Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE- SEMESTER–IV (NEW) EXAMINATION – WINTER 2020

Subject Code:3141907 Date:15/02/2021

Subject Name:Fundamentals of Machine Design

Time:02:30 PM TO 04:30 PM Total Marks:56

Instructions:

1. **Attempt any FOUR questions out of EIGHT questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the following terms: **03**
(i) Hooke's law (ii) Poisson's ratio (iii) Preferred series.

(b) Define: (i) Bulk modulus (ii) Modulus of rigidity. Derive the relation between bulk modulus and modulus of rigidity with usual notations. **04**

(c) Explain the manufacturing considerations in design of machine component. **07**

Q.2 **(a)** Explain the parallel and perpendicular axes theorem for finding moment of inertia of planer cross-sections. **03**

(b) An unknown weight falls through 10 mm on a collar rigidly attached to the lower end of a vertical bar 3 m long and 600 mm^2 in section. If the maximum instantaneous extension is known to be 2 mm, what is the corresponding stress and the value of unknown weight? Take E = 200 kN/mm^2. **04**

(c) A wall bracket with a rectangular cross-section is shown in Fig. 1. The depth of the cross-section is twice of the width. The force P acting on the bracket at 60^0 to the vertical is 5 kN. The material of the bracket is grey cast iron FG 200 and the factor of safety is 3.5. Determine the dimensions of the cross-section of the bracket. Assume maximum normal stress theory of failure. All dimensions shown in figure are in millimetre. **07**

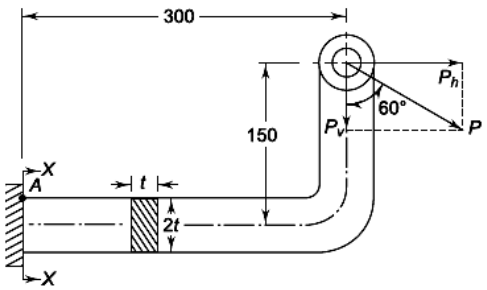


Fig. 1

Q.3 **(a)** Classify the principal static theories of failures. Explain the distortion energy (von Mises) theory with its necessary equation. **03**

(b) Define: (i) Principal stress (ii) Factor of safety (iii) Contact stress (iv) Bearing stress. **04**

(c) The load on a bolt consists of an axial pull of 10 kN together with a transverse shear force of 5 kN. Find the diameter of bolt required according to 1. Maximum principal stress theory; 2. Maximum shear stress theory. **07**

Q.4 **(a)** Differentiate between cotter and knuckle joint. Why one side of cotter is made tapered? **03**

(b) Discuss in detail the design procedure of a Bell cranked lever with its necessary diagram. **04**

(c) The big end of a connecting rod is subjected to a maximum load of 50 kN. The diameter of the circular part of the rod adjacent to the strap end is 75 mm. Design the **07**

gib and cotter joint, assuming permissible tensile stress for the material of the strap as 25 Mpa and permissible shear stress for the material of cotter and gib as 20 MPa.

Q.5 **(a)** Define: (i) Leverage (ii) Slenderness ratio (iii) Crushing stress. **03**

(b) Explain the different types of end conditions of column. Write the relations between equivalent length and actual length of a column for various end conditions. **04**

(c) A steel plate subjected to a force of 5 kN and fixed to a channel by means of three identical bolts is shown in Fig. 2. The bolts are made from plain carbon steel 45C8 (S_{yt} = 380 N/mm^2) and the factor of safety is 3. Specify the size of bolts. All dimensions shown in figures are in mm. **07**

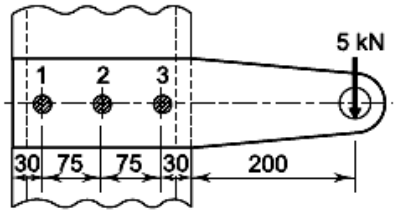


Fig. 2

Q.6 **(a)** Classify the basic types of screw fastening. Differentiate between bolt and screw. **03**

(b) Define: Self-locking screw. Derive the equation for finding efficiency of self-locking square threaded screw. **04**

(c) A vertical two start square threaded screw of a 100 mm mean diameter and 20 mm pitch supports a vertical load of 18 kN. The axial thrust on the screw is taken by a collar bearing of 250 mm outside diameter and 100 mm inside diameter. Find the force required at the end of a lever which is 400 mm long in order to lift and lower the load. The coefficient of friction for the vertical screw and nut is 0.15 and that for collar bearing is 0.20. **07**

