E927500

Mid Term II

Circuit Analysis

May 19, 2014

A. (5×5=25 points) Answer each of the following statements.

1. Explain "To mitigate the inductive aspect of the load, a capacitor is added in parallel with the load. The power factor has improved."
2. Explain "Power factor is the cosine of the phase difference between the voltage and current. It is also the cosine of the angle of the load impedance."
3. Explain "If same power loss is tolerated in single-phase and three-phase systems, the three-phase system should be more economic."
4. Describe the function in Fig. 1(a). Why?
5. Describe the function in Fig. 1(b). Why?

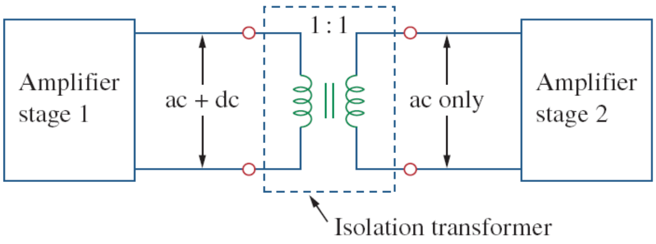

Fig. 1(a)

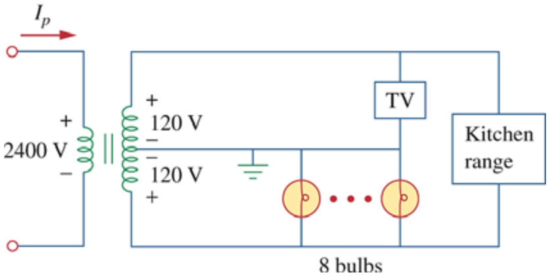

Fig. 1(b)

B. (8+12=20 points) Balanced Wye-Delta Connection + Power in a Balanced System

(a) In Fig. 2, one line voltage of a balanced Y-connected source is $\mathbf{V}_{AB} = 200\angle -20^\circ$ V. If the source is connected to a Δ-connected load of $40\angle 40^\circ\,\Omega$, find the phase and line currents. Assume the *abc* sequence.

(b) A balanced Δ-connected load is supplied by a 60 Hz three-phase source with a line voltage of 200 V. Each load phase draws 5 kW at a lagging power factor of 0.7. Find the line current and the value of capacitance needed to be connected in parallel with each load phase to raise the power factor to 0.9 lagging.

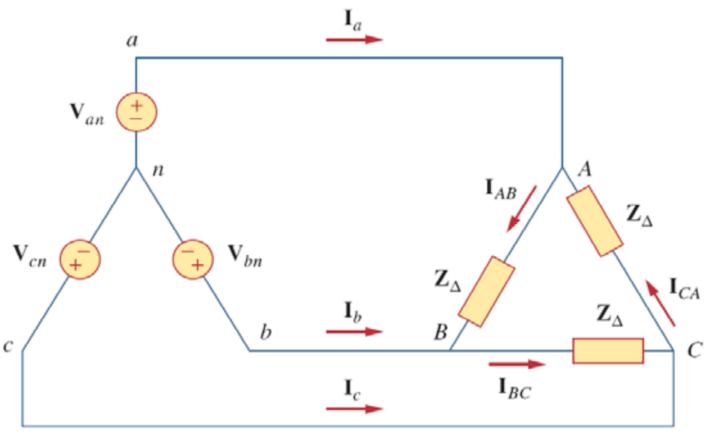

Fig. 2

C. (15+5=20 points) Mutual Inductance + Energy in a Coupled Circuit

If $M = 0.2$ H and $v_s = 2\cos 2t + 4\cos 4t$ V in the circuit of Fig. 3, (a) find i_1 and i_2. (b) Calculate the energy stored in the coupled coil at $t = 1$ s.

