Homework 5 Solution

R_{die} & R_{solder} are same as example in class

$$\alpha = \tan^{-1}\left(\frac{K_{solder}}{K_{Al}}\right) = \tan^{-1}\left(\frac{0.914}{0.533}\right) = 1.043 \text{ rad}$$

$$W_2 = \underset{W_{Die}}{0.25 \text{ in}} + 2\,\underset{T_c}{(0.05 \text{ in})}\sin 1.043 \text{ rad} = 0.336 \text{ in}$$

$$W_{eff} = \sqrt{W_D W_2} = \sqrt{(0.25)(0.336}} = 0.290 \text{ in}$$

$$R_{A1} = \frac{0.05 \text{ in}}{(0.533 \text{ W/in°C})(0.290 \text{ in})^2} = \frac{L}{KA} = 1.115 \text{°C/W}$$

$$R_{total} = 0.05 + 0.035 + 1.115 = R_{die} + R_{Solder} + R_{substrate} = 1.21 \text{°C/W}$$

(0.05 from example)

$$T_D = Q R_{total} + T_a = 12 \text{W}(1.21 \text{°C/W}) + 25\text{°C} = 39.4\text{°C}$$

Max stress

$$\beta = \sqrt{\frac{G}{t_s}\left(\frac{1}{E_D t_D} + \frac{1}{E_s t_s}\right)} = \sqrt{\frac{6.9\times10^9 \text{ Pa}}{0.05 \text{ in}}\left(\frac{1}{129\times10^9 \text{ Pa}(0.012 \text{ in})} + \frac{1}{344\times10^9 \text{ Pa}(0.05 \text{ in})}\right)}$$

$$= 9.86 \text{ in}^{-1}$$

$$S_m = \frac{(TCE_s - TCE_D) \times (T_p - T_A) \times L \times G \times \tanh\beta}{\beta \times t_B}$$

$$= \frac{(6.5\times10^{-6} - 2.8\times10^{-6}\,°C^{-1})(290 - 39.4°C)\overbrace{(0.250\times1.414 \text{ in})}^{\text{Diagonal}}(1\times10^6 \text{ psi})\tanh(9.86 \text{ in}^{-1})}{(9.86 \text{ in}^{-1})(0.002 \text{ in})}$$

$$= 1.66\times10^4 \text{ psi}$$