Q.7 **(a)** Discuss the different terminology for power screw. **03**

(b) List the different theories of fatigue failure. Explain the Modified Goodman criteria of fatigue failure with diagram. **04**

(c) A 45 mm diameter shaft is made of steel with a yield strength of 400 MPa. A parallel key of size 14 mm wide and 9 mm thick made of steel with a yield strength of 340 Mpa is to be used. Find the required length of key, if the shaft is loaded to transmit the maximum permissible torque. Use maximum shear stress theory and assume a factor of safety of 2. **07**

Q.8 **(a)** Discuss the procedure for fatigue design under combined stresses. **03**

(b) Define: Cumulative fatigue damage. Derive the equation for finding cumulative damage in fatigue failure. **04**

(c) A machine component is subjected to a flexural stress which fluctuates between + 300 MN/m^2 and – 150 MN/m^2. Determine the value of minimum ultimate strength according to 1. Gerber relation; 2. Modified Goodman relation; and 3. Soderberg relation. Take yield strength = 0.55 Ultimate strength; Endurance strength = 0.5 Ultimate strength; and factor of safety = 2. **07**

****

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – WINTER 2021

Subject Code:3141907 Date:03/01/2022

Subject Name:Fundamentals of Machine Design

Time:10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

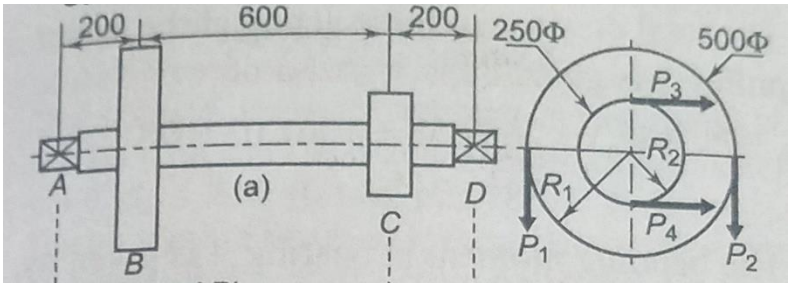
Q.1	**(a)**	Explain the Hooke's law with a neat sketch for ductile materials.	**03**
	(b)	Derive the equation for simple bending. Also state the assumptions in this derivation.	**04**
	(c)	Define and explain the following: a) Modulus of elasticity b) Modulus of rigidity c) Lateral Strain d) Thermal Strain e) Poisson's ratio	**07**
Q.2	**(a)**	Discuss the different types of supports / end conditions related to beams with neat sketches.	**03**
	(b)	Explain the Euler's Formula and Rankin's Formula used for columns design.	**04**
	(c)	Explain the following: 1. Aesthetic and Ergonomic considerations in Design 2. Materials Selection in Machine Design	**07**
		OR	
	(c)	Explain the following: 1. Manufacturing considerations in design 2. Standardization in design	**07**
Q.3	**(a)**	Write a detailed note on: Contact stresses and its examples	**03**
	(b)	Define the factor of safety. State and explain the factors affecting its selection.	**04**
	(c)	Design a knuckle joint to transmit 70 kN. The design stresses may be taken as 70 MPa in tension, compression and crushing for rod. The design stresses may be taken as 120 MPa in tension, 66 MPa in shear and 120 MPa in crushing in shear for pin.	**07**
		OR	
Q.3	**(a)**	Explain the use of bush and boss in lever design with neat sketches.	**03**
	(b)	State and explain the different theories of failures and its importance. Explain Distortion energy (von Mises) theory.	**04**
	(c)	A bell crank lever is to be designed to lift the load of 75 kN acting at the end of short arm of the lever. The length of short arm and long arm is 100 mm and 500	**07**

mm respectively. Allowable shear stress and tensile stress for lever and pin materials is 60 N/mm^2 and 60 N/mm^2 respectively. Allowable bearing pressure for pin material is 10 N/mm^2. For pin L/D=1. 5 and for the rectangular cross section of the lever, ratio of height to width is 4. Assume that the arm of bending moment on the lever extends up to the axis of the fulcrum. Determine: (1) dimension of the fulcrum pin (2) dimensions of lever.

