

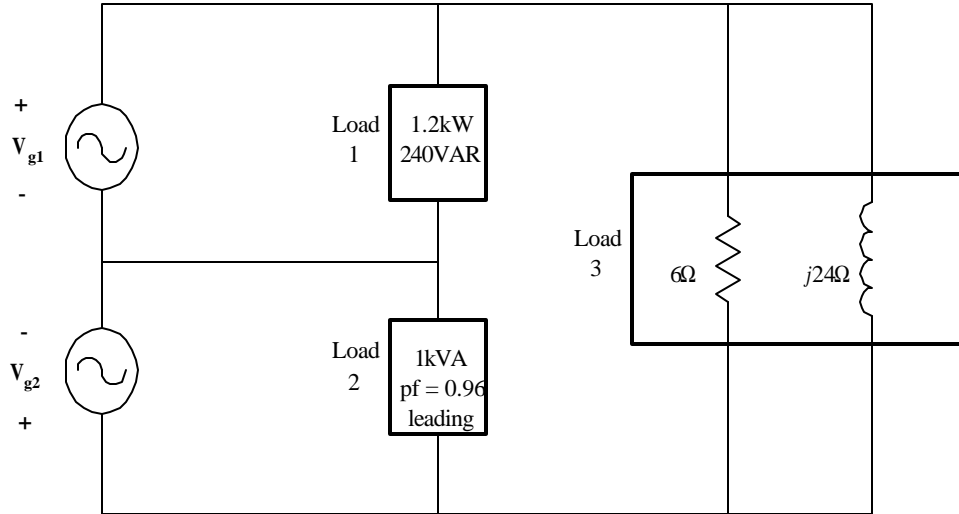
**United States Naval Academy
Electrical Engineering Department
EE 228 EXAM I**

1. Put your name on the test.
2. There should be 11 pages in the exam. The first is the title page. There are seven problems.
3. Show all your work to receive maximum partial credit. If you make an assumption, state it. Express your answers with proper units.
4. You have 70 minutes to complete the exam.
5. Each page is scored as follows:

| Problem | Points | Score |
|---------|--------|-------|
| 1 | 50 | |
| 2 | 42 | |
| 3 | 55 | |
| 4 | 20 | |
| 5 | 45 | |
| 6 | 18 | |
| 7 | 20 | |
| Total | 250 | |

Name: _____

1. (50pts) The circuit below depicts three loads in a typical house. Load 1 is a dishwasher, load 2 is an office, and load 3 is an oven, where the two 60-Hz phase voltages are $\mathbf{V}_{g1} = 120\angle 0^\circ \text{ V}_{\text{rms}}$ and $\mathbf{V}_{g2} = 120\angle 180^\circ \text{ V}_{\text{rms}}$. The oven (load 3) is represented as a parallel combination of a resistor and an inductor.



a) (15pts) Solve for the complex power absorbed by the oven (load 3). Represent it in **rectangular form**.

$$\mathbf{S}_3 = \underline{\hspace{10em}}$$

b) (15pts) Solve for the average and reactive power dissipated in the office (load 2).

$$P_2 = \underline{\hspace{10em}}$$

$$Q_2 = \underline{\hspace{10em}}$$

c) (10pts) Solve for the total complex power supplied by the source \mathbf{V}_{g1} .

$$\mathbf{S}_{g1} = \underline{\hspace{2cm}}$$

d) (10pts) Find the capacitor value (placed in parallel with load 1) that corrects the power factor of load 1 to unity.

$$C = \underline{\hspace{2cm}}$$

2. (42pts) A balanced Y- Δ three-phase circuit with positive phase sequence has the following characteristics:

Source phase voltage ('b' phase): $\mathbf{V}_{bn} = 120\angle -120^\circ \text{ V}_{\text{rms}}$

