Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION, DECEMBER 2018

Course Code: ME401

Course Name: DESIGN OF MACHINE ELEMENTS - I

Max. Marks: 100 Duration: 3 Hours

Use of approved design data book is permitted

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Distinguish between standards and codes (2)

b) Explain notch sensitivity factor, q. What is the relationship between fatigue stress concentration factor and q. (2)

c) Explain the procedure to determine the endurance limit of a material. Also plot the SN curve for steel and aluminium. (5)

d) Draw the stress- strain behaviour of the following materials (6)

i) Ductile ii) brittle and iii) perfectly elastic-plastic

2 a) Explain maximum principal stress theory and max shear stress theory of failure. (2)

b) The stresses acting at a critical point in a component are σ_{xx}=60MPa, σ_{xy}=30MPa, σ_{xz}=20MPa, σ_{yy}=40MPa, σ_{zz}=25MPa and σ_{yz}=20MPa. The component is made of steel having the following material properties. Ultimate strength in tension, σ_u=600MPa, yield strength in tension, σ_y= 400 MPa, yield strength in shear ,τ_y= 200 MPa and poisson's ratio,μ =0.3. Determine the factor of safety using all the five static failure theories. (13)

3 a) What is fatigue stress concentration factor? (2)

b) A smooth cantilever beam of circular cross section made of hot rolled steelis subjected to an axial load which varies from 7 k N in tension to 5 k N in compression. It is also subjected to a transverse load at the free end which varies from +8 k N to – 6 k N.The length of the cantilever is 400 mm. The material properties are σ_u=500 MPa, σ_y= 300 MPa. Factor of safety may be taken as 2. Find the diameter of the beam for a reliability of 90 %. (13)

PART B

Answer any two full questions, each carries 15 marks.

4 a) What are the failure modes of a riveted joint? (2)

b) Explain thread loosening. What are the factors influencing thread loosening? (3)

c) Distinguish between self-locking and overhauling. (2)

d) The lead screw of a lathe has 50 x 8 threads .The screw must exert an axial force of 4 k N in order to drive the tool carriage. The thrust is carried on a collar 120 mm outside diameter and 60 mm inside diameter. The screw rotates at 40 r.p.m. The coefficient of friction for the screw and collar is 0.15 and 0.12 respectively. Determine the power required to drive the screw and the efficiency of the lead screw. (8)

5 a) What is initial tension in a bolted joint? Why is it necessary? (2)

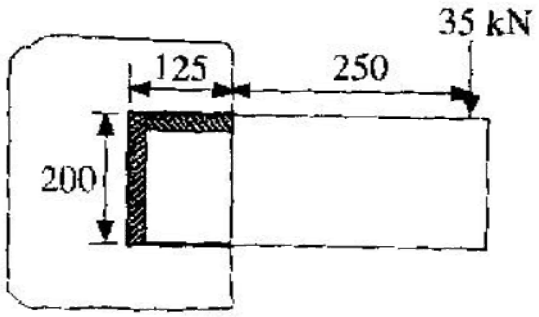
b) What is the role of washer in a bolted joint? (2)

c) A cylinder head is held on the cylinder by 8 numbers of bolts. The inner diameter of the cylinder is 350 mm. The pressure inside the cylinder varies from zero to a maximum pressure of 2.5 M Pa. The ultimate tensile stress and yield stress are 630 M Pa and 380M Pa respectively. The bolts are tightened with initial preload of 1.5 times the steam load. A copper asbestos gasket is used to make the joint leak proof. Take factor of safety is 2.5. Neglect stress concentration factor. Find the size of the bolt. (11)

6 a) What are the demerits of welded joints? (2)

b) What is weld reinforcement? Why is it done? (2)

c) An eccentrically loaded weld joint is shown in figure. Find the size of the weld if the allowable shear strength is 80 MPa. All the lengths given in the figure are in mm. (11)



PART C

Answer any two full questions, each carries 20 marks.

