Alexandria Higher Institute of Engineering & Technology (AIET)		
Industrial Department		First Year
ME142	Design of Machine elements	Final, June, 12,2014
Examiners:	Dr. Rola Afify and Prof. Ahmed Elaskary	Time: 3 hour

Answer the following questions:

Question one (10 marks)

The bracket as shown in Fig.1 is to carry a load of 45 KN. Determine the diameter of the rivet if the shear stress is not to exceed 40 MPa. Assume all rivets of the same size.

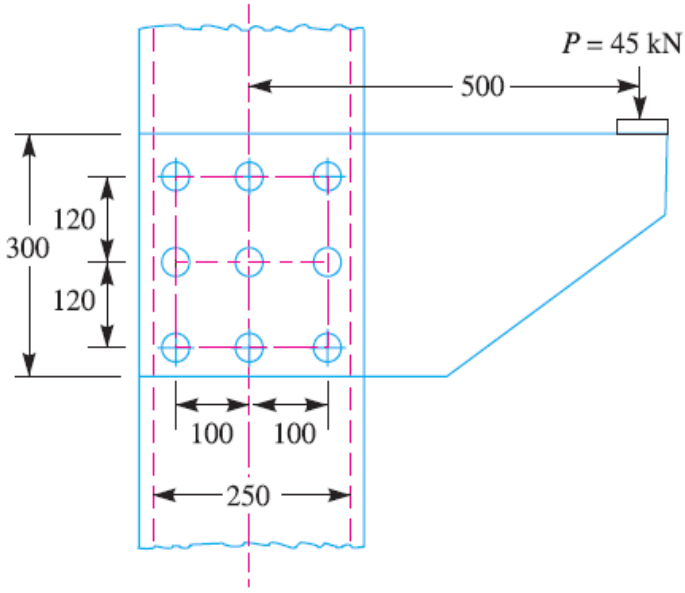
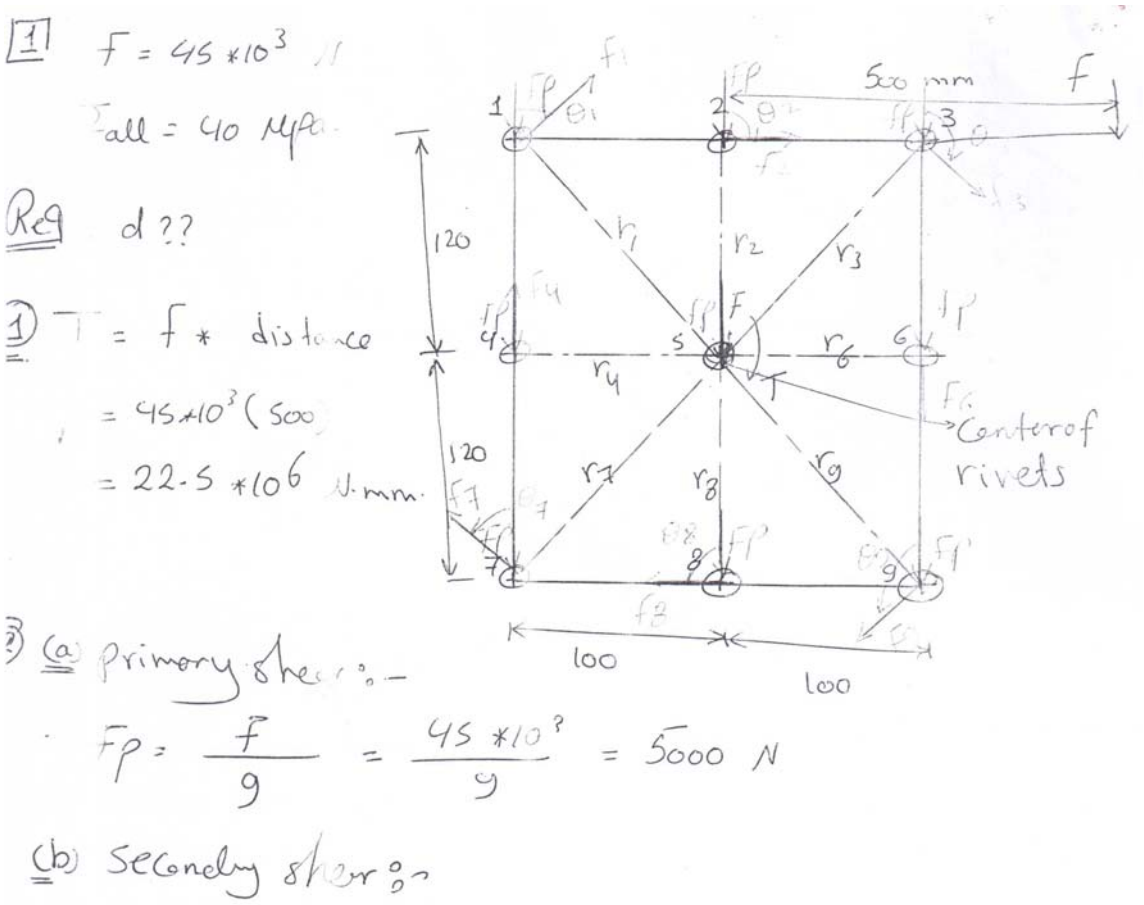


