

**B.TECH**  
**(SEM-V) THEORY EXAMINATION 2019-20**  
**MACHINE DESIGN-I**

Time: 3 Hours

Total Marks: 100

**Note** Attempt Section I first & then Section II. If any question is missed to attempt, it shall be treated as a penalty. Use of Design Handbook is allowed.

**SECTION A**

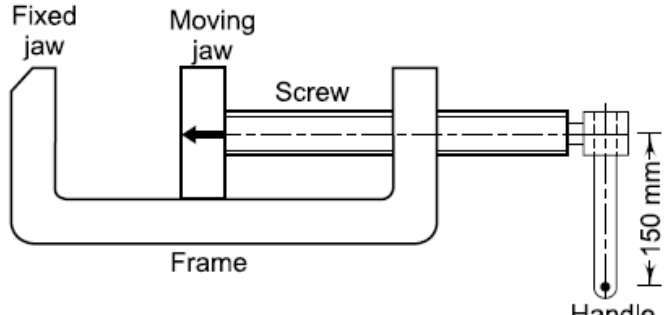
**1. Attempt all questions briefly. 2 x 10 = 20**

a.	Compare design synthesis with design analysis
b.	Explain the Ergonomic consideration
c.	It is required to standardize eleven shafts from 100 to 1000 mm diameter. Specify their diameters.
d.	What is the importance of size and surface finish factor for design?
e.	Define Notch sensitivity?
f.	Why shaft failure occurs? How it can be avoided?
g.	What material can you choose in the fabrication of spring and why
h.	What are the advantages of riveting joints?
i.	What is saddle key? What are the types of saddle keys?
j.	What is lock nut? What is the principle of lock nut?

**SECTION B**

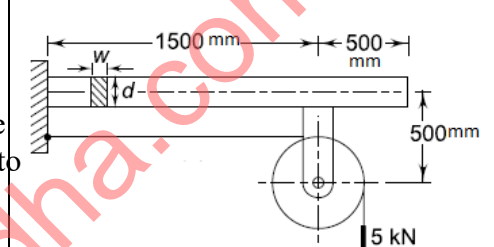
**2. Attempt any three of the following: 10x3=30**

<p>a. A bracket, made of steel FeE 200 (<math>S_t = 200 \text{ N/mm}^2</math>) and subjected to a force of 5 kN acting at an angle of <math>30^\circ</math> to the vertical, is shown in Fig. The factor of safety is 4. Determine the dimensions of the cross section of the bracket.</p>	
<p>b. Explain Soderberg method for combination of Stresses.</p>	
<p>c. A plate made of steel 20C8 (<math>S_{ut} = 440 \text{ N/mm}^2</math>) in hot rolled and normalized condition is shown in Fig. It is subjected to a completely reversed axial load of 30 kN. The notch sensitivity factor q can be taken as 0.8 and the expected reliability is 90%. The size factor is 0.85. The factor of safety is 2. Determine the plate thickness for infinite life.</p>	
<p>d. Design a muff coupling to connect two steel shafts transmitting 25 kW power at 360 rpm. The shafts and key are made of plain carbon steel 30C8 (<math>S_{yt} = S_{yc} = 400 \text{ N/mm}^2</math>). The sleeve is made of grey cast iron FG 200 (<math>S_{ut} = 200 \text{ N/mm}^2</math>). The factor of safety for the shafts and key is 4 and for the sleeve, the factor of safety is 6 based on ultimate strength.</p>	

<p>e. A machine vice, as shown in Fig., has single-start, square threads with 22 mm nominal diameter and 5 mm pitch. The outer and inner diameters of the friction collar are 55 and 45 mm respectively. The coefficients of friction for thread and collar are 0.15 and 0.17 respectively. The machinist can comfortably exert a force of 125 N on the handle at a mean radius of 150 mm.</p>	<p>Assuming uniform wear for the collar, calculate</p> <p>(i) the clamping force developed between the jaws;</p> <p>(ii) the overall efficiency of the clamp.</p> <div style="text-align: center;">  </div>
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**SECTION C**

**3. Attempt any one part of the following: 10x1=10**

<p>a. Explain the basics procedure of machine design with the help of flow chart.</p>	
<p>b. A cantilever beam of rectangular cross-section is used to support a pulley as shown in Fig. The tension in the wire rope is 5 kN. The beam is made of cast iron FG 200 and the factor of safety is 2.5. The ratio of depth to width of the cross-section is 2. Determine the dimensions of the cross-section of the beam.</p>	

**4. Attempt any one part of the following: 10x1=10**

<p>a. A forged steel bar, 50 mm in diameter, is subjected to a reversed bending stress of 250 N/mm<sup>2</sup>. The bar is made of steel 40C8 (S<sub>ut</sub> = 600 N/mm<sup>2</sup>). Calculate the life of the bar for a reliability of 90%.</p>	
<p>b. A double riveted double cover butt joint in plates 20 mm thick is made with 25 mm diameter rivets at 100 mm pitch. The permissible stresses are: <math>\sigma_t = 120</math> MPa; <math>\tau = 100</math> MPa; <math>\sigma_c = 150</math> MPa. Find the efficiency of joint, taking the strength of the rivet in double shear as twice than that of single shear.</p>	

**5. Attempt any one part of the following: 10x1=10**

<p>a. A shaft supported at the ends in ball bearings carries a straight tooth spur gear at its mid-span and is to transmit 7.5 kW at 300 r.p.m. The pitch circle diameter of the gear is 150 mm. The distances between the centerline of bearings and gear are 100 mm each. If the shaft is made of steel and the allowable shear stress is 45 MPa, determine the diameter of the shaft. The pressure angle of the gear may be taken as 20°.</p>	
<p>b. It is required to design a square key for fixing a gear on a shaft of 25 mm diameter. The shaft is transmitting 15 kW power at 720 rpm to the gear. The key is made of steel 50C4 (S<sub>yt</sub> = 460 N/mm<sup>2</sup>) and the factor of safety is 3. For key material, the yield strength in compression can be assumed to be equal to the yield strength in tension. Determine the dimensions of the key.</p>	

**6. Attempt any one part of the following:****10x1=10**

a.	A helical compression spring is used to absorb the shock. The initial compression of the spring is 30 mm and it is further compressed by 50 mm while absorbing the shock. The spring is to absorb 250 J of energy during the process. The spring index can be taken as 6. The spring is made of patented and cold-drawn steel wire with an ultimate tensile strength of 1500 N/mm <sup>2</sup> and modulus of rigidity of 81 370 N/mm <sup>2</sup> . The permissible shear stress for the spring wire should be taken as 30% of the ultimate tensile strength. Design the spring and calculate: (i) wire diameter; (ii) mean coil diameter; (iii) number of active turns; (iv) free length; and (v) pitch of the turns.
b.	The nominal diameter of a triple threaded square screw is 50 mm, while the pitch is 8 mm. It is used with a collar having an outer diameter of 100 mm and inner diameter as 65 mm. The coefficient of friction at the thread surface as well as at the collar surface can be taken as 0.15. The screw is used to raise a load of 15 kN. Using the uniform wear theory for collar friction, calculate: (i) torque required to raise the load; (ii) torque required to lower the load; and (iii) the force required to raise the load, if applied at a radius of 500 mm.

**7. Attempt any one part of the following:****10x1=10**

a.	Explain the following (i) Name the various alloying elements in 'alloy' steels and their effects. (ii) What is creep? Explain the situations where creep is a serious problem.
b.	Explain S-N diagram for steel. What is the importance of S-N diagram in designing?