

**III B. Tech I Semester Regular/Supplementary Examinations, October/November - 2019**  
**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) Define the term bearing life. Show its mathematical equation. [2M]
- b) What is a whipping action with reference to a connecting rod? [2M]
- c) Comment on the best suitable cross section for crane hook. [2M]
- d) Write the design criteria followed in the design of power screws. [3M]
- e) List out various wear considerations adopted in the design of gears. [3M]
- f) Draw the hanger wall boxes and identify different elements in it. [2M]

**PART –B****(56 Marks)**

2. A Journal bearing with a diameter of 200 mm and length 150 mm carries a load of 20 kN when the journal speed is 150 rpm. The diametric ratio is 0.0015. If possible the bearing is to operate at 35<sup>0</sup> ambient temperatures without external cooling with a maximum oil temperature of 90<sup>0</sup> C. If external cooling is required, it is to be little as possible to minimize the required oil flow rate and heat exchanger size. [14M]
  - i) What type of oil do you recommend?
  - ii) Will the bearing operate without external cooling?
  - iii) If the bearing operates without external cooling, determine the operating oil temperature.
  - iv) If the bearing operates with external cooling, determine the amount of oil in kg/min required to carry away the excess heat generated over heat dissipated, when the oil temperature rises from 85<sup>0</sup> C to 90<sup>0</sup> C, when passing through the bearing.
3. a) What are the cross-sections commonly employed for connecting rods? Why I-section is chosen for high-speed I.C engines? [7M]
- b) Determine the diameter of the connecting rod of 150 mm length, subjected to an axial compression load of 180 KN, taking to be freely hinged at the ends. Take the factor of safety to be 7.  $E = 2.15 \times 10^5 \text{ N/mm}^2$ . [7M]
4. The section of a crane hook is a rectangle 60 mm × 40 mm. The center of curvature of the section is at a distance of 80 mm from the centroid of the section. A load of 15 kN is acting through the center of curvature. Determine the maximum and minimum bending stresses induced in the hook. [14M]



5. a) List the type of threads used in power screws. Give practical example for each type of threads. State advantages and disadvantages of using different types of threads in "power screws". [8M]
- b) On what factors, the selection of a belt drive depends? Enumerate the advantages and disadvantages of a belt drive. [6M]
6. Two parallel shafts are connected by a pair of steel helical gears. The power transmitted is 15 kW at 4000 rpm of the pinion. The safe static strength for the material is 100 MPa. Gear ratio is 4:1 Stub teeth with  $20^\circ$  pressure angle in diameter plane have helix angle of  $45^\circ$ . Also calculate the necessary BHN with the standard point of wear. Check the design for dynamic load and suggest modification if necessary. Use 30 teeth on the pinion. [14M]
7. A hand lever for a brake is 0.8 m long from the centre of gravity of the spindle to the point of application of the pull of 300 N. The effective overhang from the nearest bearing is 100 mm. If the permissible stress in tension, shear and crushing is not to exceed 66 MPa, design the spindle, key and lever. Assume the arm of the lever to be rectangular having width twice of its thickness. [14M]

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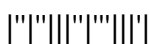
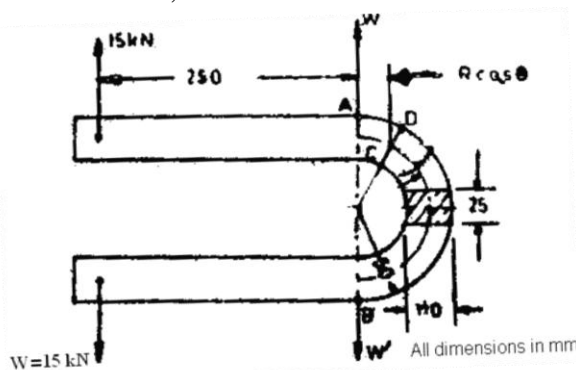
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**PART – A****(14 Marks)**

