Homework 5 Fall 2017 TA: Joseph Aymond

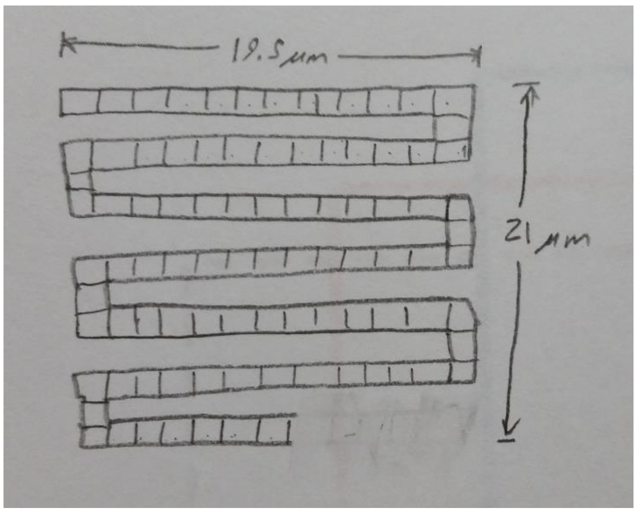
Problem 1:

Sheet Resistance of poly is 23.5 Ω/■ => $\frac{2000}{23.5} = 85.1$

Min Poly width in resistor is 1.5 µm and min spacing is 0.9 µm.

If we use 13■ X 7 lines we get 12 corners $=> 13 * 7 + 6 - 12 * .45 = 91.6$

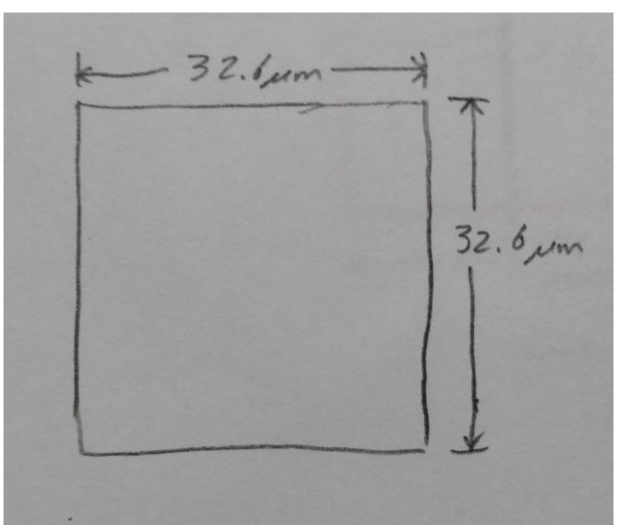
Remove 6 squares from last row to get 85.6 ■ $= 2011\ \Omega \cong 2\ k\Omega$



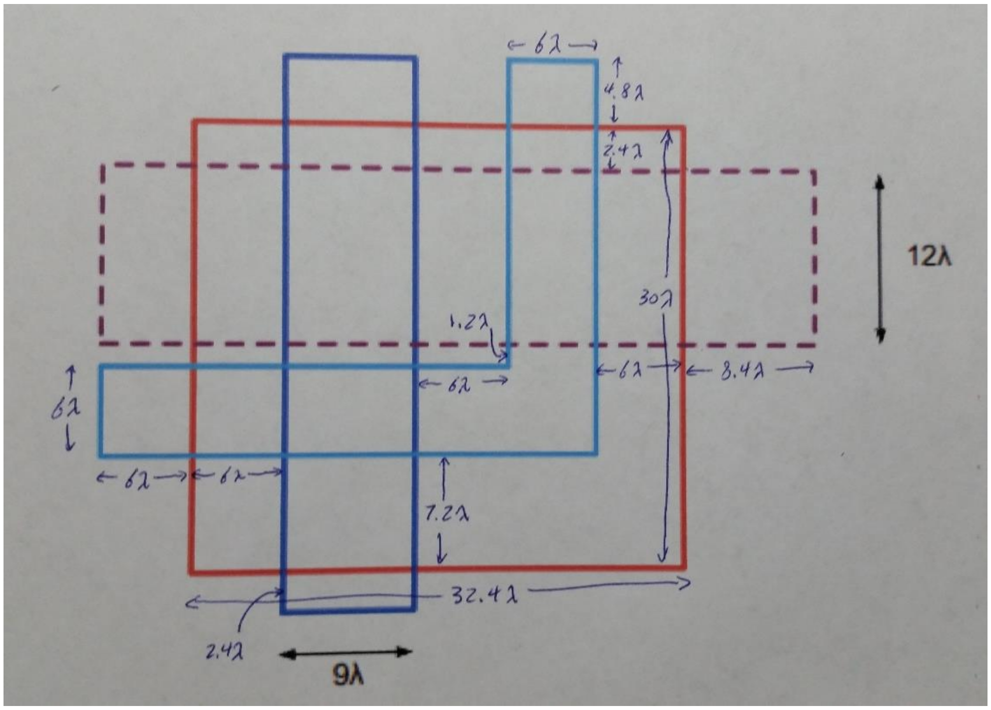
Problem 2:

Using poly and poly2 => 938 aF/µm^2

$$A_C = \frac{1 * 10^{-12}\,F}{938 * 10^{-18}\,F/\mu m^2} = 1066\ \mu m^2 => \sqrt{A_C} = 32.6\mu m$$



Problem 3:



$$C_{32} = A_{32} * 35\frac{aF}{\mu m^2} = \lambda^2 * (6 * 9) = 226.8\, aF$$

$$C_{31} = A_{31} * 13\frac{aF}{\mu m^2} = \lambda^2 * (12 * 6) = 63.18\, aF$$

$$C_{3P} = A_{3P} * 9\frac{aF}{\mu m^2} = \lambda^2 * (6 * 6 + 6 * 12 + 6 * 1.2) = 93.312\, aF$$

$$C_{3S} = A_{3S} * 7\frac{aF}{\mu m^2} = \lambda^2 * (6 * 6 + 6 * 4.8) = 40.82\, aF$$

$$C_{21} = A_{21} * 31\frac{aF}{\mu m^2} = \lambda^2 * (12 * 9) = 301.32\, aF$$

$$C_{2P} = A_{2P} * 15\frac{aF}{\mu m^2} = \lambda^2 * (6 * 12 + 12 * 18) = 388.8\, aF$$

$$C_{2S} = A_{2S} * 12\frac{aF}{\mu m^2} = \lambda^2 * (6 * 12 + 12 * 8.4) = 186.62\, aF$$

$$C_{1P} = A_{1P} * 56\frac{aF}{\mu m^2} = \lambda^2 * (30 * 9) = 1360.8\, aF$$

$$C_{1S} = A_{1S} * 27\frac{aF}{\mu m^2} = \lambda^2 * (2.4 * 9 + 4.8 * 9) = 157.46\, aF$$

$$C_{PS} = A_{PS} * 84\frac{aF}{\mu m^2} = \lambda^2 * (30 * 32.4) = 7348.32\, aF$$

Problem 4:

$$R(320) = 2034 * \left(1 + (320 - 250) * \left(\frac{800}{10^6}\right)\right) = 2148\ \Omega$$

Problem 5:

$$\mu = \mu_{min} + \frac{\mu_{max} - \mu_{min}}{1 + \left(\frac{N}{N_r}\right)^{\alpha}} = 52.2 + \frac{1417 - 52.2}{1 + \left(\frac{1014}{9.68 * 10^{16}}\right)^{0.68}} = 1404$$

$$R_s = \frac{1}{q * N * \mu * t} = \frac{1}{1.6 * 10^{-19} * 10^{14} * 1404 * 10^{-4}} = 445.2 * 10^3\ \Omega/\blacksquare$$

$$R = R_s * \left(\frac{L}{W}\right) = 445.2 * 10^3 * \left(\frac{100}{2}\right) = 22.26 * 10^6\ \Omega$$

Problem 6:

Value of combination is $R_T = R_1 + R_2$

Substitution and algebra yield $R_T = (R_1 + R_2) * (1 + \frac{\Delta T}{10^6} * \left(\frac{R_1}{R_1+R_2} * TCR_1 + \frac{R_2}{R_1+R_2} * TCR_2\right)$

This matches the form of the original equation if $TCR_T = \left(\frac{R_1}{R_1+R_2} * TCR_1 + \frac{R_2}{R_1+R_2} * TCR_2\right)$

=> $TCR_T = 66.67\ ppm/°\mathrm{C}$

The TCR is $\frac{1400}{66.67} = 21$ times less than just an n+ doped resistor.

Problem 7:

$$R = R_s * \left(\frac{L}{W}\right) = 23.5 * \left(\frac{200}{1}\right) = 4700\ \Omega$$

$$C_{PS} = \left(84 \frac{aF}{\mu m^2}\right) * (200 * 1) = 16.8\ fF$$

$$C_{P2} = \left(15 \frac{aF}{\mu m^2}\right) * (200 * 1) = 3\ fF$$