7 a) What are the requirements of spring material? (2)

b) What is nipping in leaf springs? Explain its purpose (3)

c) Design a truck spring that has 12 numbers of leaves, two of which are full length leaves. The spring supports are 1 meter apart and the central band is 70 mm wide. The central load is to be 6 kN with a permissible stress of 200 MPa. Determine the thickness, width, leaf lengths and deflection of the spring leaves if the ratio of total depth to width of the spring is 3. (15)

8 a) Compare the strength and stiffness of a hollow shaft of same outside diameter as that of a solid shaft. (5)

b) A shaft is supported by two bearings 1 m apart. A 600 mm diameter pulley is mounted at a distance of 300 mm to the right of left hand bearing and this drives a pulley directly below it with the help of a belt having maximum tension of 2.25 kN. Another pulley 400 mm diameter is placed 200 mm to the left of right hand bearing and is driven with the help of electric motor and belt, which is placed horizontally to the right. The angle of contact for both the pulley is 180^0 and μ=0.24. Determine the suitable diameter for a solid shaft .The allowable working stress is 63 MPa in tension and 42 MPa in shear for the material of the shaft. Assume that the torque on one pulley is equal to that on the other pulley. (15)

9 a) Prove that a square key is equally strong in crushing and shearing. (5)

b) Design a bushed-pin type flexible coupling to connect a pump shaft to a motor shaft transmitting 32 kW at 960 rpm. The overall torque is 20% more than mean torque. Material properties are as follows: (15)

1. The allowable shear and crushing stress for shaft and key material is 40 MPa and 80 MPa respectively.
2. The allowable shear stress for cast iron is 15 MPa.
3. The allowable bearing pressure for rubber bush is 0.8 MPa.

The material of the pin is same as that of shaft and key

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(S), MAY 2019

Course Code: ME401

Course Name: DESIGN OF MACHINE ELEMENTS – I

Max. Marks: 100 Duration: 3 Hours

Use of approved design data book is permitted

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain the steps involved in the design process. (2)

b) What is factor of safety? What are the factors affecting factor of safety? (4)

c) What are the endurance strength modification factors? (3)

d) Explain the effect of stress concentration on ductile and brittle materials under static and variable loading. (6)

2 a) Explain impact factor. (2)

b) A 50 mm diameter steel shaft with a 20 mm transverse hole is simultaneously subjected to a bending stress which varies from + 100 MPa to – 70 MPa. and a torsional stress which varies from + 80 MPa to -50 MPa. Find the factor of safety for infinite life assuming the following properties. Ultimate strength in tension 800MPa, Yield strength 550MPa. Surface correction factor = 0.85, size factor =0.85 and Notch sensitivity factor = 0.9. Use maximum distortion energy theory. (13)

3 a) How will you design a component made of steel subjected to variable load for a finite life? (4)

b) A carbon steel rod of circular cross section is subjected to a bending moment which varies from 300 Nm to 500 Nm and an axial load which varies from 6 kN to 9 kN .Determine the diameter of the rod for a factor of safety of 3.Take σ_u= 600 MPa, σ_y=400 MPa (11)

PART B

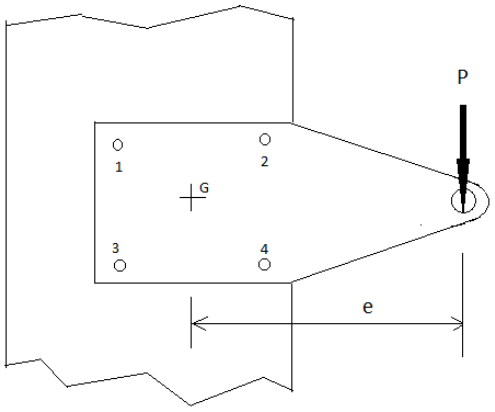
Answer any two full questions, each carries 15 marks.

4 a) What is the tensile stress area of screw thread? (2)

b) Determine the safe tensile load for M12,M20 and M30 coarse grade bolts, assuming a safe tensile stress of 43 MPa. (3)

c) A plate as shown in figure below is subjected to an eccentric force (P) of 15 kN (10)

with an eccentricity (e) of 450 mm from the CG of the bolts. The centre distance between bolts 1 and 2 is 210 mm, and the centre distance between bolts 1 and 3 is 150 mm. All the bolts are identical. The bolts are made from plain carbon steel 25C8 and the factor of safety is 2.5. Find the size of the bolts.



5 Design a screw jack using C40 carbon steel having a capacity of 15 kN to lift 250 mm height. Take a factor of safety of 4. (15)

6 a) Explain with sketches confined and unconfined gaskets. (2)

b) Explain the effect of confined and unconfined gaskets on the spring constant. (2)

c) Two plates bolted to form an assembly is initially tightened by a spanner so as to induce a preload of 3 kN in the bolt. Then it is subjected to an external load of 8 kN .The bolt with coarse thread, made of plain carbon steel is having a tensile yield strength of 400 MPa. The effective stiffness of the parts held together by the bolt is 3 times the stiffness of the bolt. Determine the size of the bolt assuming a factor of safety of 3. (11)

PART C

Answer any twofull questions, each carries 20 marks.

