Electric Circuits - Homework 05

Automation Class 1904

(Due date: 2020/1/3)

1. (10 Point) Ans:

   a).By the question:

   $$f = 400Hz$$

   b).From this question we know:

   $$\theta_v = 0^\circ$$
   $$I = \frac{V}{j\omega L} = \frac{100}{\omega L}\angle -90^\circ$$

   Thus:

   $$\theta_i = -90^\circ$$

   c).By the question b and condition:

   $$I_m = \frac{100}{\omega L} = 20$$

   Thus:

   $$\omega L = 5\Omega$$

   d).Because:

   $$\omega = 2\pi f = 800\pi$$

   Then:

   $$L = \frac{5}{800\pi} = 1.99mH$$

   e).

   $$Z_L = j\omega L = j5\Omega$$

2. (10 Points)Ans:

By the question use Node-voltage Method:

$$\frac{v_1-v_g}{20}+\frac{v_1}{j2}+\frac{v_1-v_2}{Z}=0$$
$$\frac{v_2-v_1}{Z}+\frac{v_2}{-j10}+\frac{v_2-v_g}{3+j1}-I_g=0$$

Thus

$$v_2=209-j63V$$

Use v_2 to equotion 1:

$$Z=-0.9+j6.37$$

3. (20 Points)Ans:

Step 1: Voltage source to Current source:

$$I_1 = \frac{240\angle 0^\circ}{j60 - j36} = 10\angle -90^\circ A$$

Step2: Calculate impedance Z

$$Z = j24||24 = 12 + j12$$

Step3: Current source to Voltage source

$$V_2 = I_1 Z = 120 - j120 = 120\sqrt{2}\angle -45^\circ V$$

4. (10 Points)

Ans:

By the question use Node-Voltage Method:

$$\frac{v_0}{-j8} + \frac{v_0 - 2.4I_\Delta}{j4} + \frac{v_0}{5} - (10 + j20) = 0$$
$$I_\Delta = \frac{v_0}{-j8}$$

Simplify it:

$$I_\Delta - 2I_\Delta + j0.6I_\Delta - j1.6I_\Delta = 10 + j20$$
$$I_\Delta = -15 - j5$$

Thus:

$$v_0 = -40 + j120$$

5. (10 Points)

Ans:

By the question:

$$Z_{Th} = 45 + j125 + (\frac{\omega M}{|Z_{22}|})^2 \bar{Z}_{22} = 77 + j109$$

Then:

$$V_{Th} = \frac{425}{10+j5} \times j20 = 340 + j680$$

6. (10 Points)

Ans:

By the question:

$$i_g = 4cos2000t \quad mA = 4\angle 0° mA$$

Then:

$$Z_c = \frac{1}{j\omega c} = -j3125\Omega$$
$$Z_L = j\omega L = -j200\Omega$$
$$Z_{eq} = 500 + [-j3125||(j200 + 1000)] = \frac{23269500}{15289} - j\frac{2075000}{15289}$$

Thus:

$$P_g = -\frac{1}{2}|I|^2 ReZ_{eq} = -12mW$$

The source delivers 12mW of power to the circuit.

7. (10 Points)

Ans:

a).By the question:

$$S_1 = 16 + j28 \quad KVA$$
$$S_2 = 6 - j8 \quad KVA$$
$$S_3 = 8 + j0 \quad KVA$$

Then:

$$S = S_1 + S_2 + S_3 = 30 + j20$$

And:

$$200I^* = S$$
$$I = 150 - j100$$

Then:

$$Z = \frac{200}{150 - j100} = 0.923 + j0.615 = 1.11\angle 33.69^\circ$$

b).By a:

$$pf = cos(33.69^\circ) = 0.8321 \quad lagging$$

8. (10 Points)

Ans:

a).Open circuit:

$$v_{Th} = \frac{760}{28+j96}(j50) = 364.8 + j106.4$$

Short circuit:

$$(28 + j96)I_1 - j50I_{sc} = 120$$
$$-j50I_1 - (31 + j100)I_{sc} = 0$$

Thus:

$$I_{sc} = 0.48 - j0.518$$
$$|I_{sc}| = 0.7A$$

Then:

$$Z_{Th} = \frac{V_{Th}}{I_{sc}} = 521 + j152$$
$$Z_L = Z_{Th}^* = 521 - j152$$
$$I_L = \frac{v_{Th}}{Z_{Th}+Z_L} = 0.35 + j0.1 \; P_L = |I_L|^2 Re(Z_L) = 69W$$

b).By the question:

$$I_1 = \frac{Z_{22}I_2}{j\omega M} = 0.762 - j0.0017 = 0.762\angle 1.28°$$

And:

$$P_{tr} = 760 \times 0.762 \times cos1.28 - (0.762)^2 \times 8 = 161.4W$$
$$\%delivered = \frac{69}{161.4} \times 100 = 42.75\%$$

9. (10 Points)

Ans:

a).By the question:

$$I_{aA} = \frac{200}{25} = 8A \quad (rms)$$
$$I_{bB} = \frac{200\angle -120^\circ}{30-j40} = 4\angle -66.87^\circ A \quad (rms)$$
$$I_{cC} = \frac{200\angle 120^\circ}{80-j60} = 2\angle 83.13^\circ A \quad (rms)$$

The magnitudes are unequal and the phase angles are not $120^\circ apart$.

b).

$$I_0 = I_{aA} + I_{bB} + I_{cC} = 9.96\angle -9.79^\circ A \quad (rms)$$