BITS, PILANI – DUBAI CAMPUS

Knowledge Village, Dubai

Year II – Semester II 2004 – 2005

COMPREHENSIVE EXAMINATION (Closed Book)

Course No.: ES UC272 **Course Title:** Electrical Sciences - II

Date: May 31, 2005 **Time:** 3 Hours **M.M.** = 80 (40 %)

NOTE:

(i) Answer all the questions.
(ii) The question paper is divided into two parts, Part-A and Part-B.
(iii) ***WRITE THE ANSWERS OF PART-A AND PART-B IN SEPARATE ANSWER SHEETS. MARK YOUR ANSWER SHEETS CLEARLY AS 'A' AND 'B'.***
(iv) Answer all the parts of a question in continuation.
(v) Do not leave any blank page(s) in between the answers.

Part -- A

QUESTION 1 (2+2+4+2)

(a) Explain briefly what is meant by a phasor in AC circuit theory and why phasors are useful for calculations in AC circuits.

(b) Show on a phasor diagram the phasors, -1, -1+2j, $\sqrt{2}\angle -45^\circ$, and $\frac{1}{\sqrt{2}}+\frac{1}{\sqrt{2}}j$.

(c) In figure (1) below, the voltage source produces a sinusoidal waveform of angular frequency $\omega = 10^4 \ rads^{-1}$. Evaluate the impedance of the series connection of R and L, and the amplitude and phase of the current $\bar{I}_S$ drawn from the source.

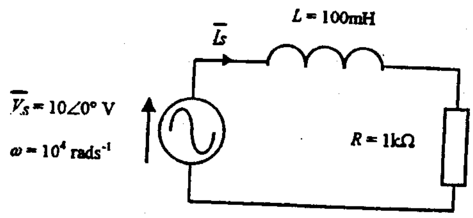


Figure (1)

(d) Define Voltage Regulation of a synchronous generator.

QUESTION 2

A 208-V three-phase power system is shown in figure (2). It consists of an ideal 208-V Y-connected three-phase generator connected through a three-phase transmission line to a Y-connected load. The transmission line has an impedance of 0.06 + j0.12 Ω per phase, and the load has an impedance of 12 + j9 Ω per phase.

(7 × 2 = 14)

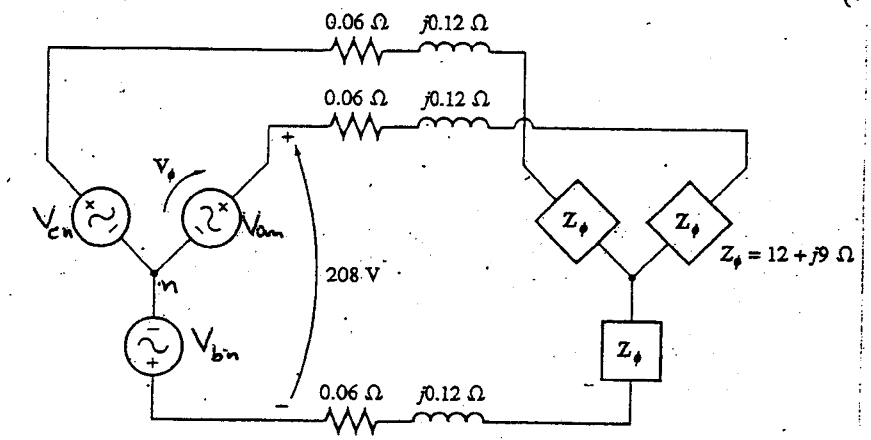


Fig. (2)

For this power system, find:

(i) The magnitude of the line current I_L

(ii) The magnitude of the load's line and phase voltages V_{LL} and $V_{\phi L}$

(iii) The real, reactive, and apparent powers consumed by the load

(iv) The power factor of the load

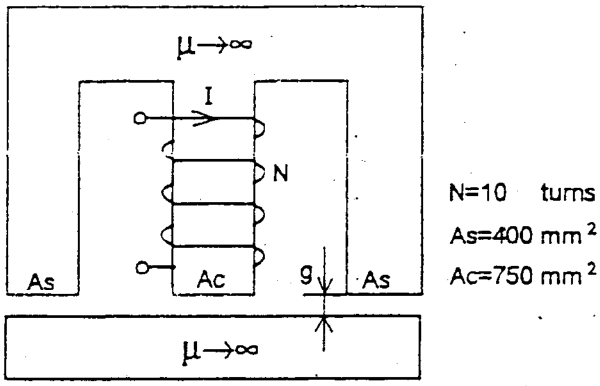
(v) The real, reactive, and apparent powers consumed by the transmission line

(vi) The real, reactive, and apparent powers supplied by the generator

(vii) The generator's power factor

QUESTION 3

(a) Figure (3) below shows an EI-core inductor. The inductor winding has 10 turns. The cross sectional areas of the central and each of the side legs are 750 mm^2 and 400 mm^2 respectively. Assume the permeability of the core material $\mu \to \infty$ and ignore leakage and fringing effects. (10)



Figure(3): An EI - Core inductor

Calculate:

(i) The required air gap length if the inductance is 100 μH, and

(ii) The total magnetic energy stored in the 100 μH inductor if the current in the winding is 300 A DC.

(b) Explain the practical procedure of obtaining synchronous reactance of a synchronous machine. (4)

Part -- B

QUESTION 4

(a) With the help of circuit diagrams, discuss what tests are conducted to measure core loss and cu loss for single phase transformer. Distinguish between the efficiency and the regulation of a transformer. Show how power factor affects both of them. (4+2+1)

(b) A 2500/250 V, 25 KVA transformer has a core loss of 130 W and full load copper loss of 320 W. Calculate its efficiency at full load, 0.8 pf.
The transformer is now connected as an autotransformer to give 2500/2750 V. Calculate its KVA rating and efficiency at full load, 0.8 pf and compare with the two winding KVA rating and efficiency. Why can auto transformers handle more power than conventional transformers of the same size? (2+3+1+1)

QUESTION 5

(a) Derive the emf equation for a DC Machine. Explain clearly the circuit model of a DC machine for motoring and generating mode. Define critical resistance and how it can be obtained from magnetization characteristics of DC Shunt generator.

(3+3+2)

(b) A 10 kW, 230 V DC shunt motor has armature resistance of 0.1 Ω. It runs at no load speed of 1500 rpm. When delivering a certain load, the motor draws an armature current of 200 A. Find the speed at which the motor will run at this load and the torque develop. Assume that the armature reaction on load causes a 4% reduction in the flux/pole compared to its no-load value. (3+3)

QUESTION 6

(a) How does an induction motor develop torque? Why is it impossible for an Induction motor to operate at synchronous speed? Develop an expression for the frequency of rotor current in three phase induction motor. Why such type of motors are popular for industrial use. (2+1+2+2)

(b) Draw the equivalent circuit of a three phase, star connected, induction motor of 400 V, 50 Hz, 4 pole having the following per phase constants referred to stator R_1= 0.15 Ohm, X_1= 0.45 Ohm, R_2 = 0.12 Ohm, X_2= 0.45 Ohm, X_m = 28.5 Ohm.
If the fixed losses are 380 W and the motor is operated at rated voltage and frequency at a slip of 4% calculate air gap power and shaft torque. (2+3+2)

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BITS, Pilani-Dubai Campus,
Knowledge Village, Dubai
Second Semester 2004-2005
Test II (Open Book)

Course No ES UC 272
Date: Ist May 2005

Course Title
Max Marks 40

Electrical Sciences II
Times: 50 Minutes

Answer all questions.