Fig. 1



$$f_m = \frac{T * r_m}{\sum_{i=1}^{n} r_i}$$

$\rightarrow r_2 = r_8 = 120\ mm$

$\rightarrow r_4 = r_6 = 100\ mm$

$\rightarrow r_1 = r_3 = r_5 = r_7 = \sqrt{(120)^2 + (100)^2} = 156.2\ mm$

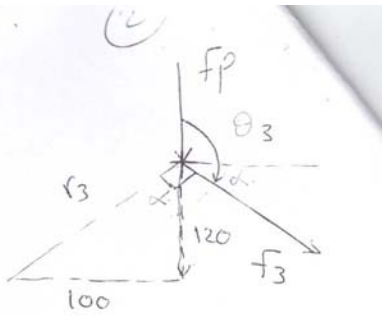
$r_1^2 = r_3^2 = r_7^2 = r_9^2 = 24400\ mm^2$

$\tan \alpha = \frac{100}{120}$

$\alpha = \tan^{-1} \frac{100}{120} = 39.8^\circ$

$\theta = 90 + \alpha = 129.8^\circ$

$\cos \theta = 0.64$



$$f_3 = \frac{T * r_3}{r_1^2 + r_2^2 + r_3^2 + r_4^2 + r_5^2 + r_6^2 + r_7^2 + r_8^2 + r_9^2}$$

$$f_3 = \frac{22.6 * 10^6 * 156.2}{1463393.76} = 24113.87\ N$$

3)

