تصميم الآلات

Kafr El-Sheikh University	Machine Design	3rd Year Mechanical [MDP 3012]
Faculty of Engineering		Final Exam –June, 2018
Mechanical Engineering Department		Full Marks: 100, Time: 4 Hours

Answer all the following questions: (All dimensions are in mm)

Assume reasonable values for any missing data

Question (1): [15 Marks]

An Aluminum column of length (L) and rectangular cross section has a fixed end (B) and supports a centric load at (A) as shown in figure (1). Two smooth and rounded fixed plates restrain end (A) from moving in one of the vertical planes of symmetry of the column, but allow it to move in the other plane.

1. *Determine the ratio of (a/b) of the two sides of the cross section corresponding to the most efficient design against buckling.*
2. *Design the most efficient cross section for the column (find a and b), knowing that a factor of safety of 2.5 is required. Take L=500 mm, E=70 GPa and F=20 KN.*

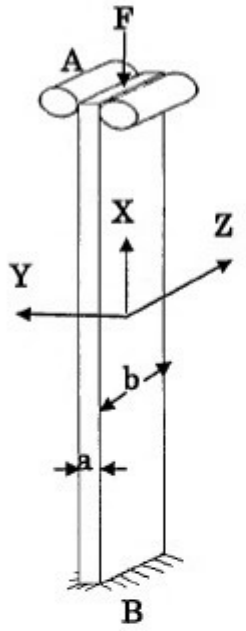


Figure (1)

Question (2): [15 Marks]

A) For the Knuckle Joint shown in figure (2), determine an algebraic expression (equations ONLY) for each of the following:

1. *Tensile Stress at section x-x.*
2. *Shearing Stress in the Pin.*
3. *Bearing Stress between the Pin and the Eye.*
4. *Bearing Stress between the Pin and the Fork.*
5. *Tensile Stress across the hole in the Eye.*
6. *Tensile Stress across the hole in the Fork.*
7. *Tear out of the Eye by the Pin.*
8. *Tear out of the Fork by the Pin.*

B) If the Pin, Eye and the Fork are made of steal of allowable Normal Stress σ_{all}=50 MPa, allowable Bearing Stress σb_{all}=100 MPa, and allowable Shear Stress τ_{all}= 30 MPa, and the applied Force F= 60000 N. Find the safe dimensions of the Knuckle Joint parts (Pin, Eye and Fork).

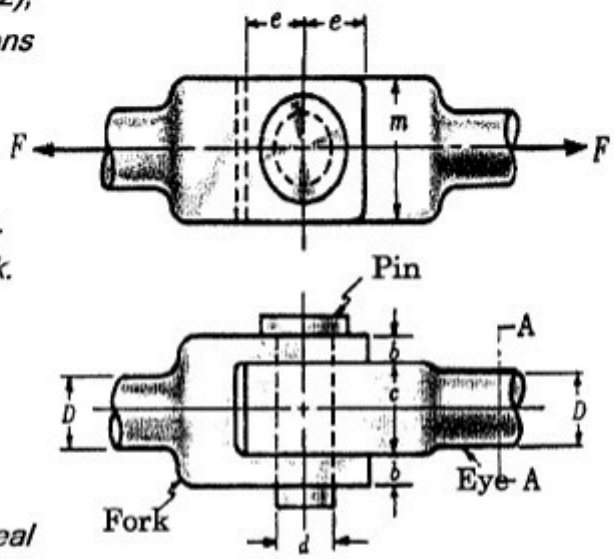


Figure (2)

Question (3): [15 Marks]

Design with neat sketches the layout and speed flow chart of a machine tool speed gearbox as follows:

Given that :	*Required*
Number of speeds (18)	*1. Minimum number of Shafts*
Maximum speed Nmax =2220 rpm	*2. Number of two and three Sliding Blocks*
Minimum speed Nmin =100 rpm	*3. Speed Values (from N1 to N18)*
Speed distribution (Geometric)	*4. Minimum number of Fixed gears*
	5. Minimum number of Sliding gears

Question (4): [15 Marks]

Figure (3) shows a bracket bolted to a column by 4 steel bolts of equal size, and carries a load of P=30 kN. Given that for bolt material, τall = 40MPa. , determine:

a) The resultant force on each bolt.

b) The size of the bolts.

