Question 10.2

$$\sigma_x = -36 \text{ kN/m}^2 \quad \sigma_y = -19 \text{ kN/m}^2$$

$$\tau_{xy} = 14 \text{ kN/m}^2 \quad \phi = 45°$$

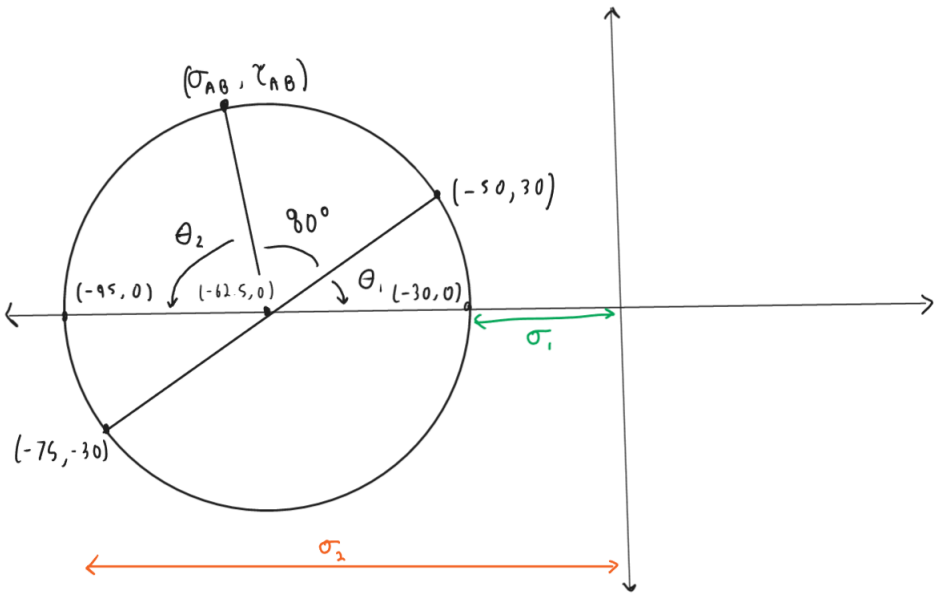
$$\sigma_1 = \frac{\sigma_x + \sigma_y}{2} + \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \boxed{-11.12 \text{ kN/m}^2}$$

$$\sigma_2 = \frac{\sigma_x + \sigma_y}{2} - \sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \boxed{-43.88 \text{ kN/m}^2}$$

$$\sigma_n = \frac{\sigma_x + \sigma_y}{2} + \frac{\sigma_x - \sigma_y}{2}\cos(2\phi) + \tau_{xy}\sin(2\phi) = \boxed{-13.5 \text{ kN/m}^2}$$

$$\tau_{AB} = \frac{\sigma_x - \sigma_y}{2}\sin(2\phi) + \tau_{xy}\cos(2\phi) = \boxed{-8.5 \text{ kN/m}^2}$$

Question 10.4



The center of the circle is:

$$\frac{\sigma_x + \sigma_y}{2} = \frac{-50 - 75}{2} = -62.5$$

The radius is:

$$\sqrt{\left(\frac{\sigma_x - \sigma_y}{2}\right)^2 + \tau_{xy}^2} = \sqrt{\left(\frac{-50 + 75}{2}\right)^2 + 30^2} = 32.5$$

$$\sigma_1 = -62.5 + 32.5 = \boxed{-30 \text{ kN/m}^2}$$

$$\sigma_2 = -62.5 - 32.5 = \boxed{-95 \text{ kN/m}^2}$$

$$\tau_{max} = \boxed{32.5 \text{ kN/m}^2}$$

$$\theta_1 = \tan^{-1}\left(\frac{50}{30}\right) = 30.96^\circ$$

$$\theta_2 = 180 - 80 - \theta_1 = 69.04^\circ$$

$$\sigma_{AB} = \sigma_1 - R - R\cos(\theta_2) = -30 - 32.5 - 32.5 \times \cos(69.04) = \boxed{-94.9 \text{ kN/m}^2}$$

$$\tau_{AB} = -R\sin(\theta_2) = -32.5\sin(69.04) = \boxed{-30.42 \text{ kN/m}^2}$$

Question 10.16

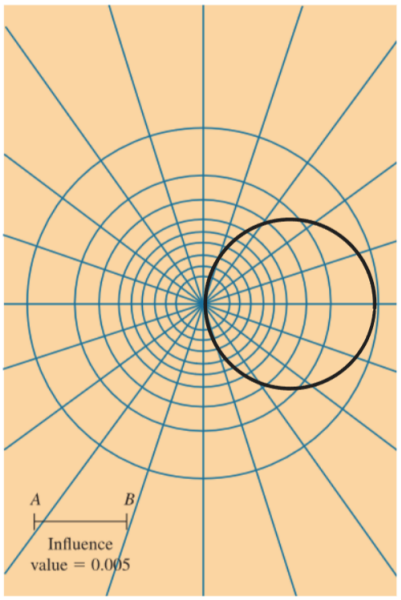
r/R is zero, so the first column in tables 10.9 and 10.10 are used. This requires a lot of linear interpolation, which was done in excel. Once A' and B' are obtained, the following equation is used:

$$\Delta q_z = q(A' + B')$$

Below are tabulated values. (We know from the question that $q = 200$ kN/m^2)

Depth (m)	z/R	A'	B'	$\Delta\sigma_z$ (kN/m^2)
1.5	0.375	0.64962	0.348368	199.5975
3	0.75	0.400925	0.38289	156.763
6	1.5	0.16795	0.25602	84.794
9	2.25	0.088545	0.15348	48.405
12	3	0.05132	0.09487	29.238

Question 10.18



The amount of elements enclosed is approximately 65. Now use the following equation:

$$\Delta\sigma_z = (IV)qM = 0.005 \times 300 \times 65 = \boxed{97.5 \text{ kN/m}^2}$$

Question 10.20

We need to calculate a bunch of values to calculate I_4.

$$m_1 = \frac{L}{B} = \frac{4}{2} = 2$$

$$b = \frac{B}{2} = 1$$

$$n_1 = \frac{z}{b} = 3.5$$

I just took an average from the two values in table 10.12.

$$I_4 = \frac{2.93 + 0.19}{2} = 0.242$$

$$\Delta\sigma_z = 100 \times 0.242 = \boxed{24.2 \text{ kN/m}^2}$$