ELECTRONICS MIDTERM

Read each question carefully. Record your answer with correct units in the spaces provided. Please show your work.

1 - A researcher measures an r.m.s. voltage to be $V_{\text{RMS}} = 1200\text{V}$. at 1660c.p.s.(cycles per second) What is the corresponding peak voltage $V_p$, peak-to-peak voltage $V_{pp}$, and angular frequency $\omega$?

$$V_p = \underline{1700\text{ V}}$$

$$V_{pp} = 2V_p = \underline{3400\text{ V}}$$

$$\omega = 2\pi f = \underline{10430 \text{ rd/s}}$$

$$V_p = \sqrt{2} \times 1200 = 1700\text{ V}$$

$$V_{pp} = 2V_p = 3400\text{ V}$$

$$\omega = 2\pi f = 10430 \text{ rd/s}$$

2- A meter reading indicates that $V_{ab} = 1.5\text{ V}$. What voltage $V$ is the power supply producing?

$$V = \underline{4.7 \text{ V}}$$

$$R_{23} = (2.7) (10)/12.7\ \Omega=2.13\ \Omega$$

$$V_{av} = 1.0/(2.13+1.0)\ V$$

$$V = (3.13/1.0)\ 1.5\text{ V} = 4.7\text{ V}$$
3- Using Thevenin’s theorem, find the effective voltage $V_{\text{TH}}$ and effective resistance $R_{\text{TH}}$ of the circuit at a,b.

$$V_{\text{TH}} = \boxed{13.6 \text{ V}}$$

$$R_{\text{TH}} = \boxed{0.68 \Omega}$$

\[ \begin{align*}
20V & \quad \bigg/ & 1\Omega & \quad \bigg/ & 2.7\Omega & \quad \bigg/ & 10\Omega \\
\end{align*} \]

\[ R_{23} = (2.7)(10.0)/12.7 = 2.13 \Omega \]

(1) Find $V_{ab} = V_{\text{TH}} = (2.13/3.13) \times 20V = \boxed{13.6 \text{ V}}$

(2) Short the voltage supply and find $R_{ab}$.

\[ 1/R_{ab} = 1/1 + 1/2.7 + 1/10 = 1.47 \Omega^{-1} \text{ (three in parallel!!)} \]

\[ R_{ab} = R_{\text{TH}} = \boxed{0.68 \Omega} \]

4- With a peak supply voltage of $V_p = 20V$ and frequency $f = 120\text{Hz}$, determine the r.m.s voltage measured at a,b, $V_{ab}$ (rms).

\[ \omega = 2\pi f = 754 \text{ rd/s} \quad |Z_c| = 1/\omega C = 663 \Omega \]

\[ |Z_{\text{TOT}}| = \left( (2.7)^2 + (1/\omega C)^2 \right)^{1/2} = 2780 \Omega \]

\[ V_{ab} = \frac{|(1/\omega C) / Z_{\text{TOT}}|}{V_{\text{in}}} = (2700/2780) \times 20V = 19.4V \]

\[ V_{ab} \text{ (rms)} = 19.4/\sqrt{2} = \boxed{13.7 \text{ V}} \]
5- As the frequency is adjusted in the circuit of Problem #4, find the frequency break (at 
–3 db) Is this circuit a low or high pass filter? Carefully sketch the Gain vs f.

\[ f_B = 29.5 \text{ Hz} \]  
High Pass or Low Pass (circle one)

\[
\text{Gain} = 1.25 \quad 1.00 \quad 0.75 \quad 0.50 \quad 0.25 \quad 0.00 \\
\text{f = 1Hz 10 100 1K 10K 100K 1M 10MHz}
\]

\[
\text{RC} = (2700)(2\times10^{-6}) = 0.0054 \text{ s} \\
f_B = \frac{1}{2\pi RC} = 29.5 \text{ Hz}
\]

6- A filter reduces the gain of a circuit by 50, Vout/Vin = 1/50. What db filter is being 
used?

\[ \text{db} = -34\text{db} \]

\[
db = 20 \log(1/50) = -34\text{db}
\]
7-Determine the resonance frequency \( f_0 \) and \( Q \) of this series R-L-C circuit. Would you say it is a low or high \( Q \) circuit? Explain.

\[
\begin{align*}
    f_0 &= 112.5 \text{ Hz} \\
    Q &= 0.35
\end{align*}
\]

\[f_0 = \frac{1}{2\pi}\sqrt{\frac{L}{C}} = 112.5 \text{ Hz} \]
\[Q = \frac{X_L}{R} = \omega L/R = 0.35\]

Explain LO or HI \( Q \): \( LO Q \) because height to width ratio < 1.

8-A audio signal generator has an output impedance of 600\( \Omega \). To drive an 8W speaker with maximum power transfer an impedance matching transformer is used. Specify the transformers winding ratio \( N_1/N_2 \). If \( V_1=10V \) what current and voltage are developed in the secondary coil?

\[
\begin{align*}
    N_1/N_2 &= 8.7 \\
    I_2 &= 0.15V \\
    V_2 &= 1.15V
\end{align*}
\]

\[
\begin{align*}
    (N_1/N_2)^2 &= 600/8 \\
    N_1/N_2 &= 8.7 \\
    I_1 &= V_1/R_1 = 0.017 \text{ A} \\
    V_2 &= V_1 (N_2/N_1) = 1.15V \\
    I_2 &= V_2/8 = 0.15V
\end{align*}
\]