Sub Code: RME501

Paper Id: 140506 Roll No:

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

Time: 3 Hours ***Total Marks: 70***

Note: 1. Attempt all Sections. If require any missing data; then choose suitably.

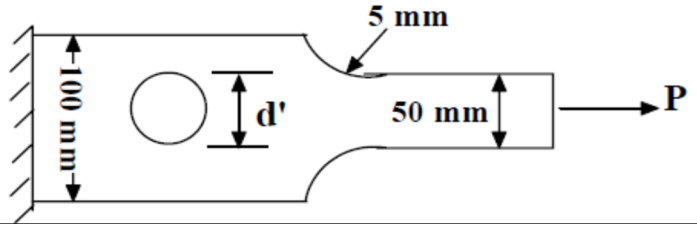
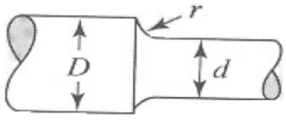
SECTION A

1. Attempt *all* questions in brief. 2 x 7 = 14

a.	What is 20Cr18Ni2 designation of steel?
b.	Discuss how shaft is designed for rigidity.
c.	Explain modified Goodman diagram for torsional shear stresses.
d.	What is 'self-locking' of power screw? What is the condition for self-locking?
e.	Distinguish between hot and cold riveting.
f.	What is Kennedy key? Give its applications.
g.	What is Wahl factor? Why is it used?

SECTION B

2. Attempt any *three* of the following: 7 x 3 = 21

a.	The stresses induced at a critical point in a machine component made of steel 45C8 (S_{ut}=380 N/mm^2) are as follows: σ_x=100 N/mm^2, σ_y=40 N/mm^{2}and τ_{xy}= 80 N/mm^2 Calculate the factor of safety by (i) Maximum normal stress theory (ii) Maximum shear stress theory and (iii) Maximum distortion energy theory.
b.	A component machined from a plate made of steel 45C8 (S_{ut}=630 N/mm^2) is shown in figure. It is subjected to a completely reversed axial force of P=75 kN. The expected reliability is 90% and the factor of safety is 2. The size factor is 0.85. The plate thickness is 28 mm for infinite life. Determine the hole diameter. 
c.	A cantilever stepped shaft of cold drawn steel 20C8 (S_{ut}=540 N/mm^2) as shown in figure is subjected to a bending moment which varies from 100 N-m to 300 N-m. The notch sensitivity factor *q* can be taken as 0.85 and the expected reliability is 95%. Determine the life of the shaft, if finite life exists.  r = 6 mm d = 30 mm D = 40 mm.
d.	A propeller shaft for a launch transmits 75 kW at 150 rpm and is subjected to a maximum bending moment of 1 kN-m and an axial thrust of 70 kN. Find the shaft diameter based on maximum principal stress, if the shear strength of the shaft material is limited to 100 MPa.
e.	Derive the expression for obtaining the maximum efficiency of a square threaded screw.

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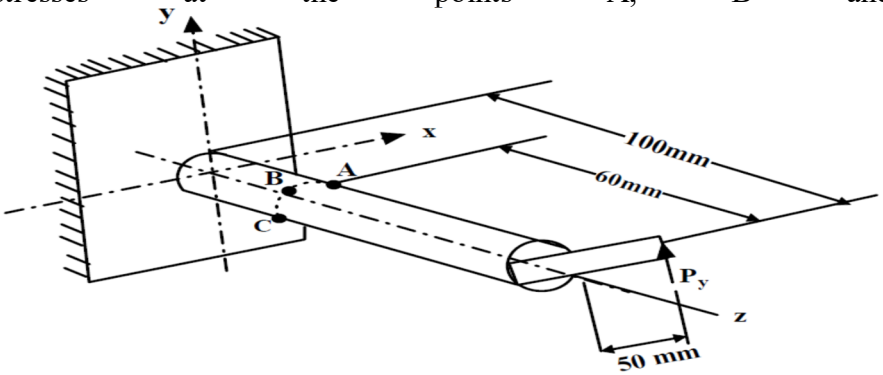
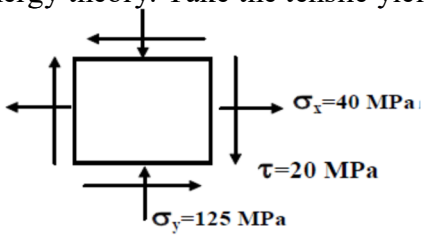
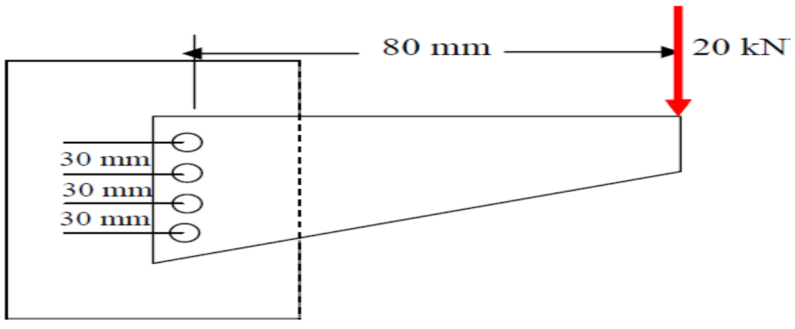
SECTION C

3. Attempt any *one* part of the following: 7 x 1 = 7

(a)	A vertical load P_y=20 KN is applied at the free end of a cylindrical bar of radius 50 mm as shown in figure. Determine the principal and maximum shear stresses at the points A, B and C. 
(b)	The state of stress at a point for a material is shown in the figure. Find the factor of safety using (a) Maximum shear stress theory (b) Maximum distortion energy theory. Take the tensile yield strength of the material as 400 MPa. 

