears are working for one shift per day in an industrial atmosphere and to work for two years before their replacement.	L6	CO5	12M
9.	A pair of helical gears in a milling machine is used to transmit 4.5 kW at 1000 rpm of the pinion and the velocity ratio is 3:1. The helix angle of the gear is 15^0 and both gears are made of steel C45. The gears are 20^0 FDI and the pinion is to have minimum of 20 teeth. The gear is to work 8 hrs/day for 3 years. Design the helical gears. Take the required hardness for both gears is more than 350 BHN.	L6	CO5	12M
10.	(a) Explain the causes of Gear tooth failure.	L2	CO5	6M
	(b) Write a short note on Gear materials.	L6	CO5	6M

UNIT V

DESIGN OF GEARS & DESIGN OF IC ENGINE PARTS

1.	A Pair of Straight bevel gear has a velocity ratio of 2:1. The pitch circle diameter of the pinion is 80mm and the large end of the tooth. A 5kW power is supplied to the pinion which rotates at 800 rpm. The face width is 40mm and the pressure angle is 20^{o}. Calculate the tangential, axial and radial components of the resultant tooth force acting on the pinion.	L5	CO5	12M
2	(a) A pair of Straight bevel gears consists of a 30 teeth pinion meshing with a 48 teeth gear. The gears are mounted 0n shafts, which are intersecting at right angle. The module at the large end of the tooth is 4mm Calculate: (i) the pitch circle diameters of the pinion and the gear. (ii) the pitch angles for the pinion and gear; and (iii) the cone distance.	L5	CO5	8M
	(b) List the forces acting on the connecting rod.	L6	CO6	4M
3.	A Pair of worm gear is designated as 2/54/10/5. Calculate (i) Centre distance (ii)Speed reduction (iii) The dimensions of the worm (iv) the dimensions of the worm wheel.	L5	CO6	12M
4.	A triple threaded worm has teeth of 6mm module and pitch circle diameter of 50mm. If the worm gear has 30 teeth of 14 ½ degrees and the coefficient of friction of the worm gearing is 0.05. Find 1.the lead angle of the worm 2. Velocity ratio 3. Centre distance, 4.efficiency of the worm gearing.	L5	CO6	12M
5.	A worm drive transmits 15kW at 2000 r.p.m to a machine carriage at 75 r.p.m. The worm is triple threaded and has 65 mm pitch diameter. The worm gear has 90 teeth of 6mm module. The tooth form is to be 20 degrees full depth involute. The coefficient of friction between the mating teeth may be taken as 0.10. Calculate : 1. Tangential force acting on the worm; 2. Axial thrust and separating force on worm and 3. Efficiency of the worm drive.	L6	CO6	12M
6.	(a) Enumerate the qualities of good cylinder liners.	L2	CO6	6M
	(b) What is the function of piston? Explain piston troubles.	L1	CO6	6M

7.	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^2; Mechanical efficiency = 80%. Determine: 1) Bore and length of the cylinder; 2)Thickness of the cylinder head & 3)Size of studs for cylinder head.	L5	CO6	12M
8.	Design a connecting rod for an IC engine running at 1800rpm and developing a maximum pressure of 3.15 N/mm2 the diameter of piston is 100mm, mass of the reciprocating parts per cylinder is 2.25kg, length of connecting rod is 380mm, stroke of piston is 190mm and compression ratio 6:1. Take a 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, corresponding bearing pressure as 10N/mm2 and 15 N/mm^2. The density of the material rod may be taken as 8000kg/m^3 and the allowable stress in the bolts as 60 N/mm2 and in cap as 80 N/mm^2. The rod is to be of I- section for which you can choose your own proportions. Draw a neat sketch. Use Rankin's formulae for which the numerator constant may be taken as 320 N/mm^2 & denominator constant as 1/7500.	L6	CO6	12M
9.	Design a cast iron piston for a single acting four stroke engine for the following data: Any other data required for the design may be assumed. Cylinder bore = 100mm Stroke = 125 mm, Maximum gas pressure = 5 N/mm^2, Indicated mean effective pressure = 0.75 N/mm, Mechanical efficiency = 80%,Fuel consumption = 0.15 kg per brake power per hour Higher calorific value of fuel = 42 × 103 kJ/kg Speed = 2000 rpm Tensile stress for cast iron (σt) = 38 MPa.	L6	CO6	12M
10.	Design a plain carbon steel centre crank shaft 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^2; Maximum combustion pressure = 2.5 N/mm^2; Weight of fly wheel used as a pulley = 50 kN; Total belt pull = 6.5 kN. When the crank has turned through 35 degrees from the top dead centre, the pressure on the piston is 1 N/mm^2 and 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.	L6	CO6	12M

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