**Elec-275: Winter 2013 Final Exam Solution**

1. (a) For the time-domain circuit of Fig. 1, draw its phasor domain circuit. [Designate I1,  I2, and V as the phasors of *i­­1(t)*, *i­­­2 (t)*, and *v(t)* respectively]. Draw this phasor circuit.

(b) Using **mesh analysis** on this phasor circuit, determine I2 and V. Use the meshes shown.

(c) Then write the time domain expressions of *i2(t)* and *v(t)*.

**Solution:**

(a) Phasor circuit:

**0.5**

**100 **

**I1**

**-j100**

**j100**

**j10**

**+**

**V**

**-**

**400 **

**I2**

(b) I1 = 0.5

KVL: 500 I2 -(100+j100) I1 = 0; or 500 I2 = (100+j100) 0.5= 50+j50.

or **I2** = 0,1+j0.1 = 0.141445; **V2**= -j100 I2 = 14.14-45.

(c) ***i2(t)***= 0.1414 cos(1000t+45) amps; ***v2(t)***= 14.14 cos (10000t-45) volts.

2. Using **nodal analysis** in the phasor circuit of Fig.2,

(a) determine the voltages V2, V3, and the current I ;

 (b) draw the phasor diagrams (plot of phasors in the complex plane) of V1, V2­, V3, and I.



**10 **

**+**

\_

**j 20 **

**-j 10 **

**5 **



**V1**

**V2**

**V3**

**I**

**j 10 **

**Ref = 0 V**

**Solution:**

(a) KCL @ V2: ; or (-1+j2)V2 + 2 V3 = j 20 ... (1)

KCL @ V3 :; or V2 + j2V3 = -10+j17.32 ...(2)

From (1) and (2): **V2** = 6.3341.6 ; **V3** = 5.324.2; **I** = V2/(j20) = 0.3165-48.4

(b) Phasor diagrams may now be drawn.

3. (a) Replace the circuit to the left of ***a - b*** of Fig. 3 by its **Thevenin** equivalent. Draw this equivalent circuit.

(b) Using this equivalent circuits, determine the current **I** through the load resistor RL.

***a***

**8 volts**

**6 **

**2 **

***b***

**12 volts**

**2 Amps**

**12** ****

**6 **

**RL = 7 **

**I**

**Solution:**

Vth:

**V2**

**V1**

***a***

**12** ****

**2 **

+

voc

-

**6 **

**2 Amps**

**12 volts**

**6 **

**8 volts**

***b***

KCL @ V1: ; or 9V1 - 6 V2 = 36 ... (1)

KCL @ V2 : ; or -3V1 + 4 V2 = 8 ... (2).

From (1) and (2), V2 = **Vth** = 10 volts.

**Rth** = 3 . Thevenin equivalent:

**10 volts**

**3** ****

(b)  **I** = 1 A.

4. An ideal transformer with a turns ratio of **N** in Fig. 4 is used to match the load **ZL** for maximum power transfer. For that purpose, determine:

(a) the transformer turns ratio;

(b) the value of the capacitor **C**;

(c) the power absorbed by the load**.**

**50 **

**+**

\_

***vs = 100 sin(1000t)***

***volts***

**400 mH**

**800 **

**(RL)**

**C**

**ZL (Load)**

***1:N***

**Solution:**

**50 **

**+**

\_

**100 0**

**j400 **

**800 **

**(RL)**

**-jXc**

***1:N***

(a): ; **N** = 4.

(b) **C** = 40 F.

(c) **P** =  watts.

5. A three-phase 60 Hz power supply is connected to a three-phase motor as shown in

Fig. 5. Find:

(a) the power factor

(b) the apparent power of the motor

(c) the real power of the motor

(d) the reactive power of the motor.

+

-

**-**

**+**

**j 9.5 **

**j9.5 **

****

**5 **

**a**

**5 **

**a'**

**b**

**b'**

**c**

**c'**

-

**+**

**j 9.5 **

120

volts rms,

120

volts rms

Motor

120

volts rms

**Solution:**

Using single phase circuit: ZL = 5+j9.5 = 10.73562.24

(a) **P.F.** = cos 62.24 = 0.4657.

(b) S == 624.7+j 1187

Total power = 3 S = 4024.2 62.24

**Apparent power** = 4024.2 VA

(c) **Real power**= 1874.34 W

(d) **Reactive power** = 3561 VAR.

6. For the magnetic circuit of Fig.6:

* Air gap cross sectional area = 2 cm2 cm (for both gaps)
* Air gap lengths:

lg1 = 2 mm

lg2 = 4 mm

* Neglect the reluctance of the magnetic metallic structure (compared to those of the air gaps), as well as the fringing effect.
* The magnetizing coil has 100 turns and carries a current of 0.5 amps.

(a) Determine, for each air gap:

(i) the reluctance **R**;

(ii) the flux ****

(b) Find

(i) the flux density **B** for air gap-1 only;

(ii) the field intensity **H** for air gap-1 only.

(c) Find the equivalent reluctance seen by the magnetomotive force **NI**.

**Solution:**

A = 410-4 m2.

(a) Air gap 1: (i) **R1** = A-turns/Wb;

(ii)**1** Wb.

Air gap 2: (i) **R2** = 7.98106  A-turns/Wb;

(ii) **2** = 6.28310-6 Wb.

(b) (i) **B**  Wb/m2

(ii) **H = **A-turn/m.

(c) Req = R1 || R2 = 2.65 A-turn/Wb.

7. (a) If = 240/120 = 2 A.

At no-load: Ia= 6- 2 = 4A. Eb = 240- 0.44 = 238.4 = (Ka)m

= Kaor **Ka**

(b) At full-load: Ia = 50 -2 = 48 amps; **Eb** = 240 - 48 0.4 = 220.8 volts.

(c) Speed = m = rpm.

(d) Torque = (Ka) Ia = 1.13848 = 54.637 N-m

(e) Power= Torquespeed = 54.637= 10,598.4 W = 14.2 HP.

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