Solve all Questions. All dimensions are in mm.
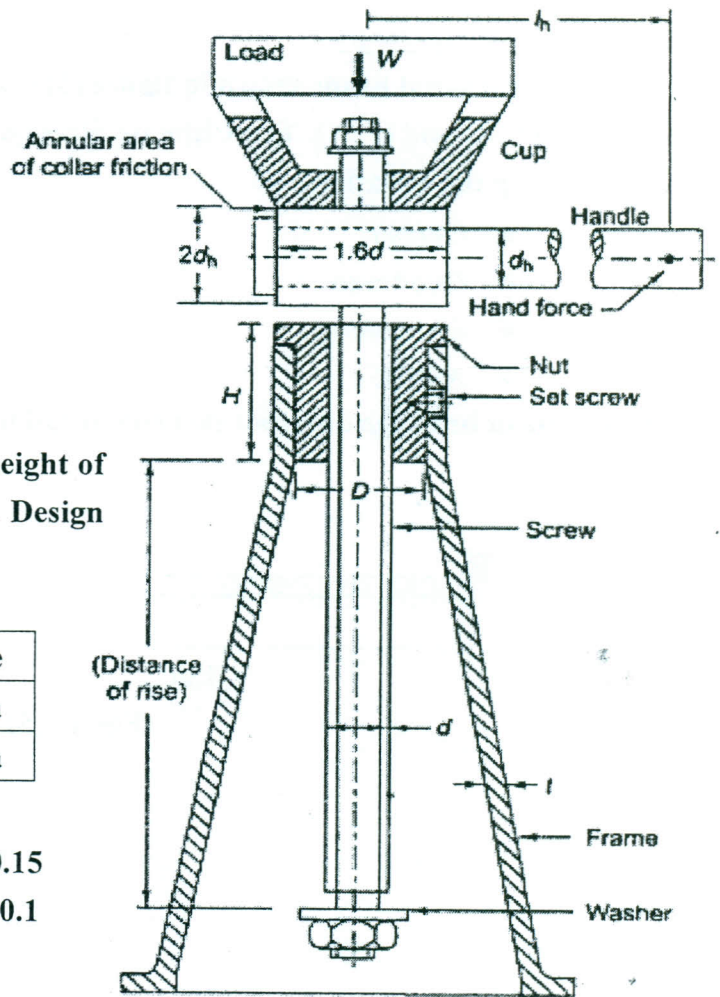## Assume reasonable values for any missing data.

Question1:(30 Marks)

Figure (1) shows a Motor of P=10hp, and N=1200 rpm. The motor drives Pulley P1 that transmits power to Pulley P2 through a Flat Belt. Gear G1 is mounted with P2 on the same shaft. G2 meshes with Gear G1 and transmits power to a Machine through a Flange Coupling. The combined fatigue and shock factors for torsion and bending may be taken as 1.5 and 2 respectively. It is required to design the following elements:
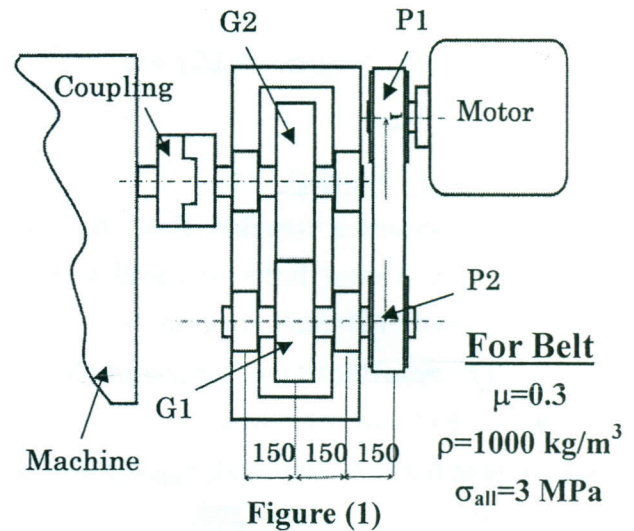
1. Details of the Flat Belt.
2. Diameter of the Shaft carrying Gear 2.
3. Coupling, its 4 bolts and square Keys.