Q.4 **(a)** Explain the design of shaft based on rigidity and stiffness. **03**

(b) State the different types of keys and explain the design of key – rectangular cross section with neat sketches stating equations. **04**

(c) The layout of transmission shaft is shown in fig below carrying two pulleys B and C and supported on two bearings A and D. Power is supplied to the shaft by means of a vertical belt on pulley B ,which is then transmitted to pulley C carrying horizontal belt. The maximum tension in belt on pulley B is 2.5 kN. The angle of warp on both the pulleys is 180^0 and coefficient of friction 0.24. The shaft is made of plain carbon steel 30C8 having σ_{yt} = 400MPa and factor of safety is 3.find the shaft diameter on strength basis. **07**



OR

Q.4 **(a)** State the advantages and disadvantages of hollow shaft over solid shaft. **03**

(b) Explain the design of splines with neat sketch. **04**

(c) Explain the terms: Moment of inertia and Polar moment of inertia. **02**

Explain the design of eccentric loaded bolted joints. **05**

Q.5 **(a)** Explain the Soderberg and Goodman diagram with neat sketches. **03**

(b) State the different types of screw threads used in power screw and explain any three of them. **04**

(c) A solid circular shaft 15 mm in diameter is subjected to torsional shear stress which varies from 0 to 35 N/mm^2 and at the same time subjected to an axial stress that varies from - 15 to + 30 N/mm^2.The frequencies of variation of these stresses are equal to the shaft speed. The shaft is made of steel FeE 400 having Ultimate tensile stress 540 N/mm^2 and yield stress 400 N/mm^2. The corrected endurance limit of the shaft is 200 N/mm^2. Determine the factor of safety. **07**

OR

Q.5 **(a)** What is self-locking of power screw? Explain the condition for self-locking. **03**

(b) What do you mean by stress concentration? State the reasons for stress concentration and explain any two of the methods used for reducing it. **04**

(c) A double threaded power screw is to lift a load of 5 kN. The nominal diameter is 60 mm and the pitch is 9 mm. The threads are Acme type ($2\Theta = 29^0$) and the coefficient of friction at the screw thread is 0.15.Neglecting the collar friction, calculate **07**

1. Torque required to raise the load
2. Torque required to lower the load
3. Efficiency of the screw for lifting the load

****

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER– IV EXAMINATION – SUMMER 2020

Subject Code: 3141907 Date:28/10/2020

Subject Name: Fundamentals of Machine Design

Time: 10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**

Q.1 **(a)** Explain the following terms: **03**
(i) Center of gravity (ii) Polar Moment of inertia (iii) Standardization.

(b) Explain the basic procedure for design of machine elements. **04**

(c) A manufacturer is interested in starting a business with five different models of tractors ranging from 7.5 to 75 kW capacities. Specify power capacities of the models. There is an expansion plan to further increase the number of models from five to nine to fulfill the requirement of farmers. Specify the power capacities of the additional models. **07**

Q.2 **(a)** Determine the moment of inertia for rectangular cross-section about X-axis and Y-axis passing from their CG. **03**

(b) Define: (i) Poisson's ratio (ii) Bulk modulus (iii) Hooke's law (iv) Volumetric strain. **04**

(c) An I - section girder, 200 mm wide by 300 mm depth flange and web of thickness is 20 mm is used as simply supported beam for a span of 7 m. The girder carries a distributed load of 5 KN /m and a concentrated load of 20 KN at mid-span. Refer figure 1. Determine the following: **07**
(i) Moment of inertia for the cross-section of the girder
(ii) The maximum bending stress

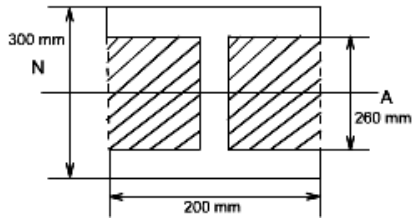


Figure 1

OR

(c) A composite bar made of aluminium and steel is held between the supports as shown in figure 2. The bars are stress free at a temperature of 37°C. What will be the stress in the two bars when the temperature is 20°C, if (a) the supports are unyielding; and (b) the supports yield and come nearer to each other by 0.10 mm? **07**

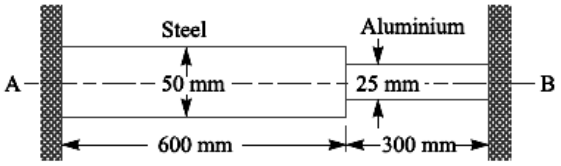


Figure 2

Q.3 **(a)** Why taper is provided on cotter? What is its normal value? State its applications. **03**