7 a) Derive the expression for the stress in graduated semi-elliptical leaf spring. (5)

b) A railway wagon weighing 3 tons is moving with a velocity of 3 m/s. It is brought to rest by two buffer springs of diameter 200 mm. The maximum deflection allowed is 160 mm. The allowable shear stress in spring material is 600 MPa. Take G=84 GPa. Design the spring. (15)

8 a) How to ensure alignment of shaft before fixing coupling bolts in a flange (3)

couplings?

b) Distinguish between rigid and flexible coupling (5)

c) A rectangular sunk key 14 mm wide, 10 mm thick and 75 mm long is required to transmit 1200 N-m torque from a 50 mm diameter solid shaft. Determine whether the length is sufficient or not if the permissible shear stress and crushing stress are limited to 56 MPa and 168 MPa respectively. (12)

9 a) What is critical speed of a shaft? (2)

b) Explain shock and fatigue factor. (3)

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 rpm. The angle of lap of the belt is 180^0 and the coefficient of friction between the belt and pulley is 0.3. The shock and fatigue factors for bending and twisting are 1.5 and 2.0. The allowable shear stress in the shaft may be taken as 35 MPa. (15)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

SEVENTH SEMESTER B.TECH DEGREE EXAMINATION(R&S), DECEMBER 2019

Course Code: ME401

Course Name: DESIGN OF MACHINE ELEMENTS - I

Max. Marks: 100 Duration: 3 Hours

(i) Use of approved design data book is permitted

(ii) Missing data if any may be suitable assumed

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) What do you mean by preferred numbers? Explain with the help of an example. (5)

b) Define the term notch sensitivity. Establish the relationship between notch sensitivity and fatigue stress concentration factor. (5)

c) Distinguish between ductile and brittle materials with the help of a stress- strain diagram? (5)

2 a) A cantilever beam of square section supports an electric motor weighing 1000 N at a distance of 400 mm from the fixed end. If the allowable stress of beam material is 100 N/mm^2, Determine section of beam. (5)

b) A mild steel shaft is subjected to a 3500 N-m of bending moment at its critical point and transmits a torque of 2500 N-m. The shaft is made of steel having a yield stress of 230 MPa. Estimate the size of the shaft (FOS =2) based on following theories of failure (10)

1. Maximum normal stress theory
2. Maximum shear stress theory
3. Distortion energy theory

3 a) What are the factors affecting the endurance strength? (3)

b) Explain the procedure for the design of a component for finite life under varying amplitude loading? (4)

c) A steel shaft is subjected to a torque that varies over a range of +/- 40%. Determine the diameter of the shaft if it transmits 14 kW at 225 rpm. The material has a ultimate tensile strength of 600 MPa and yield strength of 400 MPa. FOS =3. (8)

PART B

Answer any two full questions, each carries 15 marks.

4 a) Show by neat sketches the various modes of failure of riveted joint? (5)

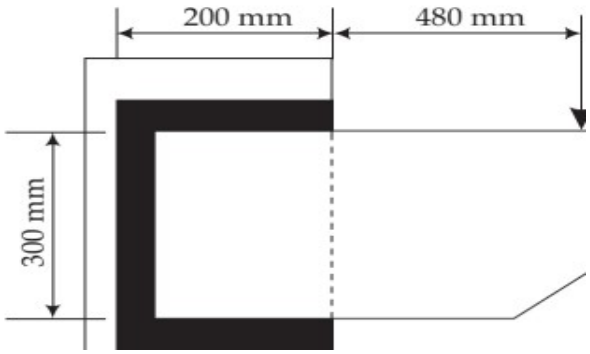
b) Two lengths of mild steel rods having width 200 mm and thickness 12.5 mm are connected with a butt joint with equal width straps. Design lozenge joint if the permissible working stress in plate and rivet material are 80 N/mm^2 in tension 50 N/mm^2 in shear and 150 N/mm^2 in crushing. (10)

5 a) What is meant by pre-tension in bolts? What is its significance? (5)

b) The cylinder head is fastened to the cylinder of a compressor using 6 bolts (steel C 20) of M20 size. The maximum fluid pressure is 3.2 MPa, cylinder diameter is 70 mm. A soft copper gasket is used. Assume the initial tension required in each bolt as 40kN, Determine the factor of safety? (10)

6 a) Why do we design the weld joints based on throat area? (3)

b) Determine the size of the weld for a bracket loaded as shown in the figure. The allowable stress in the weld as 60 MPa . (12)



PART C

Answer any two full questions, each carries 20 marks.