1. a) Write down the properties of good bearing materials. [2M]
- b) Enlist the principal functions of the cylinder liners. [2M]
- c) State the significance of neutral axis in curved beams. [2M]
- d) What are the different elements of a rope drive? [3M]
- e) Define the load concentration factor in gear drives design. [3M]
- f) How do you understand the various types and functions of levers? [2M]

**PART – B****(56 Marks)**

2. a) Distinguish the “Hydrodynamic” and “Hydrostatic Bearings” with figures and suitable applications. [7M]
- b) A bearing is required to carry 4500 N stationary radial load. The shaft rotates at 1000 rpm and the life desired is 30000 hrs. The running conditions are steady and no shock loading. Select a suitable bearing? [7M]
3. Design a C.I trunk-type piston for a single cylinder, four stroke cycle engine, developing 5 kW at 600 rpm. Diameter of piston is 120 mm and the maximum explosion pressure is 4.5 MPa. Heat supplied to the engine is 19000 kJ/kWh. About 6% of the heat is conducted through the piston crown. The heat conduction factor for C.I may be taken as 46 W/m<sup>0</sup>C. The temperature difference between the centre and edge of the crown may be taken as 250<sup>0</sup> C. [14M]
4. A load of 10 kN is applied to a steel curved beam as shown in the figure. [14M]  
 Compute the increase in distance between the points A and B due to the load.  
 Assume  $G = 0.84 \times 10^5 \text{ N/mm}^2$ ,  $E = 2.10 \times 10^5 \text{ N/mm}^2$ .



5. Design a roller chain drive for driving a compressor by 12 kW electric motor running at 1200 rpm. The compressor speed is around 350 rpm. The compressor operates for 16 hours per day. [14M]
6. a) Explain why helical gears are capable of transmitting greater power at high speed as compared to the spur gear? [6M]  
b) A pair of spur gears has pinion made of material with 80 MPa safe static bending stresses, gear made of material with safe static bending stresses of 55 MPa. The module and face width of the teeth are 5 mm and 60 mm respectively. The pinion Rotates at 60 rpm. The number of teeth on pinions and gear are 20 and 80 respectively. Find the capacity in kW of the gear drive. The error is limited to  $e = 16 + 1.25(m + 0.25\sqrt{d})$  microns. B.H.N of the pinion material is 250. [8M]
7. A workshop crane is lifting a load of 25 kN through a wire rope and a hook. 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  $1 \text{ m/s}^2$ . Calculate the diameter of the wire rope. Take a factor of safety of 6 and young's modulus for the wire rope  $80 \text{ kN/mm}^2$ . The ultimate stress may be taken as 1800 MPa. The cross - sectional area of the wire rope may be taken as 0.38 times the square of the wire rope diameter. [14M]

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**PART –A**

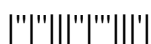
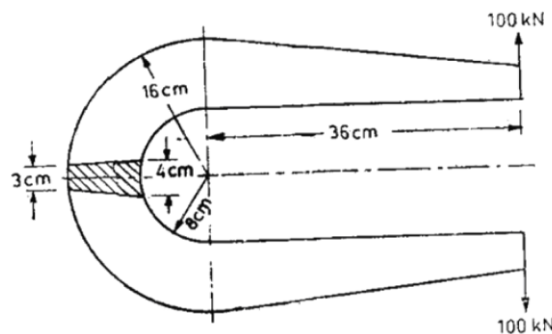
**(14 Marks)**

1. a) Lists the method of bearing lubrication. [2M]
- b) What are the forces acting on piston? [2M]
- c) Why trapezoidal geometry is most suitable for crane hook? [2M]
- d) List out the various materials available for belt manufacturing. [3M]
- e) Write the mathematical expression for dynamic load factor used in the design of gears. [3M]
- f) What is a bracket? Sketch at least two types of bracket systems. [2M]

