Homework 2

Chapters 4 and 5
4.2) \( Z_s = 600 \Omega \) source
\( Z_L = 8 \Omega \) load
Maximum power is transferred when \( Z_s = Z_L \).
Hence, the secondary of the transformer is \( Z_L \).
So:
\[
\frac{Z_L}{Z_s} = \frac{Z_{\text{second}}}{Z_{\text{primary}}} = \left( \frac{N_{\text{second}}}{N_{\text{primary}}} \right)^2 = \left( \frac{N_L}{N_s} \right)^2
\]
or
\[
N_L/N_s = \left( \frac{Z_L}{Z_s} \right)^{1/2} = \left( \frac{8 \Omega}{600 \Omega} \right)^{1/2} = 0.115
\]
Finally, the transformer must have:
\( N_{\text{second}} = 0.115 N_{\text{primary}} \)

4.13) From the previous problem:
\( C_{\text{cable}} = 30 \times 10^{-6} \text{ F/m} \)
\( L_{\text{cable}} = 0.169 \times 10^{-6} \text{ H/m} \)

Hence, the cable's impedance is:
\[
Z_{\text{cable}} = \sqrt{L_C} = 175 \Omega
\]

Since pulse generator has 75 \( \Omega \) output impedance, the interface between the pulse generator and the cable will have no reflections. The only reflections will occur at the cable-detector interface. At this interface, the reflected amplitude coefficient is:
\[
A_R = \frac{Z_{\text{detected}} - Z_{\text{cable}}}{Z_{\text{detected}} + Z_{\text{cable}}}
\]
\[
= \frac{1 \Omega - 75 \Omega}{1 \Omega + 75 \Omega} = 0.96
\]
This means 94% of the signal is transmitted. The reflected portion is absorbed by the pulse generator, so no further reflections
5.1) 

Note large capacitors (electrolytic) which set ripple voltage. The ±12V supplies will also require a low pass filter. The ±5V supply can simply use a voltage regulator.

On the output side of the transformer, the power output is: 
\[ P = IV = (12V)(0.5A) + (5V)(0.25A) + (12V)(0.1A) \]
\[ = 6W + 1.25W + 1.2W \]
\[ = 8.45W \]

Considering that 0.85A is drawn on the secondary side of the transformer, a 1A transformer should prove sufficient.

5.2) 

C1 is large and chosen to set initial ripple. If \( R = R_e \), then \( R \) and \( R_e \) form a voltage divider; since \( V_0 = 15V \), \( V_0 \cdot C_0 = 30V \). If we desire to have \( C_1 \) create a 1% ripple: \( C_1 = \frac{1}{0.01} \)

where \( dV = 0.01 \cdot 30V = 0.3V \)
\[ I = 0.1A \]
\[ V = R \cdot 60Hz \cdot 120Hz \] for full wave rectifier
Then: \[ C_1 = \frac{0.1 A}{0.3 V \cdot 120 \mu s} = 2800 \mu F \]

R and C form a low-pass filter. The 0.3V ripple from C1 needs to be reduced to 0.0015V, or by a factor of 200. One requires the RC time constant of the filter to be \( > 200 \) longer than the frequency of the rectified signal:

\[ \tau = 200RC \geq \frac{1}{120Hz} \]

Since:

\[ R = R_C = \frac{V}{I} = \frac{15V}{15mA} = 150 \Omega \]

So:

\[ C_e = \frac{1}{(200)(120Hz)(150\Omega)} = 0.25 \times 10^{-6} F = 0.25 \mu F \]