7 a) Why do we consider Wahl's factor for the design of helical compression springs? (4)

b) What is surging in springs? (4)

c) A spring is subjected to a variable load varying from 500 N to 900 N. Determine diameter of wire and mean diameter of coils. Yield strength in shear 750 MPa, torsional fatigue strength 350 MPa. (12)

8 a) Differentiate between torsional rigidity and lateral rigidity of shaft. (5)

b) A solid steel shaft of 500 mm long between bearings 'A' and 'C' and carrying a (15)

cast iron pulley at 'B' which is at 300 mm from the bearing 'A'. The pulley is directly coupled to a 5 kW motor running at 750 rpm. The motor is located left side of the bearing 'A'. The cast iron pulley is of 250 mm in diameter and weighing 100 N and is driving a machine shaft running below it. The belt from pulley to the machine is inclined 60^{o} to the vertical. Determine the appropriate diameter of the shaft, assuming moderate shock conditions, the friction factor between the pulley and the belt as 0.3, factor of safety 4.0.

9 a) Prove that compressive stress induced in square key is twice that of shear stress (5)

b) Design a protected type CI flange coupling for a steel shaft transmitting 28 kW at 200 rpm. The allowable shear stress in the shaft and key material is 40 MPa. The maximum torque transmitted is to be 20% greater than the mean torque. The allowable shear stress in the bolt is 60 MPa and allowable shear stress in CI flange is 40 MPa (15)

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Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

B.Tech S7 (S) Examination Sept 2020

Course Code: ME401

Course Name: DESIGN OF MACHINE ELEMENTS - I

Max. Marks: 100 Duration: 3 Hours

(i) Use of approved design data book is permitted

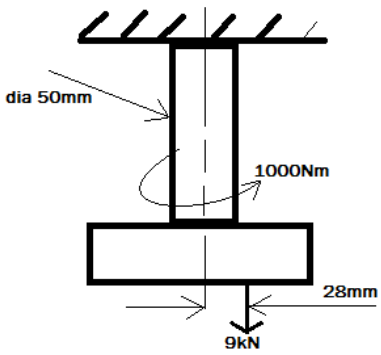
(ii) Missing data if any may be suitably assumed

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Draw the engineering stress-strain diagram of mild steel and explain the salient points on it. (5)

b) A load of 9 kN is applied to the steel rod of 50 mm diameter as shown in Figure. If a torsional moment of 100 N-m is applied on it, Determine the maximum tensile stress and maximum shear stress. (10)



2 a) What is factor of safety? What are the factors to be considered in the selection of factor of safety (FoS)? (3)

b) What is notch sensitivity factor and explain its significance in the design under dynamic loading. (3)

c) State and explain the theories of failure (a) Rankine theory (b) von Mises theory and (c) Maximum shear stress theory. Plot the region of safety for each theory. (9)

3 a) Explain Soderberg, Goodman and Gerber's criteria for design under fatigue loading. (6)

b) A steel shaft subjected to a torque that varies over a range of ±40%. Determine the diameter of the shaft if it transmits 15 kW at 250 rpm. The material has an ultimate strength of 600 MPa and yield strength of 400 MPa. Take FoS 3. (9)

PART B

Answer any two full questions, each carries 15 marks.

4 a) What is the difference between lead and pitch? Write the relation connecting them. (2)

b) Explain the stresses acting on a Screw fastener. (6)

c) A cylinder head is fastened to the cylinder of a compressor using 6 bolts of M20 size. Bolt material is C20 steel. The maximum fluid pressure is 3.5 MPa, and the cylinder diameter is 75 mm. A soft gasket is used. Assume the initial tension required in each bolt as 40 kN. Determine the factor of safety. (7)

5 a) What do you mean by the efficiency of a power screw? How do you find the efficiency of a self-locking screw? (4)

b) What are the different types of threads used in power screw? (2)

c) The square thread of a screw jack 80 x 72 x 16 (*in mm*), with a double start is to raise a load of 100 kN. The mean collar diameter is 130 mm. The coefficient of friction for the threads and the collar are 0.1 and 0.2 respectively. Determine (9)

a. The torque required to raise the load.

b. The efficiency of the screw.

c. Whether self-locking exists?