**PART –B**

**(56 Marks)**

2. a) Distinguish between full and partial journal bearings. [4M]
- b) Design a journal bearing for a centrifugal pump running 1440 r.p.m. The diameter of the journal is 100 mm and load on each bearing is 20 KN. The factor  $ZN/P$  may be taken as 28 for centrifugal pump bearings. The bearing is running at  $75^{\circ}$  C temperature and the atmosphere temperature is  $30^{\circ}$  C. The energy dissipation coefficient is  $87.5W/m^2^{\circ}C$ . Take diametric clearance as 0.1 mm. [10M]
3. Design a plain carbon steel centre crankshaft for a single acting four stroke single cylinder engine for the following data: [14M]  
 Bore=400 mm, stroke=600 mm, engine speed=200 rpm  
 Mean effective pressure= $0.5 N/mm^2$   
 Maximum combustion pressure= $2.5 N/mm^2$ ,  
 Weight of flywheel used as a pulley=50 KN. Total Belt pull=6.5 KN.  
 When the crank has turned through  $35^{\circ}$  from the top dead centre the pressure on the piston is  $1 N/mm^2$  and the 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.
4. Determine the maximum stress in the frame of the 100kN punch press as shown in the figure. [14M]



5. A machine slide weighing 3000 N is elevated by a double start acme threaded screw at the rate of 840 mm/min. If the coefficient of friction be 0.12, calculate the power to drive the slide. The end of the screw is carried on a thrust collar of 32 mm inside diameter and 58 mm outside diameter. The pitch of the screw thread is 6 mm and outside diameter of the screw is 40 mm. If the screw is of steel, is it strong enough to sustain the load? Draw a neat sketch of the system. [14M]
6. A cast steel spur pinion ( $\sigma_d=200$  MPa) running at 450 rpm transmits 20 kW power to a cast iron gear ( $\sigma_d=80$  MPa) running at approximately 112 rpm. The load is steady. Design the drive and check for dynamic and wear loads. [14M]
7. a) Design a wire rope for a vertical mine hoist to lift a load of 50 kN, from a depth of 250 m. rope speed of 8 m./s is to be attained in 18 seconds. Take factor of safety as 6. Assuming suitable data if necessary. [7M]
- b) The effective length of hand lever is 1 meter. The effective overhang from the nearest bearing is 150 mm. The lever and shaft are made of alloy steel for which tensile yield strength is 460 N/mm<sup>2</sup>. If the maximum force exerted at the handle is 300 N, design the lever and the shaft with a safety with a safety factor of 4. [7M]

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**PART –A****(14 Marks)**

1. a) Define Bearing characteristic number. [2M]
- b) Write the mathematical equation for the thrust exerted by the connecting rod. [2M]
- c) Draw the bending stress distribution over a curved beam. [2M]
- d) Define the term belt slip. [3M]
- e) Distinguish the module and circular pitch in the gears. [3M]
- f) What is a rocker arm? List at least two areas of its application. [2M]

**PART –B****(56 Marks)**

2. a) Differentiate between hydrostatic and hydrodynamic bearing providing their neat sketch. [7M]
- b) An 80 mm long journal bearing supports a load of 2800 N on a 50 mm diameter shaft. The bearing has a radial clearance of 0.05 mm and the viscosity of the oil is 0.021 kg/m-s at the operating temperature. If the bearing is capable of dissipating 80 J/s, determine the maximum safe speed. [7M]
3. A connecting rod is required to be designed for a high speed four stroke I.C engine. [14M]  
 The following data are available:  
 Diameter of piston = 88 mm.  
 Mass of reciprocating parts = 1.6 kg.  
 Length of connecting rod(centre to centre)= 300 mm  
 Stroke=125 mm. R.P.M =2220 (when developing 50 KW)  
 Possible over speed = 3000 rpm;  
 Compression ratio = 6.8:1 (approximately);  
 Probable maximum explosion pressure (assumed shortly after dead centre say at about  $3^0$ ) = 3.5 N/mm<sup>2</sup>. Draw fully dimensioned drawings of the connecting rod showing the provision for the lubrication.
4. Design a crane hook for a 30 KN crane. The hook is to be of swiveling type and of [14M]  
 i) Triangular section, ii) Circular section.  
 Choose the suitable values for the stresses.
5. The lead screw of a lathe has 50 x 8 threads. 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 screw rotates at 30 rpm. [14M]  
 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.



