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ENGI 301
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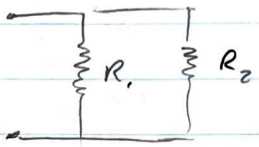
# Problem Set #1

1. a. 220 Ohm → red, red, black, gold ← gold for 5% tolerance
   b. 330 Ohm → orange, orange, brown, gold
   c. 1k Ohm → brown, black, red, gold
   d. 2.2k Ohm → red, red, red, gold
   e. 4.7k Ohm → yellow, violet, red, gold
   f. 10k Ohm → brown, black, orange, gold
   g. 100k Ohm → brown, black, yellow, gold

2. a. 250 Ohm

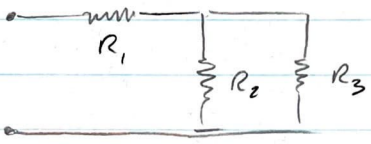



$R_1 = 1k\Omega$
$R_2 = 330\Omega$

$$R_{eq} = \frac{1}{\frac{1}{1k\Omega} + \frac{1}{330\Omega}}$$

$$R_{eq} = 250\Omega$$

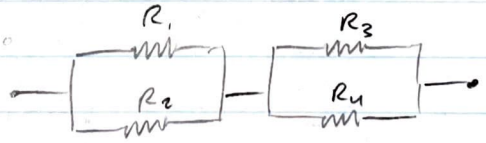
b. 2500 Ohm




$R_1 = 1k\Omega$
$R_2 = 2.2k\Omega$
$R_3 = 4.7k\Omega$

$$R_{eq} = 1k\Omega + \frac{1}{\frac{1}{2.2k\Omega} + \frac{1}{4.7k\Omega}} = 1k\Omega + 1.5k\Omega = 2.5k\Omega$$

c. 1750 Ohm




$R_1 = 2.2k\Omega$ $R_3 = 1k\Omega$
$R_2 = 4.7k\Omega$ $R_4 = 330\Omega$

$$R_{eq} = \frac{1}{\frac{1}{2.2k\Omega} + \frac{1}{4.7k\Omega}} + \frac{1}{\frac{1}{1k\Omega} + \frac{1}{330\Omega}} = 1.5k\Omega + 250\Omega = 1.75k\Omega$$

3. 250 Ohm: Minimum value: $R_1 = 0.95 \cdot 1k\Omega = 950\Omega$

$$R_2 = 0.95 \cdot 330\Omega = 313.5\Omega$$

$$R_{eq,min} = \frac{1}{\frac{1}{950\Omega} + \frac{1}{313.5\Omega}} = 235.71\Omega$$

Maximum values: $R_1 = 1.05 \cdot 1k\Omega = 1050\Omega$

$$R_2 = 1.05 \cdot 330\Omega = 346.5\Omega$$

$$R_{eq,max} = \frac{1}{\frac{1}{1050\Omega} + \frac{1}{346.5\Omega}} = 260.53\Omega$$

Max: 261Ω
Min: 236Ω

4. According to the LTL-4234 datasheet, the maximum forward current that can be maintained across the entire operating temperature range is 10 mA (from Fig. 3). Assuming the diode has no resistance ...

$$V = IR \rightarrow R = \frac{V}{I} = \frac{3.3\,V}{10\,mA} = 330\,\Omega \rightarrow \boxed{R_1 = 330\,\Omega}$$

5. a. According to the TL5209 datasheet section 9.2.2.1:

$$V_{out} = 1.242\,V \cdot \left(1 + \frac{R_2}{R_1}\right)$$

$$V_{out} = 1.242\,V \cdot \left(1 + \frac{470\,k\Omega}{280\,k\Omega}\right) = 3.327\,V \rightarrow \boxed{V_{out} = 3.3\,V}$$

b. $V_{out,max} = 1.242\,V \cdot \left(1 + \frac{1.01\,(470\,k\Omega)}{0.99\,(280\,k\Omega)}\right) = 3.369\,V \rightarrow \boxed{V_{out,max} = 3.37\,V}$

$$V_{out,min} = 1.242\,V \cdot \left(1 + \frac{0.99\,(470\,k\Omega)}{1.01\,(280\,k\Omega)}\right) = 3.286\,V \rightarrow \boxed{V_{out,min} = 3.29\,V}$$

c. Over the entire temperature of -40°C to 125°C, the TL5209 has a voltage accuracy of ± 2% according to the table in section 7.5.

d. $\eta$ = power efficiency → $P_{in} = V_{in} \cdot (I_{in}) = V_{in}\left(I_{out} - \cancel{I_{ground}}\right)$ (negligible)

$$P_{out} = V_{out}\,(I_{out})$$

$$\eta = \frac{P_{out}}{P_{in}} = \frac{V_{out}\,\cancel{I_{out}}}{V_{in}\,\cancel{I_{out}}} = \frac{V_{out}}{V_{in}} = \frac{3.327\,V}{5\,V} = 0.665 \rightarrow \boxed{\eta = 0.665}$$