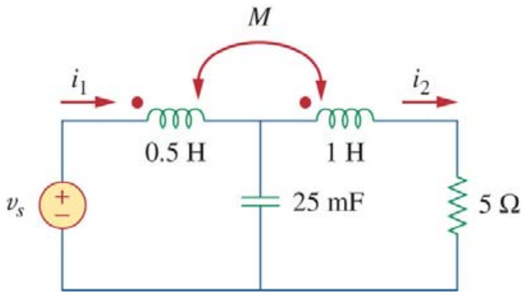

Fig. 3

D. (8+5+12+5=30 points) Ideal Transformer with Equivalent Circuit + Impedance Matching + Maximum Power Transfer

(a) Please derive and draw an equivalent circuit for Fig. 4(a) obtained by reflecting the primary circuit to the secondary side.

As the circuit of Fig. 4(b), an ideal transformer can be used to match the load, R = 5 Ω, to the amplifier to achieve maximum power transfer. The Thevenin equivalent of the amplifier is: $\mathbf{V}_{Th} = 120 + j0$ V and $\mathbf{Z}_{Th} = 400 + j300$ Ω.

(b) Find the required turns ratio for maximum power transfer.

(c) Determine the load voltages and the power transfers without/with the ideal transformer based on $P = V^2 / R$ and the equivalent circuit by reflecting the primary circuit to the secondary one in (a).

(d) Calculate the complex power supplied by the source.

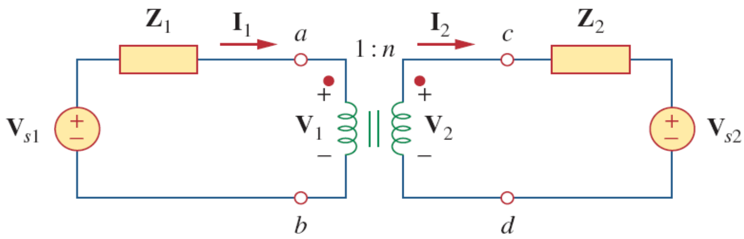

Fig. 4(a)

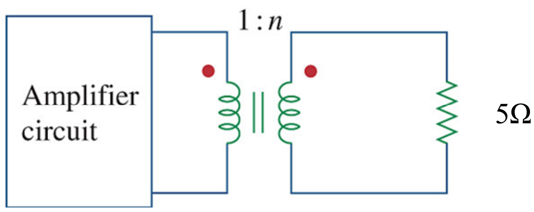

Fig. 4(b)

E. (4+5+6=15 points) *PSpice*

(a) We have a dependent source as in Fig. 5(a) in the library. Please explain what the function of this element is. The parameters of a circuit are R1 = 10 kΩ, R2 = 100 Ω, C = 0.01uF, and Vi(t) = 5sin(100t), we plot the circuit diagram as Fig. 5(b) in *PSpice*. However, there are **2 mistakes** in the circuit diagram. Please point them out.

(b) Where is the "dot" position of magnetically coupled inductors in *PSpice*? There are two elements in *PSpice* as shown in Fig. 5(c) for the simulation of transformer, please explain the differences between them.

(c) Write out the four analysis types for simulation in *PSpice*. If we want to get the current or voltage value from simulation output file, what element should we use in *PSice*.

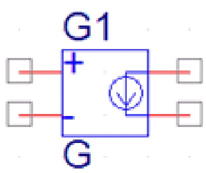

Fig. 5(a)

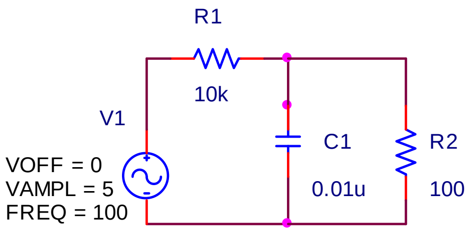

Fig. 5(b)

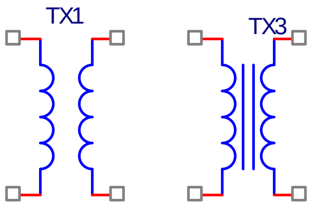

Fig. 5(c)