6. A pair of cast steel annealed spur gears with cast teeth transmits 18.75 kW and 60 rev/min of the pinion. The pitch diameter of the pinion is approximately 0.23 m and the velocity ratio is 2.5. Determine the module and face of the gears; also the correct pitch diameters and tooth numbers. Check for dynamic and wear loads. [14M]
7. a) Name the type of stresses induced in the wire ropes. [4M]  
b) Design a foot lever, which is 1000 mm from the centre of shaft to the point of application of 800 N load. Find: Dimensions of rectangular arm of the foot lever at 60 mm from the centre of shaft assuming width of the arm as 3 times thickness. The allowable tensile stress may be taken as  $73 \text{ N/mm}^2$ . [10M]

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## III B. Tech I Semester Supplementary Examinations, October/November - 2020

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(Mechanical Engineering)

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 4. Design data book is permitted for the examination

**PART -A****(14 Marks)**

1. a) What is equivalent static load and equivalent dynamic load? [2M]
- b) What is a piston slap? How it can be controlled? [2M]
- c) What are the assumptions to be considered for the bending of the beams? [2M]
- d) What is the polygon action of chain drive? [3M]
- e) Why the selection of bearing is more important in helical gears? [3M]
- f) Describe the applications of rope sheaves. [2M]

**PART -B****(56 Marks)**

2. a) Derive the expression for finding the life of the bearing subjected to variable loading. [7M]
- b) A 3 kN load is supported by a journal bearing of 75 mm diameter and 75 mm length. Diametric clearance 0.05 mm and bearing is lubricated by the oil of 0.0207 paS viscosity at operating temperature. Determine the maximum speed of rotation of bearing when it is capable of dissipating 80 watts by heat transfer. [7M]
3. a) Explain the stresses developed in the connecting rod. What do you mean by whipping stress? [7M]
- b) Design an overhung crankshaft with two main bearings for an I.C engine with the following data: Cylinder bore=250 mm, Stroke length=300 mm, Flywheel weight=25 kN, Maximum pressure=2.5 N/mm<sup>2</sup>, Maximum torque at crank rotation 30°, the pressure at that instant = 1.7 N / mm<sup>2</sup>. [7M]
4. a) Derive the expression for the radius of the neutral axis for a trapezoidal section. [7M]
- b) A shaft is transmitting 97.5 kW at 180 rpm. If the allowable shear stress in the material is 60 MPa, Find the suitable diameter for the shaft. The shaft is not to twist more than 1 degree in a length of 3 meters. Assume C = 80 GPa. [7M]
5. a) Explain the design procedure of Power screw and screw jack and write the condition for self - locking screws. [7M]
- b) A roller chain is used to connect two shafts spaced 25 pitches apart to transmit 75 kW at 300 rpm of a 17 tooth driver sprocket to 34 tooth driven sprocket. The working period is 18 hours per day with abnormal service conditions. Specify the length and size of the chain. [7M]



6. a) Describe the interference phenomenon in involute gears. Also, state the conditions to avoid interference. [7M]
- b) A pair of parallel helical gear consists of an 18 teeth pinion meshing with a 45 teeth gear. The normal module is 3 mm. The helix angle is  $23^\circ$  while the normal pressure angle is  $20^\circ$ . Calculate: i) the transverse module, ii) transverse pressure angle and axial pitch. [7M]
7. a) Explain the design and construction procedure of Wire ropes. [7M]
- b) Design the lever of a lever loaded safety valve with the force  $P=5$  kN. Use forged steel for the lever with  $\sigma_t=90$  MPa and 30C8 for the pins with  $\sigma_t=80$  MPa,  $P_b=20$  MPa, and  $\tau=40$  MPa. [7M]

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## III B. Tech I Semester Regular/Supplementary Examinations, March – 2021

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(Mechanical Engineering)

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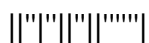
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**PART –A****(14 Marks)**

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 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. [7M]
- 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.



