EE 153 FINAL EXAM

WINTER SEMESTER 2000

CLOSED BOOK

2 HOUR TIME LIMIT

CALCULATORS ARE ALLOWED

There are 12 problems; please look over your exam to make sure you have 12 different problems. **Do any ten (10) problems!** Draw a large X through the two problems that you do not want to be graded. If you do not indicate which problems you want to leave out, the first 10 problems will be graded.

Do all work for each problem only on the page(s) supplied for that problem. **DO NOT**, for instance, continue Problem 3 on the back of Problem 2. Extra blank paper will be supplied if needed. If extra paper is used, show the additional work for each problem on a separate sheet and staple the extra sheet(s) to the appropriate problem(s).

**ALL PHASORS WILL BE IN BOLD FACE TYPE**
Consider the following circuit driven by voltage source $v_s(t) = 100 \cos(2t + 30^\circ)$ V.

Redraw the circuit in frequency domain.
Calculate voltage $v_o(t)$ and current $i(t)$.
Show the voltage phasors $V_s$ and $V_o$, and I on phasor diagram.
Write differential equation relating $v_o$ and $v_s$.
Find transfer function $H(j\omega) = V_o / V_s$.

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Answer:

$v_o(t) = \underline{\ldots}$ \hspace{1cm} $i(t) = \underline{\ldots}$ \hspace{1cm} $v_s(t) = \underline{\ldots}$

$(\underline{\ldots})v_o = (\underline{\ldots})v_s$

$H(j\omega) = \underline{\ldots}$
(2) For the following circuit

Find $H_{1s}(j\omega) = V_1 / V_s$
Find $H_{21}(j\omega) = V_2 / V_1$
Find $H_{2s}(j\omega) = V_2 / V_s$
Given that $v_s(t) = 100\cos(10t + 45^\circ) \, V$
find $v_2(t)$.

Answer:

$H_{1s}(j\omega) =$

$H_{21}(j\omega) =$

$H_{2s}(j\omega) =$

$v_2(t) =$
(3) Find $v_o(t)$ for the following circuit.

\[ 10 \cos(4t - 30^\circ) \ A \]

\[ 12 \ V \]

\[ 50 \cos(2t + 45^\circ) \ V \]

\[ 1 \ H \]

\[ \frac{1}{4} \ F \]

\[ 4 \ \Omega \]

\[ 2 \ \Omega \]

\[ 2 \ H \]

\[ v_o \]

Answer:

\[ v_o(t) = \text{expression} \]
(4) A 240 V$_{\text{rms}}$ single phase 60 Hz system is connected to a 20 hp motor that is 95% efficient and a power factor of .8 lagging. Draw power triangle. Find line current $I_{L1}$. A second load of either an inductor or a capacitor is added in parallel to make the power factor equal to 1. Find the size of the added capacitor or inductor and the line current, $I_L$ of the combined load. (745.7 watt = 1 hp)

Answer:

Power Triangle

$I_{L1}$

$C$ or $L$ =

$I_L$ =
For the following circuit: Find the Thévenin equivalent current. What load \( Z_L \) should be added across terminals \( a-b \) so that maximum power is delivered to the load. What is the maximum transfer power \( P_{L(max)} \) to the above load.

Answer:

\[
Z_{TH} = \text{___________} \\
V_{TH} = \text{___________} \\
Z_L = \text{___________} \\
P_{L(max)} = \text{___________}
\]
Find transfer function \( H(j\omega) = \frac{V_o}{V_s} \). Graph \(|H|\) vs \(\omega\).

Find half power cutoff frequency. Determine if it is a high pass, low pass, band pass or band reject filter. Find \(v_o(t)\) if \(v_s(t) = 100\cos(1000t + 30^\circ)\).

Answer:

\[ H(j\omega) = \] 

\[ |H| \]

\[ \omega_c = \] 

High pass low pass band pass band reject

\[ v_o(t) = \]
(7) The pole-zero plot shown below refers to an impedance, $Z(s)$. Find $Z(s)$, and the particular response, $v_p(t)$ for an input $i(t) = 6\cos(t + 45^\circ)$ A.

Answer:

$Z(s) =$ __________________________

$v_p(t) =$ __________________________
(8) Determine the node voltages, $V_1$ and $V_2$ in the following network.

![Circuit Diagram]

**Answer:**

$V_1 =$

$V_2 =$
(9) Determine the mesh currents, $I_1$ and $I_2$ in the following circuit if $V_s = 120\angle 0^\circ \text{ V}$. 

Answer:

$I_1 =$

$I_2 =$
(10) For an ideal transformer shown below find the power, $P_L$ delivered to the load.

$$V_s = 1000 \angle 0^\circ \text{V}$$

$R_1 = 1000 \Omega$

$10:1$

$Z_L$

$I_1$

$I_2$

$V_1$

$V_2$

$+ {j} 20$

Answer:

$$P_L = \boxed{\text{ }}$$
(11) Each phase of a (wye)Y-connected load consists of a 50 Ω resistance in parallel with a 100 μF capacitance. Find the impedance of each phase, $Z_\Delta$, of an equivalent (delta)Δ-connected load. The frequency of operation is 60 Hz.

Answer:

$$Z_\Delta = \text{_____}$$
(12) A balanced three-phase source serves three loads as follows:
Load 1: 24 kW at 0.6 lagging power factor,
Load 2: 10 kW at unity power factor
Load 3: 12 kVA at 0.8 leading power factor

If the line voltage at the loads is 208 V rms at 60 Hz, determine the line current, $I_L$ and the combined power factor of the loads, $PF_{load}$.

Answer:

\[ I_L = \frac{P_{total}}{V_{rms}} \]

\[ PF_{load} = \frac{P_{total}}{V_{rms} I_L} \]