4. Attempt any *one* part of the following: 7 x 1 = 7

(a)	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 is subjected to an axial stress that varies from -15 to +30 N/mm^2. The frequency of variation of these stresses is equal to the shaft speed. The shaft is made of steel FeE 400 (S_{ut}=540 N/mm^2 and S_{yt}=400 N/mm^2) and the corrected endurance limit of the shaft is 200 N/mm^2. Determine the factor of safety.
(b)	A bracket is supported by means of 4 rivets of same size as shown in figure. Determine the diameter of the rivet if the working shear stress is limited to 140 MPa. 

5. Attempt any *one* part of the following: 7 x 1 = 7

(a)	The problem is shown in the given figure. A pulley drive is transmitting power to a pinion, which in turn is transmitting power to some other machine element. Pulley and pinion diameters are 400mm and 200mm respectively. Shaft has to be designed for minor to heavy shock. Assume a suitable material for the shaft.

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	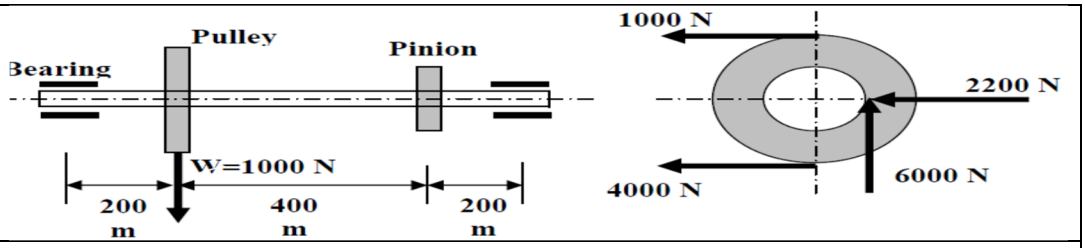
(b)	A steel shaft 800 mm long transmitting 15 kW at 400 rpm is supported at two bearings at the two ends. A gear wheel having 80 teeth and 500 mm pitch circle diameter is mounted at 200 mm from the left hand side bearing and receives power from a pinion meshing with it. The axis of pinion and gear lie in a horizontal plane. A pulley of 300 mm diameter is mounted at 200 mm from the right hand side bearing and is used for transmitting power by a belt. The belt lap angle is 180 degrees. The coefficient of friction between belt and pulley is 0.3. Design and sketch the arrangement of the shaft assuming the values of safe shear stress as 55 MPa. Take torsion and bending factor 1.5 and 2 respectively.

6. Attempt any *one* part of the following: 7 x 1 = 7

(a)	A railway wagon moving at a velocity of 2 m/s is brought to rest by a bumper consisting of two helical compression springs attached in parallel. The springs are compressed by 150 mm in bringing the wagon to rest. The mass of the wagon is 1000 kg. The spring index can be taken as 6. The springs are made of oil hardened and tempered steel wire with ultimate tensile strength of 1500 N/mm^2 and modulus of rigidity of 81370 N/mm^2. The permissible shear stress for the spring wire can be taken as 50% of the ultimate tensile strength. Design the springs and calculate: (i) Maximum force on each spring (ii) Wire diameter (iii) Mean coil diameter (iv) No. of active coils
(b)	Design a helical spring for a spring loaded safety valve for the following conditions: Operating pressure= $1N/mm^2$ Maximum pressure when the valve blows off freely= 1.075 N/mm^2 Maximum lift of the valve when the pressure is 1.075 N/mm^2 = 6mm Diameter of valve seat = 100mm Maximum shear stress= 400 MPa Modulus of rigidity =86 kN/mm^2 Spring index =5.5

7. Attempt any *one* part of the following: 7 x 1 = 7

(a)	A flat key is used to connect a pulley to a 45 mm diameter shaft. The standard cross section of the key is 14 x 9 mm. The key is made of commercial steel (S_{yt}=S_{yc}=230 N/mm^2) and the factor of safety is 3. Determine the length of key, if 15 kW power at 360 rpm is transmitted through the key joint.
(b)	A double threaded power screw is used to raise a load of 5 kN. The nominal diameter is 60 mm and the pitch is 9 mm. The threads are ACME type ($2\theta=29°$) and the coefficient of friction at the screw threads is 0.15. Neglecting collar friction, calculate: (i) The torque required to raise the load (ii) The torque required to lower the load (iii) The efficiency of the screw for lifting load