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 concept of eccentricity 'e' in a circular cross section. [7M]
5. a) An open belt of density  $970 \text{ kg/mm}^3$  has a cross section of  $300 \text{ mm} \times 10 \text{ mm}$ . The driving and smaller pulley has a diameter of  $315 \text{ mm}$ . The input power is  $30 \text{ kW}$  at  $970 \text{ rpm}$ . The angle of wrap on the larger pulley is  $205^\circ$ . The coefficient of friction between the belt and both pulleys is  $0.35$ . If the maximum allowable stress in the belt should not exceed  $3 \text{ MPa}$ , verify if the belt is safe in tension. [7M]
- b) Write a note on the various stresses occurring in a power screw and nut. Explain the need for a friction collar in the body of a power screw. [7M]
6. a) What are the advantages of helical gears over spur gears? Explain the concept of virtual number of teeth with the help of a sketch. [7M]
- b) A spur gear pair with a module of  $6 \text{ mm}$  has transmission ratio of  $4$ . The number of teeth on the pinion is  $16$  of  $20^\circ$  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  $105 \text{ MPa}$ , calculate the power that the gear pair can transmit based on the beam strength of the teeth. [7M]
7. a) A single steel wire rope of  $6 \times 37$  constructions lifts a load of  $20 \text{ kN}$ . The factor of 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? [7M]
- b) What is a bell crank lever? What are its applications? Explain with a sketch and a force analysis. [7M]

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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. [7M]  
 Explain how the coefficient of friction is obtained with the help of Sommerfeld number?
- 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]

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<sup>2</sup>. The surface hardness on the pinion is 350 BHN and on the gear it is 280 BHN. Calculate the following: [7M]  
(i) Beam strength of the gears (using the velocity factor)  
(ii) Wear strength of the gears.  
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 calculation. [2M]
- b) Make a simple line sketch to show how the wrist pin is assembled inside the piston of an IC engine. [2M]
- c) Explain why there will be a shift of the neutral axis from the centroidal axis in a curved beam subjected to bending. [2M]
- 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 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. [7M]
- b) A deep groove ball bearing of basic design no. SKF 6312 has a dynamic load 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. [7M]
3. a) Mention the criteria of design of an IC engine piston. Draw a line sketch of a piston and name the important parts. [7M]
- b) For an IC engine the following data are available: Length of connecting 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. [7M]

4. a) Draw neat sketches showing the bending stress distribution across the cross sections of (i) a straight beam of rectangular cross section, and (ii) a curved beam of circular cross section. [7M]
- b) Give examples of practical applications of curved beams. Supply line sketches for illustration. [7M]
5. a) For a V-belt drive the following details are given: Driving motor power = 15 hp; 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. [7M]
- b) The lead screw of a lathe machine with single-start trapezoidal threads of 60 mm 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. [7M]
6. a) In a spur gear transmission, the pinion and the gear have 19 and 46 teeth respectively. The gears have  $20^{\circ}$  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. [7M]
- b) A helical gear set of normal module 6 mm has 18 teeth on the pinion and 43 teeth on the gear. The normal pressure angle and the helix angle are given as  $20^{\circ}$  and  $25^{\circ}$  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. [7M]
7. a) Draw a neat sketch to show the application of a bell crank lever. Show how the force analysis is done. [7M]
- b) Discuss the various stresses occurring a steel wire rope wound on hoisting drum of a crane in the process of lifting a load. [7M]

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**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**