$$f_s = \sqrt{(f_3)^2 + (fp)^2 - 2 f_3 fp \cos \theta_3}$$

$$= \sqrt{(24113.87)^2 + (5000)^2 - 2 * 5000 * 24113.87 * \cos \theta_3}$$

$$f_s = 21263.817\ N$$

4) $\Sigma = \frac{f_s}{A} \leq \tau_{all}$

$$\frac{21263.817}{A} \leq 40$$

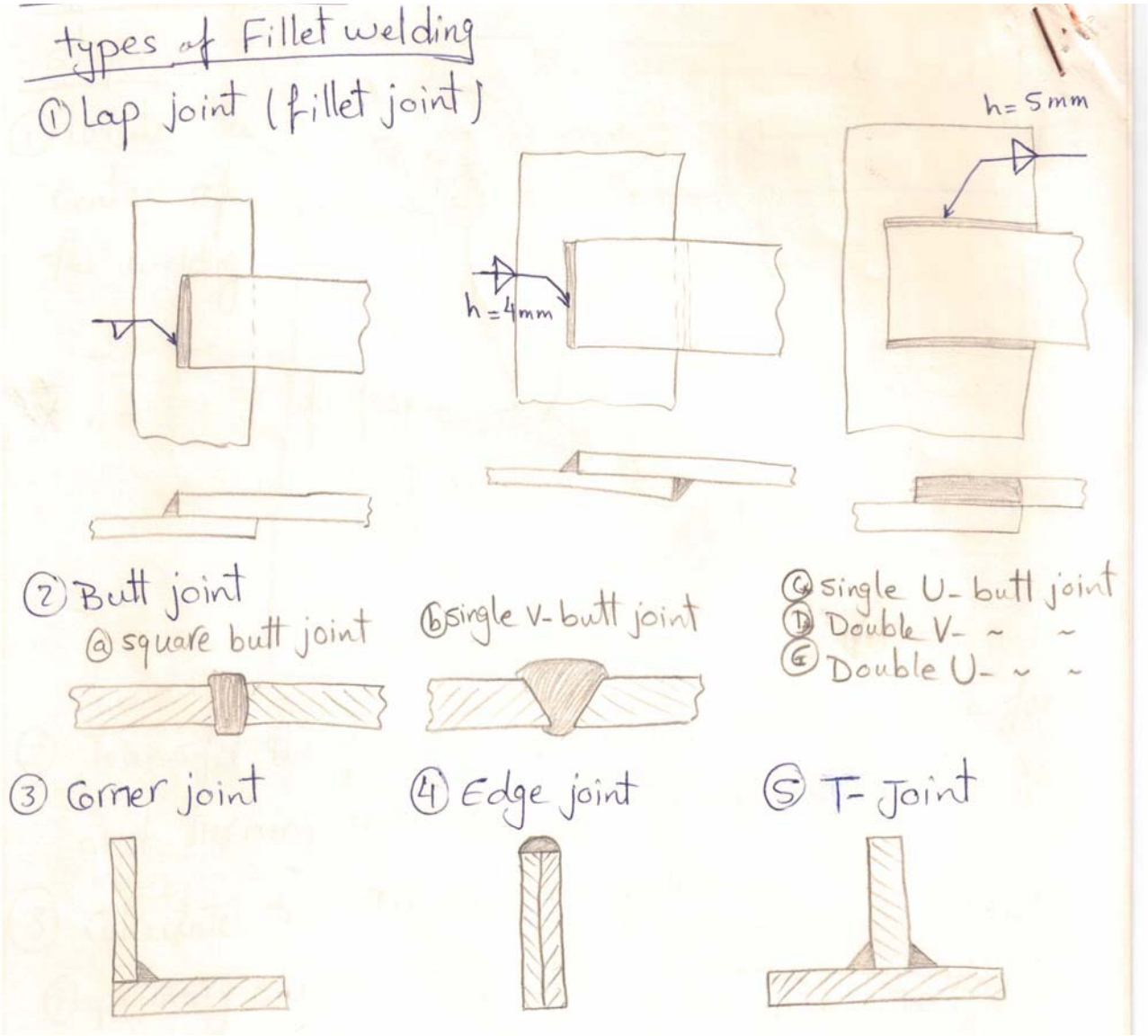
$$A \geq 531.6 \text{ mm}^2$$

$$\frac{\pi}{4} d^2 \geq 531.6 \text{ mm}^2$$

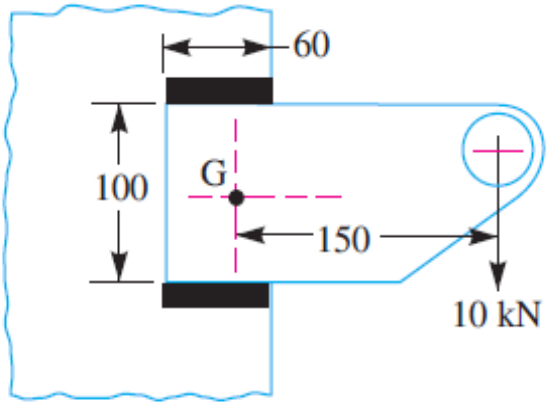
$$d \geq 26.0229 \rightarrow d = 27 \text{ mm}$$

Question two (10 marks)

a) Name and sketch types of fillet welding.



b) A bracket, shown in Fig.2, is to carry a load of 10 KN. Find the size of the weld if the allowable shear stress is not to exceed 80 MPa.