Line impedance per phase: $\mathbf{Z}_L = 1 \Omega$

Load impedance per phase: $\mathbf{Z}_D = 9 + j12 \Omega$

Total load complex power: $\mathbf{S}_D = 6.75\angle 53.1^\circ \text{ kVA}$

a) (15pts) At the source terminals, solve for the line voltage \mathbf{V}_{ab} .

$$\mathbf{V}_{ab} = \underline{\hspace{2cm}}$$

b) (15pts) Solve for the magnitude of the line current I_L .

$$I_L = \underline{\hspace{2cm}}$$

c) (12pts) Solve for the magnitude of the line voltage at the load.

$$V_{\Delta} = \underline{\hspace{2cm}}$$

3. (55pts) A DC shunt motor has the following ratings: 3Hp, 120V, 20A, 1200 rpm. The total field resistance is 240Ω and the internal armature resistance is 0.2Ω .

Given: $1\text{Hp} = 746\text{W}$; $E = K\phi\Omega$; $T_d = K\phi I_A$

a) (20pts) Solve for the efficiency of the motor.

$\eta =$ _____

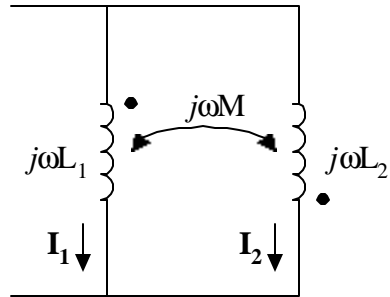
b) (20pts) Solve for the converted power.

$P_{\text{CONV}} =$ _____

c) (15pts) Assuming friction is small, find the no-load speed of the motor.

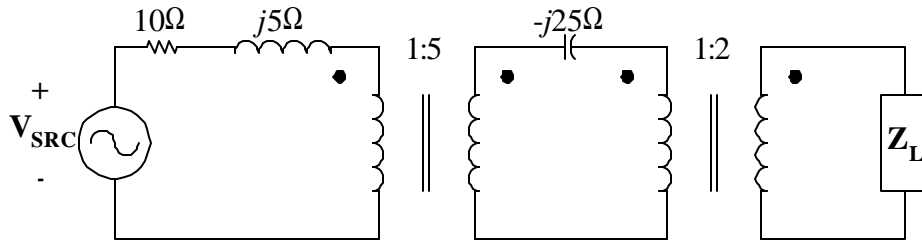
$$\omega_{NL} = \underline{\hspace{2cm}}$$

4. (20pts) For the transformer circuit below:



Determine the voltage on each coil and show that $\frac{\mathbf{I}_1}{\mathbf{I}_2} = \frac{L_2 + M}{L_1 + M}$.

5. (45pts) For the circuit shown below, the source voltage is $V_{\text{SRC}} = 12\angle 0^\circ V_{\text{rms}}$.



a) (20pts) Use the concept of reflected impedance to find the load impedance Z_L that absorbs maximum real power.

$$Z_L = \underline{\hspace{2cm}}$$

b) (10pts) Solve for the maximum real power that can be delivered to the load.

$$P_{\text{max}} = \underline{\hspace{2cm}}$$

- c) (15pts) Assuming maximum power is absorbed, solve for the magnitude of the current through the load.

$$I_L = \underline{\hspace{2cm}}$$

6. (18pts) Circle true(T) or false(F) for the following:

- T/F A DC series motor is optimal for loads requiring good traction at low speed.
- T/F An ideal transformer absorbs no power.
- T/F A motor converts mechanical power to electrical power.
- T/F An AC generator uses a commutator to insure that the current alternates direction each cycle of the waveform.
- T/F One advantage of a three-phase system for power distribution is that less copper is required.
- T/F DC is preferred over AC for distribution of power because AC voltages cannot be stepped up or down using transformers.

7. (20pts) A certain lamp dissipates 100W of average power and 25VAR of reactive power. The lamp is on 60 hours each month.

- a) (10pts) How much energy does the lamp use in kWh each month?

Energy (in kWh) _____

- b) (10pts) How much energy does the lamp use in Joules each month?

Energy (in J) _____