Element	Diameter
G1	50
G2	100
P1 and P2	150

	Steel	
τ_{all}	40MPa	
σ_{all}	80MPa	

For Belt
$\mu=0.3$
$\rho=1000 \text{ kg/m}^3$
$\sigma_{all}=3 \text{ MPa}$

Figure (1)

Question2:(30 Marks)

It is required to lift a load of 10 kN through a height of 500mm using a screw jack shown in figure (2). Design all possible details of this Jack, given that:

	Steel	Cast Iron	Bronze
τ_{all}	60MPa	25MPa	20Mpa
σ_{all}	100MPa	50Mpa	40MPa

Allowable Bearing Stresses of Bronze are: $\mu=0.15$
$\mu_c=0.1$

With Steel	With Cast Iron
18MPa	35MPa

Figure (2)

Question3:(10 Marks)

Find the tensile force (F) that acts axially on a pressure vessel of pressure (P), mean diameter (D), length (L), and thickness (t) as shown in figure (3), and causes a maximum shear stress (τ_{max}) equals to double of the hoop stress (σ_h). i.e ($\tau_{max} = 2\sigma_h$).

Note that:

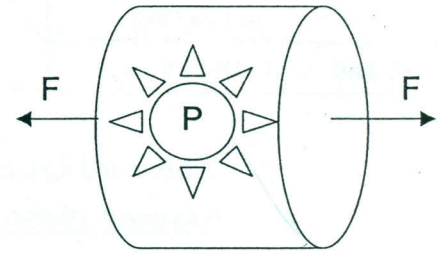$$\tau_{max} = (((\sigma_x - \sigma_y)/2)^2 + \tau_{xy}^2)^{(0.5)}$$

Figure (3)

Question 4:(15 Marks)

Figure (4) shows a bracket fixed to a steel structure by 4 steel bolts of equal size, and carries a load of P=5kN, determine:

- The resultant force on each bolt.
- The size of the bolts.

Given that for bolt material, $\tau_{all} = 50$MPa.
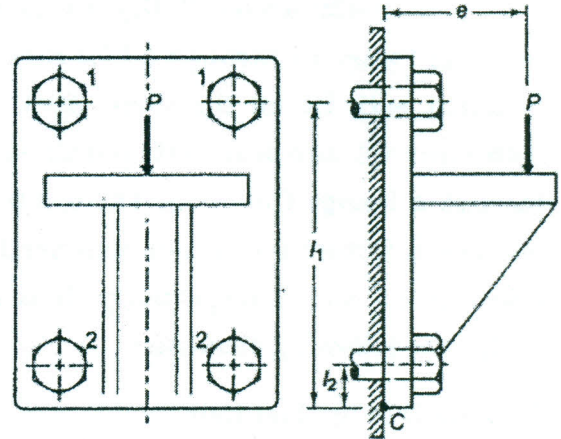
Use l2=50, l1=400, and e=200.

Figure (4)

Question5:(15 Marks)

1- The cantilevered beam shown in figure (5) is subjected to a tip force (F) varies sinusoidal between (1kN) and (5kN). The Ultimate Stress σu=300MPa. Find the values of its Factor of Fafety using the equations of:

- Gerber
- Goodman
- Soderberg
- ASME
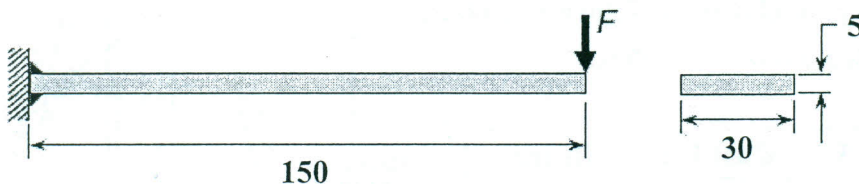
2- Discuss in brief the different theories of failure.

Figure (5)

Good Luck
Dr. Ahmed Galal

2012
30/12