Q1 Figure 1 shows a simplified rotor and stator for a dc motor. The mean path length of the stator is 50cm, and its cross sectional area is 12 cm^2. The mean path length of the rotor is 5 cm, and its cross-sectional area also may be assumed to be 12 cm^2. Each air gap between the rotor and the stator is 0.05 cm wide, and the cross sectional area of each air gap is 14 cm^2. The iron of the core has a relative permeability of 2000 and there are 200 turns of wire on the core. If the current in the wire is adjusted to be 1 A, what will be the resulting flux density in the air gaps ? (15)

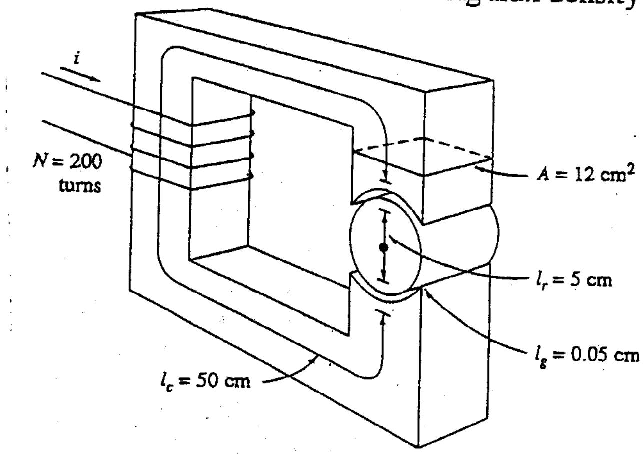

Figure 1

Q2 A single phase transformer working at unity power factor has an efficiency of 90% at both half load and full load of 500 W. Determine the efficiency at 75% of full load and the maximum efficiency. (13)

Q3 A single phase power systems consists of a 480 V 60 Hz generator supplying a load Z_{load} = 4+j3 ohm through a transmission line of impedance Z_{line} = 0.18 + j 0.24 ohm. A 1:10 step up transformer is placed at the generator end of the transmission line and a 10:1 step down transformer is placed at the load end of the line as shown in figure 2. Find Generator current I_G. (12)

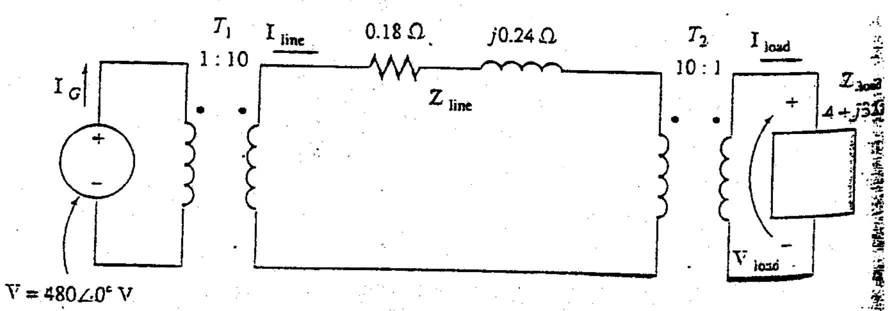

Figure 2

BITS, PILANI – DUBAI CAMPUS

Knowledge Village, Dubai

II Year (EEE/EIE/CSE) 2004 – 2005, Semester - II

TEST - I (Closed Book)

Course Title: Electrical Sciences-II (ES UC272)

Date: March 13, 2005 Time: 50 Minutes M.M. = 40 (≈20 %)

NOTE:
- (i) Answer all the questions.
- (ii) All questions to be answered in the answer sheet only.
- (iii) Answer all the parts of a question in continuation.
- (iv) Do not leave any blank page(s) in between the answers.

1.