All dimensions in mm.

Fig. 2

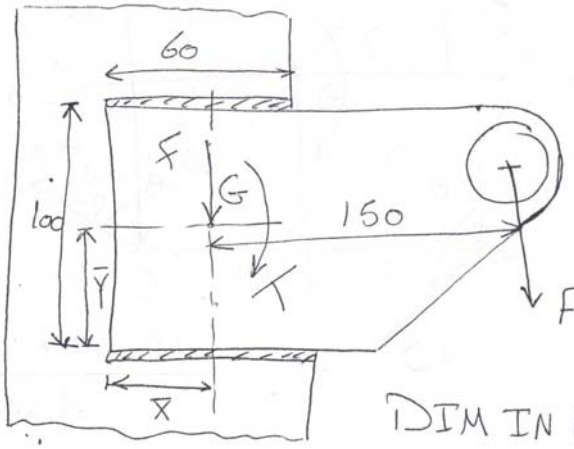
(1) $F = 10\ kN$

$\tau_{all} = 80\ MPa$

h ??

(1) $\bar{X} = \frac{60}{2} = 30\ mm$

$\bar{Y} = \frac{100}{2} = 50\ mm$



(2) $T = f * 150 = 1.5 * 10^6\ N.mm$

$d = 60\ mm$
$b = 100\ mm$

(3) $\tau_p = \frac{F}{A}$

from Table $\longrightarrow$ $A = 1.414\ hd$

$= 84.84\ h \quad mm^2$

$\tau_p = \frac{10{,}000}{84.84\ h} = \frac{117.87}{h} \longrightarrow (1)$

$\tau_s = \frac{Tr}{J} \quad \rightarrow J_u = \frac{d(3b^2 + d^2)}{6} = 336000\ mm$

$J = 0.707\ h\ J_u = 0.707\ h(336000)$

$J = 237552\ h \quad mm^4$

$r_1 = r_2 = r_3 = r_u = \sqrt{50^2 + 30^2} = 58.31\ mm$

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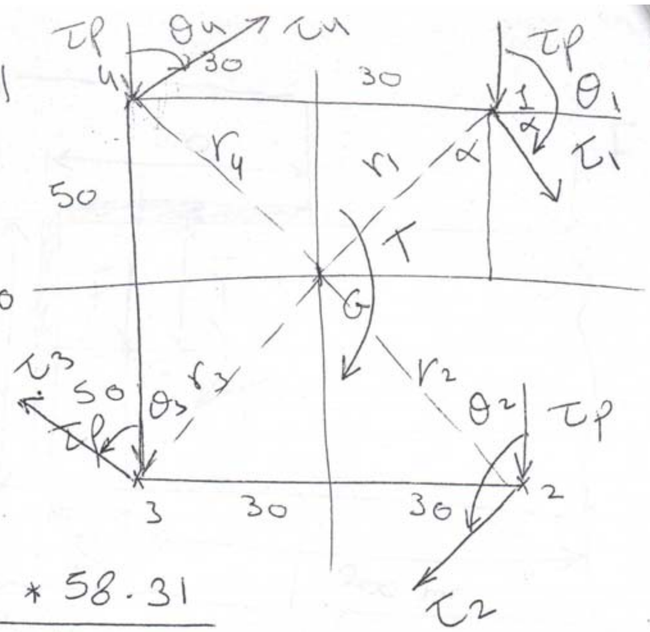
$\theta_1 = 90 + \alpha$