6 a) Explain the failures modes of riveted joints and how will you determine the efficiency of a rivet joint? (5)

b) Design a double riveted butt joint with equal widths of cover plates to join two (10)

plates of thickness 10 mm. The allowable stress for the material of the rivets and for the plates are as follows: for plate material in tension σ_t = 80 MPa, for rivet material in compression, σ_c=120 MPa, for rivet material in shear,τ = 60 MPa.

PART C

Answer any two full questions, each carries 20 marks.

7	a)	What is nipping in leaf springs?	(2)
	b)	Why the leaf springs are laminated?	(3)
	c)	A carriage weighing 25 kN is moving on a drag with linear velocity 3.6 km/hr. It is brought to rest by two helical compression springs in the form of a damper by undergoing compression of 180 mm. The spring may be assumed to have a spring index of 6 and permissible shear strength of 450 MPa. Design the spring. (Take G = 80 GPa).	(15)
8	a)	What are the different types of keys? *(any four)*; and explain its failure modes.	(5)
	b)	Design a flanged coupling to transmit a power of 25 kW at a rated speed of 500 rpm.	(15)
9	a)	Compare the strength and stiffness of a hollow shaft to that of a solid shaft if both are having same outside diameter	(5)
	b)	A shaft is supported by bearings 600 mm apart. It carries a pulley of diameter 500 mm; at 250 mm to the right of left bearing and another pulley of diameter 380 mm; at 130 mm to the right of the right bearing. The belt drive in the left pulley is vertically downward while that on the right pulley is horizontal. The permissible shear stress is not to exceed 42 MPa. The maximum tension in the smaller pulley is not to exceed 5.5 kN. Find the diameter of the shaft. (Coefficient of friction is 0.3 and angle of contact is 180^0).	(15)

Reg No.:_____ Name:_____

APJ ABDUL KALAM TECHNOLOGICAL UNIVERSITY

Seventh Semester B.Tech Degree Examination (Regular and Supplementary), December 2020

Course Code: ME401

Course Name: DESIGN OF MACHINE ELEMENTS - I

Max. Marks: 100 Duration: 3 Hours

Use of Design Data Book is permitted

Missing data if any may be suitably assumed

PART A

Answer any two full questions, each carries 15 marks. Marks

1 a) Explain the BIS system for designation of steels based on its composition? (2)

b) Define stress concentration. Give any three methods to reduce stress concentration caused by a notch on a flat plate. (7)

c) A steel column having square cross section of 90 mm side carries a load of 120 kN at an eccentricity of 12 mm in a plane bisecting the thickness. Find the maximum and minimum intensities of stress in the section. (6)

2 a) Taking stress concentration into account find the maximum stress induced in a shaft when a tensile load of 15 kN is applied to a stepped shaft of diameters 50 mm and 20 mm with a fillet of radius of 5 mm. (3)

b) A steel shaft is subjected to the following loads: the bending moment varying from -150 Nm to +400 Nm; The twisting moment varying from 70 Nm to 200 Nm and the axial force varying from -50 N to 150 N. Determine the dimension of the shaft using Von Mises Hencky theory. The frequency of variation of the loads is same as the shaft speed. The properties of the material of the shaft are yield strength = 400 MPa, endurance strength = 310 MPa, ultimate strength = 620 MPa. Take K_t = 1.85, Notch sensitivity factor (q) = 0.95, K_a= 0.75, K_b= 0.85, K_c= 0.9 and Factor of Safety (n) = 2. (12)

3 a) Explain how the strength and stiffness factors of machine elements affect the design. (3)

b) The bending stress in a machine part fluctuates between a tensile stress of 300MPa and compressive stress of 160 MPa. What should be the minimum ultimate tensile strength of this part to carry this fluctuation indefinitely according to (i) Goodman's formula (b) Soderberg relation and (c) Gerber relation? Take the yield point as 60% of ultimate tensile strength and Endurance limit as 50% of ultimate tensile strength and Factor of safety as 2. (12)

PART B

Answer any two full questions, each carries 15 marks.