(b) List the different theories of static failures. Explain maximum shear stress theory in detail with its region of safety. **04**

(c) Design a knuckle joint to transmit load of 150 kN. The design stresses may be taken as 75 MPa in tension, 60 MPa in shear and 150 MPa in compression. **07**

OR

Q.3 **(a)** Define: (i) Preferred number (ii) Contact stress (iii) Principal stress. **03**

(b) Discuss the design procedure of a rocker arm for operating the exhaust valve. **04**

(c) A mild steel bracket as shown in figure 3, is subjected to a pull of 6000 N acting at 45° to its horizontal axis. The bracket has a rectangular section whose depth is twice the thickness. Find the cross-sectional dimensions of the bracket if the permissible stress in the material of the bracket is limited to 60 MPa. **07**

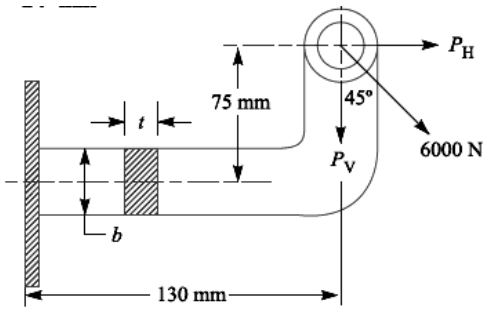


Figure 3

Q.4 **(a)** What do you mean by factor of safety? List the factors affecting for selection of factor of safety. **03**

(b) Describe the aesthetic and ergonomic considerations in design of machine component. **04**

(c) 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 MPa and in shear 120 MPa. The material for nut is phosphor-bronze for which the elastic limit may be taken as 100 MPa in tension, 90 MPa in compression and 80 MPa in shear. The bearing pressure between the nut and the screw is not to exceed 18 N/mm^2. Consider factor of safety equal to 2 and coefficient of friction between screw and nut (μ)= 0.14. Design the screw and nut only. Refer the table shown as below for standard dimensions of screw. **07**

Nominal diameter (d_o), mm	Core diameter (d_c), mm	Pitch (p), mm
40	33	7
42	35	
44	37	
46	38	8

OR

Q.4 **(a)** Define 'slenderness ratio'. State the assumptions used in Euler's column theory. **03**

(b) An I-section 400 mm × 200 mm × 10 mm and 6 m long is used as a strut with both ends fixed. Find Euler's crippling load. Take Young's modulus for the material of the section as 200 kN/mm^2. **04**

(c) Derive an equation for finding torque required to raise the load by square threaded screws with usual notations. **07**

Q.5 **(a)** Discuss the various types of power threads with their relative advantages and disadvantages. **03**

(b) Compare the weight and strength of a hollow shaft of the same external diameter as that of solid shaft. The inside diameter of the hollow shaft being half the external diameter. Both the shafts have the same material and length. **04**

(c) Design a shaft to transmit power from an electric motor to a lathe head stock through a pulley by means of a belt drive. The pulley weighs 200 N and is located at 300 mm from the centre of the bearing. The diameter of the pulley is 200 mm and the maximum power transmitted is 1 kW at 120 r.p.m. The angle of lap of the belt is 180° and coefficient of friction between the belt and the pulley is 0.3. The shock and fatigue factors for bending and twisting are 1.5 and 2 respectively. The allowable shear stress in the shaft may be taken as 35 MPa. Refer figure 4. **07**

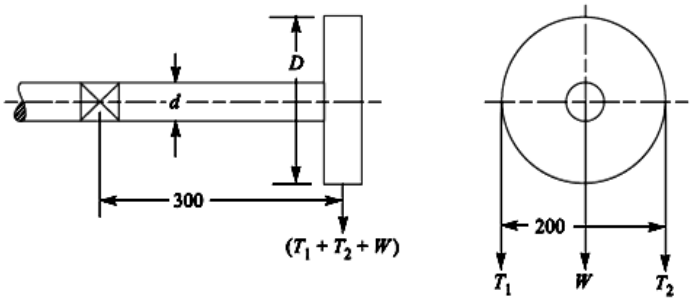


Figure 4

OR

Q.5 **(a)** Explain the following terms: **03**
(i) Cumulative damage in fatigue (ii) Fatigue failure (iii) Stress concentration.

