NAME ________________________________________________________________

Do all problems

Please write clearly and underline or [box] your answer.

1. ________

2. ________

3. ________

4. ________

5. ________

6. ________
Formulae

\[ p(t) = \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) + \frac{V_m I_m}{2} \cos(\theta_v - \theta_i) \cos 2\omega t - \frac{V_m I_m}{2} \sin(\theta_v - \theta_i) \sin 2\omega t \]

\[ p(t) = P + P \cos 2\omega t - Q \sin 2\omega t \]

\[ S = P + jQ = \frac{1}{2} \tilde{V} \tilde{I}^* = \tilde{V}_{\text{rms}} \tilde{I}_{\text{rms}}^* \]

Apparent Power \[ |S| = \sqrt{P^2 + Q^2} \]

\[ \tilde{V}_{\text{rms}} = Z \tilde{I}_{\text{rms}} \]

\[ S = Z \tilde{I}_{\text{rms}} \tilde{I}_{\text{rms}}^* = Z I_{\text{rms}}^2 = (R + jX) \tilde{I}_{\text{rms}}^2 \]

\[ S = \tilde{V}_{\text{rms}} \tilde{I}_{\text{rms}}^* = |\tilde{V}_{\text{rms}}|^2 / Z^* = |\tilde{V}_{\text{rms}}|^2 Y^* \]
1. (15%) (Source Transformation)

Do the following:
Find \( v_o(t) \) using source transformations.

Figure 1: Circuit
2. (15%) (Non-ideal Transformer)

Figure 2: Ideal Transformer

Write the mesh equations using current \( I_1, I_2 \), for the circuit shown. You do not have to solve the equations.
Find the impedance $Z_{ab}$ looking in at terminals $a - b$. 

Figure 3: Source, Transformer & Load circuit
4. (20%) (True, Reactive and Apparent Power)

Figure 4: 3 circuits

Do the following:

(a) In circuit (a), find (True) Power $P$, Reactive Power $Q$ and apparent Power $|S|$.

(b) In circuit (b), find (True) Power $P$, Reactive Power $Q$ and apparent Power $|S|$.
   You may assume inductive reactance $X_L = \omega L = 2\pi \times 60 \times 0.160 = 60 \text{ ohms}$.

(c) In Circuit (c), find (True) Power $P$, Reactive Power $Q$ and apparent Power $|S|$.
   (Note:
   \[ \tilde{I} = \frac{120\angle0^\circ}{60 + j60} = 1.410\angle-45^\circ \]
Given that,

(a) Load 1 absorbs $P = 8$ KW, leading $PF = 0.8 \ (\theta = 36.87^\circ)$

(b) Load 2 absorbs $|S| = 20$ KVA, lagging $PF = 0.6 \ (\theta = 53.13^\circ)$

Find,

(a) The total apparent power $|S|$ needed to supply the two loads.
Let $S_1$ and $S_2$ be the complex powers associated with loads $L_1 = R_1 + jX_1$ and $L_2 = R_2 + jX_2$ respectively. Let $S$ be the complex power at the terminals $a-b$.

Determine the following:

(a) How is $S$ the complex power related to complex powers $S_1$ and $S_2$?
(b) How is $|S|$ the apparent power related to apparent powers $|S_1|$ and $|S_2|$?

and give justification for your answer.