4 a) A bolt M20 x 2.5 metric thread is subjected to a fluctuating load varying from zero load (0 N) to 14 kN. Endurance strength = 210 MPa. Bolt and part are of same material and length. Take σ_y=480 MPa, Stress concentration factor= 3.85, (12)

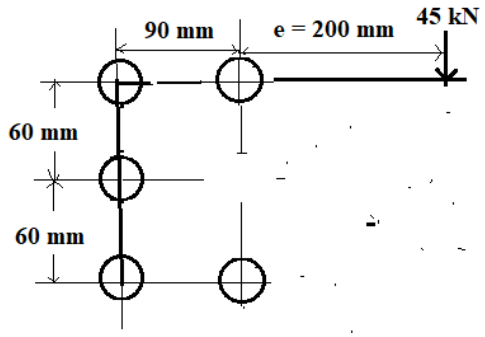
component area=365 mm^2. Calculate (i) Factor of Safety without preload (ii) minimum initial load to prevent joint opening, (iii) factor of safety with 11 kN preload and (iv) minimum force in the part for a given loading and a preload of 11 kN.

b) What do you mean by pre loading of bolts? What is its significance? (3)

5 a) A steel plate 90 mm wide and 10 mm thick is welded to another by means of single transverse and double parallel fillet weld such that the strength of the plate and the welded joint are equal. The welded plates are subjected to a static tensile force of 60 kN. Determine the length of the weld if the permissible shear stress is 80 MPa. (7)

b) A double riveted lap joint with zig-zag riveting is to be designed for 16 mm plates. The permissible stresses in tension, shear and crushing are 80MPa, 60 MPa and 120 MPa respectively. (i) State the mode in which the joint will fail. (ii) Find the efficiency of the joint. (8)

6 a) The structural connection consisting of five rivets of equal size and same material is of the form shown below (6)



The shear stress is 110 MPa and the crushing strength is 150 MPa. Find the diameter of the rivet.

b) A steam engine cylinder head of effective diameter 300 mm is subjected to a steam pressure of 1.5 MPa. The cylinder head is connected by 8 stud bolts having σ_y=320 MPa. Take 18% overload. Find the size of bolt required for the engine cylinder head and the approximate tightening torque. (9)

PART C

Answer any two full questions, each carries 20 marks.

7 a) Design a semi elliptical leaf spring made of chrome vanadium steel having permissible bending stress 300 MPa, for the rear axle of a car subjected to a load of 12 kN. The span is 1 m long and width of the clamp is 110 mm. In all 12 leaves are used out of which two are main leaves and the remaining are graduated leaves. Take the width of the plate as 40 mm. (14)

b) Design a compressive helical spring for a maximum force of 800 N and subjected to a deflection of 22 mm. The spring index is 6. The permissible shear stress is 420 MPa and modulus of rigidity for the material is 80MPa. (6)

8 a) Design a uniform solid shaft supported on bearings (say A and B) 800 mm between centres. A 20° spur gear having 600 mm pitch diameter is located at C, 200 mm to the right of the left hand bearing A and a 700 mm diameter pulley is (12)

mounted at D, 250 mm to the left of the bearing B. The gear is driven by a pinion with a downward tangential force while the pulley drives a horizontal belt having 180° wrap angle. The pulley also serves as flywheel and weighs 2 kN. The maximum belt tension is 3.5 kN and the tension ratio is 3:1. Take the yield stress for the material as 380 MPa and factor of safety as 2.

b) What do you mean by critical speed of a shaft? (4)

c) Design a rectangular sunk key made of steel for a 90 mm diameter mild steel shaft to transmit a torque of 150 Nm. Assume shear stress =50 MPa and crushing stress= 120 MPa. (4)

9 a) Two helical springs of the same axial length but different diameters of coil are coaxially placed one inside the other. The axial load is 5 kN and the deflection is 32 mm. The maximum permissible shear stress in both the springs is 150MPa. The spring indices are 5 and 9. The wire diameters are being same, neglecting the effect of stress concentration; find the wire diameters and ratio of actual number of coils of the two springs. (10)

b) Design a flange coupling which connects a motor and a pump shaft made of steel. The flange and hub of the assembly are made of cast iron having shear strength 14 MPa. The power transmitted is 3 kW at a shaft speed of 960 rpm. Take the permissible shear stress and crushing stress for steel used as 50 MPa and 90 MPa respectively. (10)

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