(b) What is endurance limit? Discuss the different factors affecting endurance limit. **04**

(c) A simply supported beam has a concentrated load at the centre which fluctuates from a value of P to 4P. The span of the beam is 500 mm and its cross-section is circular with a diameter of 60 mm. Taking for the beam material an ultimate stress of 700 MPa, a yield stress of 500 MPa, endurance limit of 330 MPa for reversed bending, and a factor of safety of 1.3, calculate the maximum value of P. Take a size factor of 0.85 and a surface finish factor of 0.9. **07**

****

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – SUMMER 2021

Subject Code:3141907 Date:06/09/2021

Subject Name:Fundamentals of Machine Design

Time:02:30 PM TO 05:00 PM Total Marks:70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	Define strain and explain different types of strain	**03**
	(b)	List the different types of stresses considered in machine design. And explain tensile and shear stress.	**04**
	(c)	Give the different theories of failures and explain maximum principal stress theory in detail with its region of safety.	**07**
Q.2	**(a)**	Explain limits, fits and tolerance.	**03**
	(b)	Explain the parallel axis theorems for moment of inertia.	**04**
	(c)	Write a short note on Knuckle joint with its design procedure.	**07**
		OR	
	(c)	An offset link subjected to a force of 25 KN is shown in fig.1. It is made of grey cast iron FG300 (Sut=300 M Pa) and FOS is 3. Determine the dimensions of cross-section of the link.	**07**

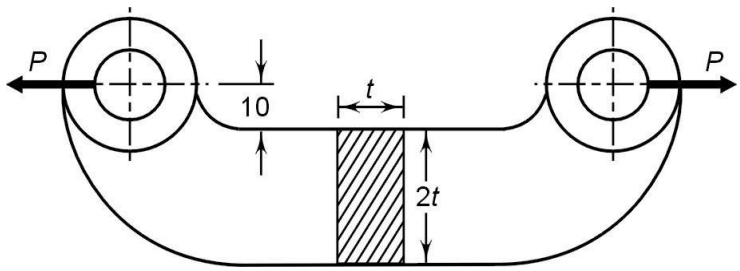


Fig.1

Q.3	**(a)**	How the hollow shafts are beneficial over the solid shaft?	**03**
	(b)	List the different types of shafts and write the material properties required for a shaft.	**04**
	(c)	What is modulus of elasticity, modulus of rigidity, Poisson's ratio. Give relation between them.	**07**
		OR	
Q.3	**(a)**	Explain Aesthetic look and Ergonomics consideration in machine design.	**03**
	(b)	Write a difference between shaft, spindle and axle.	**04**
	(c)	Design a shaft to transmit power from an electric motor to a lathe head stock through a pulley by means of a belt drive. The pulley weighs 200 N and is located at 300 mm from the centre of the bearing. The diameter of the pulley is 200 mm and the maximum power transmitted is 1 kW at 120 r.p.m. The angle of lap of the belt is 180° and coefficient of friction between the belt and the pulley is 0.3. The shock and fatigue factors for bending and twisting are 1.5 and 2.0 respectively. The allowable shear stress in the shaft may be taken as 35 MPa.	**07**

Q.4	**(a)**	Discuss torsion in solid shaft and hollow shaft.	**03**
	(b)	A hollow circular column is having external diameter 85 mm and internal diameter 65 mm. The effective length of column is 3m.Calculate slenderness ratio of column.	**04**
	(c)	Explain in detail Rankine's formula for the column.	**07**

OR

Q.4	**(a)**	Derive the equation of efficiency of square threaded screws.	**03**
	(b)	What is a key ? Discuss the different types of keys.	**04**
	(c)	Give the detail design procedure of Screw Jack .	**07**
Q.5	**(a)**	Explain different types of welded joints with neat sketches.	**03**
	(b)	What are the advantages and disadvantages of threaded joints.	**04**
	(c)	A power screw having double start square threads of 25 mm nominal diameter and 5 mm pitch is acted upon by an axial load of 10 KN. The outer and inner diameters of screw collar are 50 mm 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 r.p.m. Assuming uniform wear condition at the collar and allowable thread bearing pressure of 5.8 N/mm2, find: 1. the torque required to rotate the screw; 2. the stress in the screw; and 3. the number of threads of nut in engagement with screw.	**07**

OR

Q.5	**(a)**	What is overhauling and self locking of screws?	**03**
	(b)	What is stress concentration? Discuss the methods to reduce stress concentration	**04**
	(c)	Derive the equation for torque required to lower the load by square threaded screw.	**07**

