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| Course Number Section  Principles of Electrical Engineering ELEC 275 |
| Examination Date Time # of pages  Final Examination April 30 , 2013 3 Hours 6 |
| Instructor(s)  Dr. S.K.Das |
| Materials allowed: x No Yes  Calculators allowed: No x Yes  Non-programmable University-approved calculators are allowed. |
| Special Instructions:  Attempt all questions.  Show all steps clearly in neat and legible handwriting.  Students are required to return question paper with exam booklet(s) |

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)*.

***i(t)*= 0.5 cos(1,000t)**

**amps**

**100 **

***i1(t)***

**10 F**

**100 mH**

**10 mH**

**+**

***v(t)***

**-**

**400 **

***i2(t)***

Fig. 1 ( 9 marks)

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**

Fig. 2 (9 marks)

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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**

Fig. 3 (8 marks)

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***

Fig. 4

(8 marks)

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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

Fig. 5 (8 marks)

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**.

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Cross-section (each air gap):

2 cm2 cm

2 mm

**0.5 amps**

**100 turns**

air gap-1

air gap- 2

4 mm

Fig. 6 (9 marks)

7. The model of a DC shunt motor is shown in Fig.7. Given:

* Supply voltage = Vs : 240 volts DC
* Ra = armature resistance : 0.4 
* Rf = field resistance : 120
* No-load line current = IL: 6 amps
* Full-load line current = IL: 50 amps
* No-load speed: 2000 rpm.

Find:

(a) the motor torque constant (**Ka**);

(b) Back emf **Eb** at full-load;

(c) Full-load speed in rpm;

(d) Full-load torque in N-m;

(e) Full-load power in HP (Horse Power).

**Rf**

**Lf**

**Ra**

**La**

**+**

**\_**

**Eb**

**+**

**\_**

**Vs**

**IL**

**If**

**Ia**

**M**

Fig. 7(9 marks)

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**FORMULAS**

**Voltage & Current dividers** : (Resistors shown, but equally valid for impedances Z)





**Impedances**: ZR = R0o , ZL = jL = L+90o, ZC = 1/jC =  j /C = (1/C)90o.

**Series impedances:** Zeq = Z1 + Z2 + … + Zn. **Parallel impedances:** 1/Zeq = 1/Z1 + 1/Z2 +…+ 1/Zn

**DC Power**: PR = IV = I2R = V2 / R

**AC Power:**



**Transformers:**

****

**Magnetic circuits:**

MMF = NI , N= # of turns, I = current (A). Flux = MMF/Rm (Wb), where

Rm = Reluctance = *l* /A , (A-turn/Wb), *l* = average path length(m), A = area of cross-section (m2) and Permeability  , where r = relative permeability, o= 410-7 H/m.

**DC Motors:**

For a shunt connected motor:

IL= If + Ia. If = Vf/Rf, Vs = Eb + IaRa, Back-emf : Eb = (Kam.

Torque developed: T = (Ka Ia, where Ka is a constant,  is the ‘flux per pole’,

m is the speed (radians/sec), and Ia is the armature current.

Load power: P = Tm.

1 HP = 746 watts.

Radians/sec to RPM conversion: (radians/sec) = (2/60)N(rpm)

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