**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 bearing design? When is artificial cooling required for sliding bearing? [7M]
- b) A ball bearing is mounted on a shaft rotating at 500 rpm. The radial load on the 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. [7M]
3. a) Discuss the design procedure for determining the sizes of the small and the big end bearings in a connecting rod. [7M]
- b) An IC engine piston is made of cast iron for a cylinder with a bore of 100 mm 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. [7M]
4. a) What is normal cross section used in crane hooks? Draw a line sketch to show 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. [7M]
- b) Draw the sketch of an L-shaped wall bracket using bent rods; mark the forces 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. [7M]



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  $2.5 \text{ N/mm}^2$  and the belt weighs  $970 \text{ kg/m}^3$ . 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= $20^\circ$ ; 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 levers 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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**III B. Tech I Semester Supplementary Examinations, August - 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**

Data Book allowed

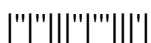
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**PART -A****(14 Marks)**

1. a) Differentiate between radial life and average life of the roller bearing. [2M]
- b) Describe the type and nature of stress in crankshaft during operation. [2M]
- c) Discuss the concept of bending stresses and write its equation. [2M]
- d) Why are ISO metric threads rarely used for the power screw while they are invariably used for fasteners? [3M]
- e) Define the formative number of teeth in case of helical gears. [3M]
- f) What are the advantages of Regular lay ropes? [2M]

**PART -B****(56 Marks)**

2. a) Explain the steps involved in selection of bearing from manufacturer's catalogue. [7M]
- b) A bearing is subjected to the radial load of 2500 N at 500 rpm for one half of the time and 700 N at 3600 rpm for the remaining time. The inner ring rotates and the load is steady. Find the rating life at 6 hrs per day. [7M]
3. a) Explain the working of a floating gudgeon pin. Why the diameter of the piston pin always smaller than the crank pin in the same engine? [7M]
- b) Design a connecting rod for a petrol engine from the following data: [7M]  
Diameter of the piston= 120 mm, Weight of the reciprocating part = 2.0 kg, Length of the connecting rod = 300mm, Stroke length = 140 mm, Speed = 2000 r.p.m, Maximum explosion pressure = 2.25 N/mm<sup>2</sup>.
4. a) Derive the equations of H section in terms of moment of inertia, section modulus and radius of gyration. [7M]
- b) A hollow shaft is required to transmit 600 kW at 110 rpm, the maximum torque being 20% greater than the mean. The shear stress is not to exceed 63 MPa and twist in a length of 3 meters not to exceed 1.4 degrees. Find the external diameter of the shaft, if the internal diameter to the external diameter is 3/8. Assume modulus of rigidity as 84 GPa. [7M]



5. a) Explain the different forms of screw threads with neat sketches. [7M]  
b) A V- belt drive is used to transmit 35 kW at 760 rpm of the driver pulley of 350 mm effective diameter. The driven pulley diameter is 1400 mm and the centre distance is 2 m, groove angle is  $40^\circ$ , mass of the belt is 0.45 kg/m and  $\mu = 0.27$ . The B type belt with a cross section area of  $140 \text{ mm}^2$  is used. The permissible tensile stress is 5.7 MPa . Find the number of belt required and the length of the belt. [7M]
6. a) Explain how and why the Lewis equation is modified in case of helical teeth? [7M]  
b) It is required to design a pair of spur gears with  $20^\circ$  full depth involute teeth based on the Lewis equation. The velocity factor is to be used to account for dynamic load. The pinion shaft is connected to a 10 kW, 1440 rpm motor. The starting torque of the motor is 150% of the rated torque. The speed reduction is 4:1. The pinions as well as gear is made of plain carbon steel 40C8 ( $S_{ut} = 600 \text{ N/mm}^2$ ) safe. The factor of safety can be taken as 1.5. Design the gears and specify the dimensions and suggest suitable surface hardness for the gears. [7M]
7. a) Describe the applications of rope sheaves and drums. [7M]  
b) Design a suitable wire rope for a bucket to lift water from a well which is 50 m deep. The weight of bucket is 1 kN. The water is to be drawn with a maximum speed of 100 m/min which is to be attained in 1.5 sec. Also take into consideration the initial slack of 100 mm. [7M]

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