$\alpha = Tan^{-1} \frac{30}{50} = 30.96^0$

$\theta_1 = \theta_2 = 120.96^0$



$\tau_1 = \tau_2 = \frac{1.5 * 10^6 * 58.31}{237552 h}$

$\tau_1 = \frac{368.196}{h} \longrightarrow (2)$

$\tau_{max} = \sqrt{\tau_1^2 + \tau p^2 - 2\tau_1 \tau p \cos\theta_1} \leq 80$

$= \sqrt{\left(\frac{368.196}{h}\right)^2 + \left(\frac{117.87}{h}\right)^2 - 2 * \frac{368.196}{h} * \frac{117.87}{h} \cdot \cos 120.9}$

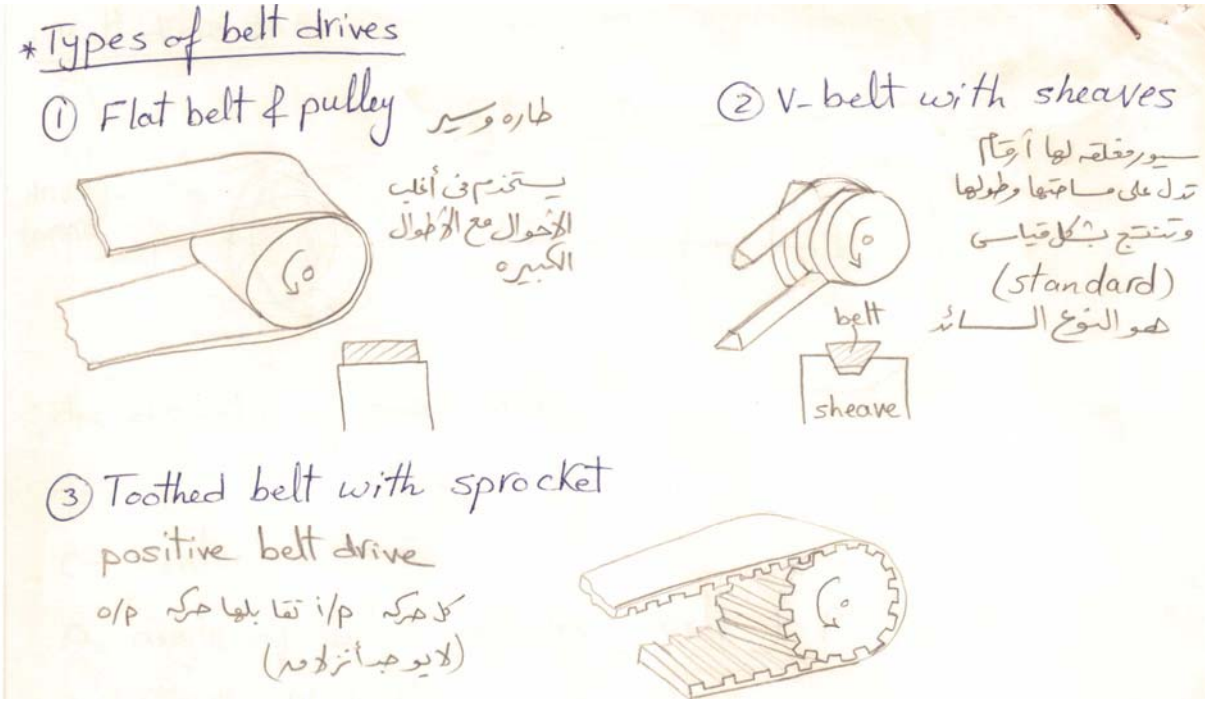
$= \sqrt{\frac{194113.87}{h^2}} \leq 80$

