

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

Time: 3 Hours

Total Marks: 100

Note: Attempt all Sections. If require any missing data; then choose suitably.
Use of Design data handbook is allowed.

SECTION A

1. Attempt all questions in brief. 2 x 10 = 20

a.	What is preferred number? State the advantage of preferred number.
b.	It is required to standardize eleven shafts from 100 to 1000 mm diameter. Specify their diameters.
c.	How will you select appropriate material for designing a component?
d.	Why stress concentration occurs? How its effect can be reduced?
e.	Define endurance strength & endurance limit.
f.	What are the different types of spring?
g.	What are the different types of rivet heads?
h.	Which theories of failure are applicable for the design of shafts? Why?
i.	What is feather key? Give its applications.
j.	What is lock nut? What is the principle of lock nut?

SECTION B

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

a.	<p>Frame of a hacksaw is shown in Fig. The initial tension P in the blades should be 300 N. The frame is made of plain carbon steel 30C8 with a tensile yield strength of 400N/mm^2 and the factor of safety is 2.5. The cross-section of the frame is rectangular with a ratio of depth to width as 3. Determine the dimensions of the cross-section.</p>	
b.	<p>A rod of a linkage mechanism made of steel 40Cr1 ($S_{ut} = 550\text{ N/mm}^2$) is subjected to a completely reversed axial load of 100 kN. The rod is machined on a lathe and the expected reliability is 95%. There is no stress concentration. Determine the diameter of the rod using a factor of safety of 2 for an infinite life condition.</p>	
c.	<p>The armature shaft of a 40 kW, 720 rpm electric motor, mounted on two bearings A and B, is shown in Fig. The total magnetic pull on the armature is 7 kN and it can be assumed to be uniformly distributed over a length of 700 mm midway between the bearings. The shaft is made of steel with an ultimate tensile strength of 770 N/mm^2 and yield strength of 580 N/mm^2. Determine the shaft diameter using the ASME code if $k_b = 1.5$ and $k_t = 1.0$. All dimensions mentioned in figure are in mm.</p>	

d.	The standard cross-section for a flat key, which is fitted on a 50 mm diameter shaft, is 16x10 mm. The key is transmitting 475N-m torque from the shaft to the hub. The key is made of commercial steel ($S_{yt} = S_{yc} = 230 \text{ N/mm}^2$). Determine the length of the key, if the factor of safety is 3.
e.	What is Alloy steel? Explain the effect of different alloying elements added to get certain beneficial effects.

SECTION C

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

<p>a.</p>	<p>The shaft of an overhang crank subjected to a force P of 1 kN is shown in Fig. The shaft is made of plain carbon steel 45C8 and the tensile yield strength is 380 N/mm^2. The factor of safety is 2. Determine the diameter of the shaft using the maximum shear stress theory. Dimensions mentioned in the figure are in mm.</p>	
<p>b.</p>	<p>Two rods are connected by means of a cotter joint. The inside diameter of the socket and outside diameter of the socket collar are 50 and 100 mm respectively. The rods are subjected to a tensile force of 50 kN. The cotter is made of steel 30C8 ($S_{yt} = 400 \text{ N/mm}^2$) and the factor of safety is 4. The width of the cotter is five times of thickness. Calculate:</p> <p>(i) width and thickness of the cotter based on shear failure; and</p> <p>(ii) width and thickness of the cotter based on bending failure.</p>	

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

a.	A rotating bar made of steel 45C8($S_{ut} = 630 \text{ N/mm}^2$) is subjected to a completelyreversed bending stress. The corrected endurance limit of the bar is 315 N/mm^2 . Calculate the fatigue strength of the bar for a life of 90,000 cycles.	
b.	Two plates, each 5 mm thick, are connected by means of four rivets as shown in Fig. The permissible stresses for rivets and plates in tension, shear and compression are 80, 60 and 120 N/mm^2 respectively. Calculate: (i) diameter of the rivets; (ii) width of the plate; and (iii) efficiency of the joint.	

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

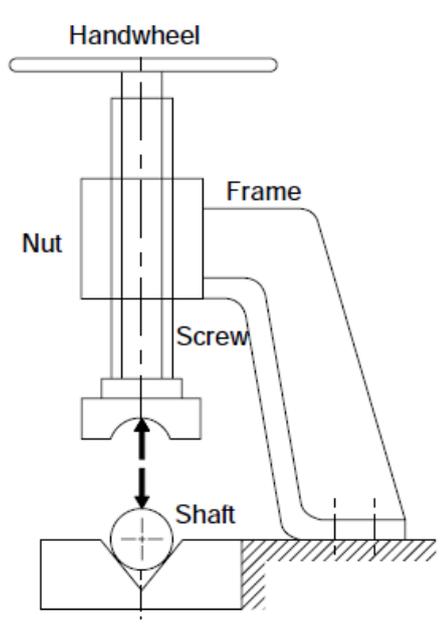
a.	A shaft supported at the ends in ball bearings carries a straight tooth spur gear at its mid-span and is to transmit 7.5 kW at 300 r.p.m. The pitch circle diameter of the gear is 150 mm. The distances between the centerline of bearings and gear are 100 mm each. If the shaft is made of steel and the allowable shear stress is 45 MPa, determine the diameter of the shaft. The pressure angle of the gear may be taken as 20° .
b.	Design a muff coupling which is used to connect two steel shafts transmitting 40 kW at 350 r.p.m. The material for the shafts and key is plain carbon steel for which allowable shear and crushing stresses may be taken as 40 MPa and 80 MPa respectively. The material for the muff is cast iron for which the allowable shear stress may be assumed as 15 MPa.

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

a.	Design a helical compression spring for a maximum load of 1000 N for a deflection of 25 mm using the value of the spring index as 5. The maximum permissible shear stress for spring wire is 420 MPa and modulus of rigidity is 84 kN/mm^2 .
b.	A helical compression spring, made of circular wire, is subjected to an axial force, which varies from 2.5 kN to 3.5 kN. Over this range of force, the deflection of the spring should be approximately 5 mm. The spring index can be taken as 5. The spring has square and ground ends. The spring is made of patented and cold-drawn steel wire with ultimate tensile strength of 1050 N/mm^2 and modulus of rigidity of 81370 N/mm^2 . The permissible shear stress for the spring wire should be taken as 50% of the ultimate tensile strength. Design the spring and calculate (i) wire diameter; (ii) mean coil diameter; (iii) number of active coils; (iv) total number of coils; (v) solid length of the spring; (vi) free length of the spring;

7. Attempt any *one* part of the following:

10x1=10

<p>a.</p>	<p>The construction of a shaftstraightener used on the shop floor is shown in. The screw has single-start square threads of 80 mm nominal diameter and 10 mm pitch. The screw is required to exert a maximum axial force of 10 kN. The mean radius of the friction collar is 30 mm. The axial length of the nut is 40 mm. The coefficient of friction at the threads and the collar is 0.12. The mean diameter of the rim of the handwheel is 500 mm. Calculate (i) the force exerted at the rim to drive the screw (ii) the efficiency of the straightener.</p>	
<p>b.</p>	<p>Two flat plates subjected to a tensile force P are connected together by means of double-strap butt joint as shown in Fig. The force P is 250 kN and the width of the plate is 200 mm. The rivets and plates are made of the same steel and the permissible stresses in tension, compression and shear are 70, 100 and 60 N/mm² respectively. Calculate: (i) the diameter of the rivets; (ii) the thickness of the plates; (iii) the dimensions of the seam, viz., p, p_t and m; (iv) the efficiency of the joint.</p>	