Given that:

L1=700, L2=100 and e=300

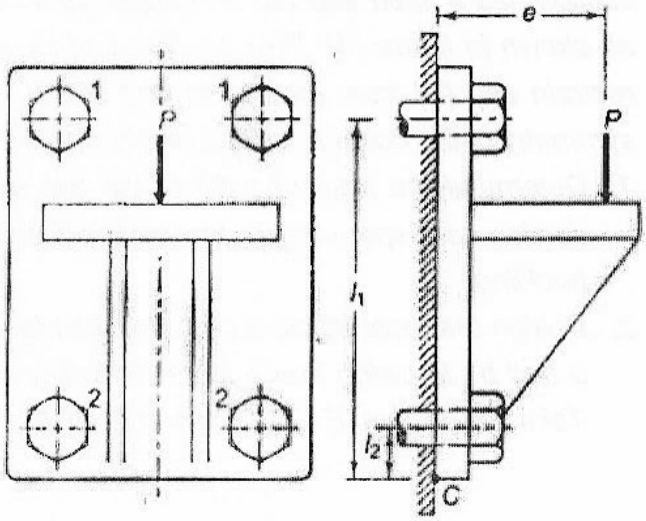


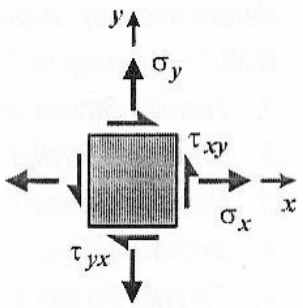
Figure (3)

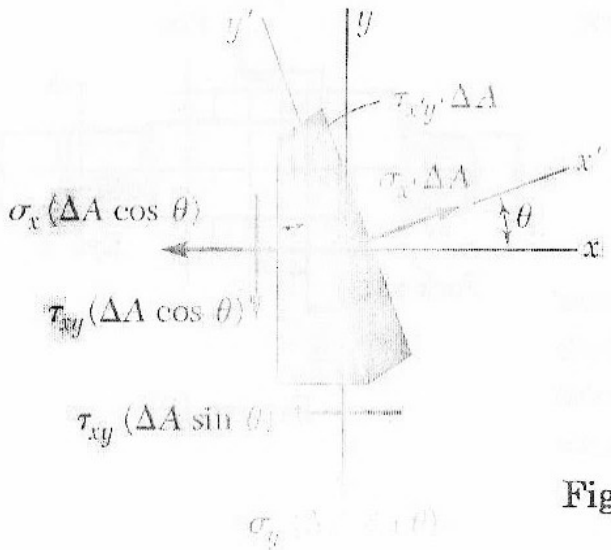
Question (5): [20 Marks]

A) From the elements shown in figure (4), prove that:

a) $\sigma_{x'} = (\sigma_x+\sigma_y)/2 + (\sigma_x-\sigma_y)/2 * \cos(2\theta) + \tau_{xy}*\sin(2\theta)$

b) $\tau_{x'y'} = \tau_{xy} * \cos(2\theta) - (\sigma_x-\sigma_y)/2 * \sin(2\theta)$





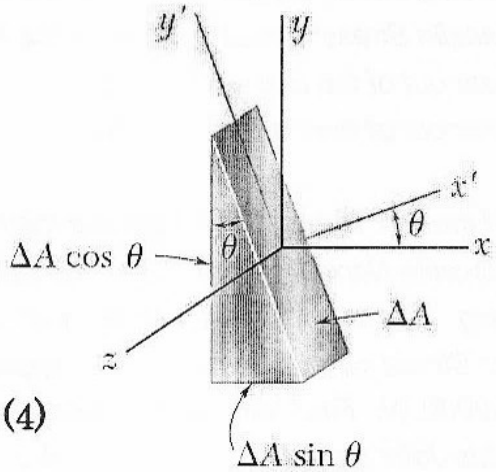


Figure (4)