****

Seat No.: _____ Enrolment No._____

GUJARAT TECHNOLOGICAL UNIVERSITY

BE - SEMESTER–IV (NEW) EXAMINATION – SUMMER 2022

Subject Code:3141907 Date:29-06-2022

Subject Name:Fundamentals of Machine Design

Time:10:30 AM TO 01:00 PM Total Marks: 70

Instructions:

1. **Attempt all questions.**
2. **Make suitable assumptions wherever necessary.**
3. **Figures to the right indicate full marks.**
4. **Simple and non-programmable scientific calculators are allowed.**

Q.1	**(a)**	List the different types of stresses considered in machine design. And explain tensile and shear stress	**03**
	(b)	Derive the equation for simple bending. Also state the assumptions in this derivation.	**04**
	(c)	Explain the manufacturing considerations in design of machine component	**07**
Q.2	**(a)**	Discuss the different types of supports / end conditions related to beams with neat sketches.	**03**
	(b)	Derive the relation between bulk modulus and modulus of rigidity with usual notations.	**04**
	(c)	Design a knuckle joint to transmit 70 kN. The design stresses may be taken as 70 MPa in tension, compression and crushing for rod. The design stresses may be taken as 120 MPa in tension, 66 MPa in shear and 120 MPa in crushing in shear for pin.	**07**
		OR	
	(c)	Write a short note on socket and spigot type cotter joint with its design procedure.	**07**
Q.3	**(a)**	Write a detailed note on: Contact stresses and its examples	**03**
	(b)	Define the factor of safety. State and explain the factors affecting its selection.	**04**
	(c)	Explain various aspects of materials selection in Machine Design	**07**
		OR	
Q.3	**(a)**	Write a difference between shaft, spindle and axle.	**03**
	(b)	State the different types of keys and explain the design of key – rectangular cross section with neat sketches stating equations.	**04**
	(c)	Design a shaft to transmit power from an electric motor to a lathe head stock through a pulley by means of a belt drive. The pulley weighs 200 N and is located at 300 mm from the centre of the bearing. The diameter of the pulley is 200 mm and the maximum power transmitted is 1 kW at 120 r.p.m. The angleof lap of the belt is 180° and coefficient of friction between the belt and the pulley is 0.3. The shock and fatigue factors for bending and twisting are 1.5 and 2.0 respectively. The allowable shear stress in the shaft may be taken as 35 MPa.	**07**
Q.4	**(a)**	Explain different types of welded joints with neat sketches.	**03**
	(b)	Explain types of fits	**04**

(c) A bell crank lever is to be designed to lift the load of 75 kN acting at the end of short arm of the lever. The length of short arm and long arm is 100 mm and 500 mm respectively. Allowable shear stress and tensile stress for lever and pin materials is 60 N/mm^2 and 60 N/mm^2 respectively. Allowable bearing pressure for pin material is 10 N/mm^2. For pin L/D=1. 5 and for the rectangular cross section of the lever, ratio of height to width is 4. Assume that the arm of bending moment on the lever extends up to the axis of the fulcrum. Determine: (1) dimension of the fulcrum pin (2) dimensions of lever. **07**

OR

Q.4 **(a)** Explain the different types of end conditions of column. **03**

(b) Explain the terms: Moment of inertia and Polar moment of inertia. **04**

(c) A hollow circular column is having external diameter 85 mm and internal diameter 65 mm. The effective length of column is 3m.Calculate slenderness ratio of column. **07**

Q.5 **(a)** Explain the Soderberg and Goodman diagram with neat sketches. **03**

(b) State the different types of screw threads used in power screw and explain any three of them. **04**

(c) Give the detail design procedure of Screw Jack. **07**

OR

Q.5 **(a)** What is self-locking of power screw? Explain the condition for self-locking. **03**

(b) What do you mean by stress concentration? State the reasons for stress concentration and explain any two of the methods used for reducing it. **04**

(c) A power screw having double start square threads of 25 mm nominal diameter and 5 mm pitch is acted upon by an axial load of 10 KN. The outer and inner diameters of screw collar are 50 mm 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 r.p.m. Assuming uniform wear condition at the collar and allowable thread bearing pressure of 5.8 N/mm2, find: 1. the torque required to rotate the screw; 2. the stress in the screw; and 3. the number of threads of nut inengagement with screw. **07**

****