$\frac{440.6}{h} \leq 80$

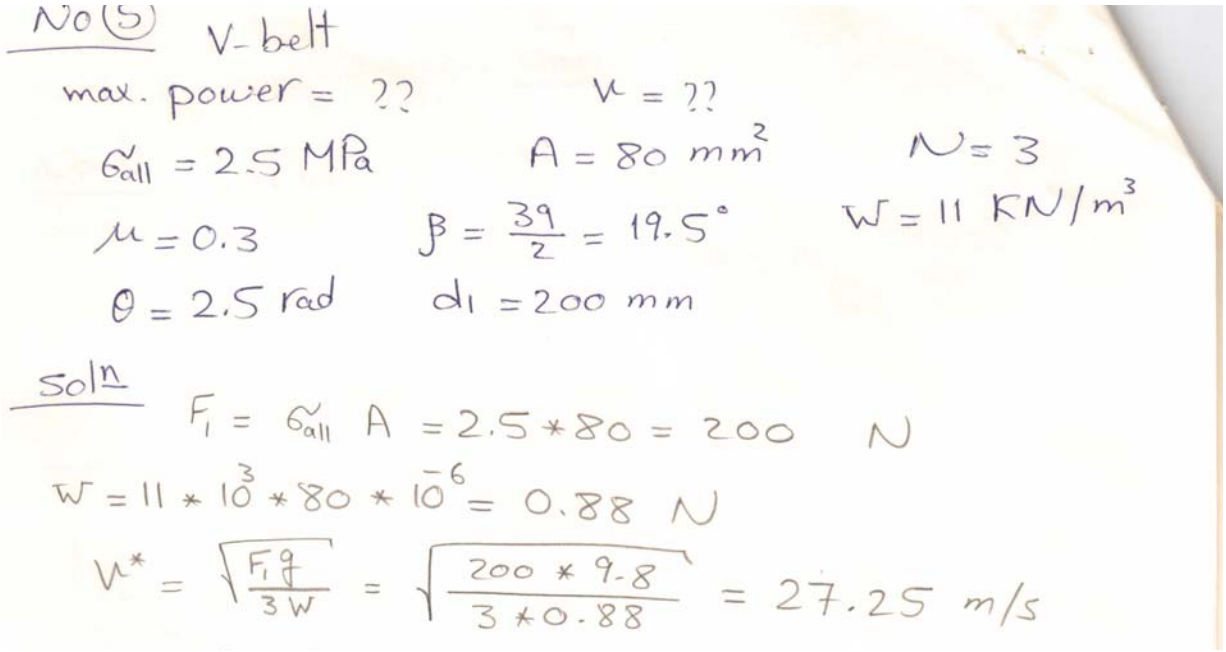
$h \geq 5.5 \ mm$

Question three (10 marks)

a) Name and sketch types of belt drives.



b) Find the maximum power and its corresponding belt speed that can be transmitted through a V-belt drive. The drive specifications are: σ_{all} = 2.5 MPa, Belt cross-section area = 80 mm^2, three belts are used, μ = 0.3, 2β = 38^o, Belt weight 11 kN/m^3, Minimum angle of contact = 2.5 rad, and motor sheave diameter is 200 mm.



$$F_c = \frac{w}{g} v^{*2} = \frac{0.88}{9.8} * (27.25)^2 = 66.6 \ N$$

$$\frac{F_1 - F_c}{F_2 - F_c} = e^{\mu_e \theta} = e^{\frac{\mu}{\sin\beta}\theta} = e^{\frac{0.3}{\sin 19.5} * 2.5} = 2.25$$

$$F_2 = F_c + \frac{F_1 - F_c}{e^{\mu_e \theta}} = 66.6 + \frac{200 - 66.6}{2.25} = 125.97 \ N$$

$$\text{max. power} = (F_1 - F_2)\, v^* * N$$

$$= (200 - 125.97) * 27.25 * 3$$

$$= 6051.698 \ \text{watt}$$

$$= 6 \ KW$$