B) A stress element on the wall of a pressure vessel as shown in Figure (4) has values of stresses as:

σ_x=160 MPa , σ_y=80 MPa and τ_{xy}=30 MPa. Find:

1. Principle stresses (σ_1 and σ_2) and their plane angles (ϕ_{n1} and ϕ_{n2}).
2. Maximum and minimum shear stresses (τ_{max} and τ_{min}) and their plane angles (ϕ_{s1} and ϕ_{s2}).
3. The plane (ϕ) at which (τ/σ)=max, and find its values of τ and σ.
4. The plane (ϕ) at which (τ/σ)=min, and find its values of τ and σ.

Question (6): [20 Marks]

Figure (5) shows a motor, which drives Pulley P1 at 1500 rpm and transmits power through a Flat Belt to Pulley P2. P2 is mounted on a shaft that carries Gear G1. G1 meshes with Gear G2.on Shaft Q which is subjected to a Torque T4=75 N.m. and transmits power to Machine Z.

Assuming no losses and neglecting the weights of elements, find:

a) Motor Power (P) [in Horse Power].

b) Cross sectional area and length of the Flat Belt and the forces acting on the belt.

c) Minimum safe diameter of Shaft Q that carries Gear G2.

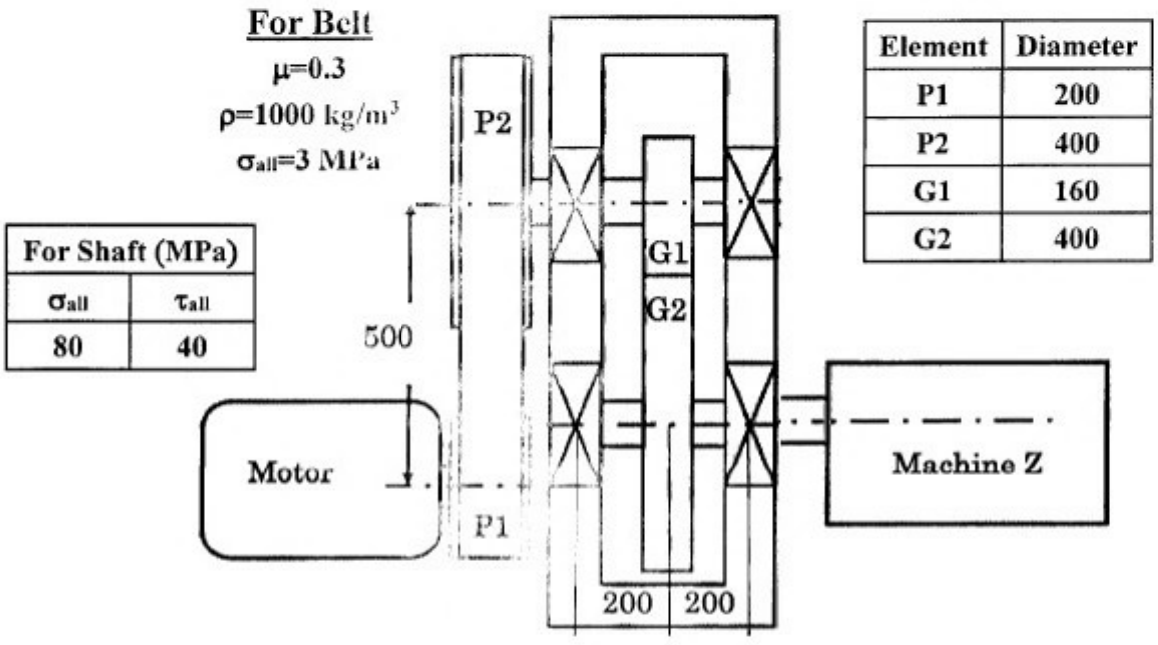


Figure (5)

Good Luck,

Associate Prof. Ahmed Galal