(i) **Draw on the same phasor diagram the phasors representing the following sinusoids.** (4 + 3 + 3)

(a) $\sin\omega t$ (b) $3\cos(\omega t - 135^o)$ (c) $2\sin(\omega t + 30^o)$ (d) $-2\sin\omega t$

(ii) **Evaluate the following phasor expressions.**

(a) $1\angle 30^o + 2\angle 60^o$ **(express result in rectangular and polar form)**

(b) $(2 + j3) \times (2\angle 45^o)$ **(express result in polar form)**

(c) $\dfrac{1 + j2}{2\angle 20^o}$ **(express result in rectangular form)**

(iii) **Using phasor arithmetic, obtain the sinusoid equal to the following sums and differences of sinusoids:**

(a) $3\sin\omega t + 4\cos\omega t$

(b) $3\sin\omega t - 4\cos\omega t$

(c) $\sin\omega t + \cos\omega t$

2. **For the series LCR circuit of figure (1), write down an expression for the total impedance at angular frequency ω. Evaluate this impedance, in amplitude and phase form, for $R = 100\ \Omega$, $L = 1\ mH$, $C = 0.2\ \mu F$ at $\omega = 10^5\ s^{-1}$. Hence find the current flowing in the circuit (in phase form) when the source has**

amplitude 10 V. Find the power factor, and the power dissipated in the resistor. Draw a phasor diagram showing the current, and all voltages, in the circuit. At what frequency does the power factor becomes equal to 1?

(13)

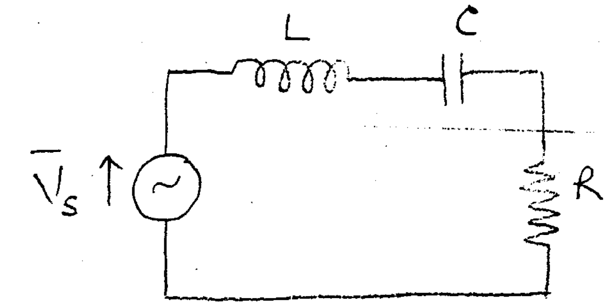

Figure - 1

3. Figure (2) represents a one-line diagram of a power system (each line representing the three phases). The load requires 30 kW at 0.8 lagging pf. Generator G_1 operates at 800 (line-to-line) and supplies 15 kW at 0.8 lagging pf. Find the load and terminal voltage and active and reactive powers supplied by G_2.

(12)

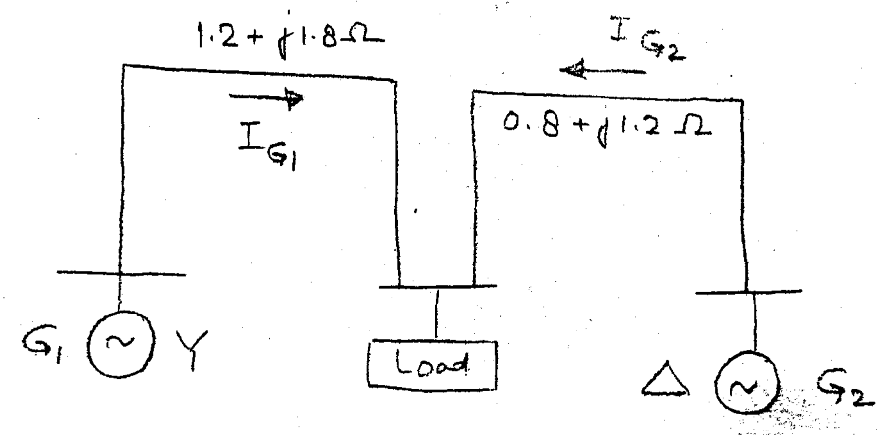

Figure - 2

4. Write down the advantages of three-phase power over the single-phase power. Draw the wave form of balanced three-phase voltages.

(3+2)

Name: **ID. No.:**

BITS, PILANI – DUBAI CAMPUS

Knowledge Village, Dubai

B.E. (Hons.) EEE/EIE/CS

Year II – Semester II 2004 – 2005

QUIZ (Closed Book)

Course: ES UC272 [Electrical Sciences-II]

Date: 23 March 2005 **Time: 30 Minutes** **M.M. = 20 (10 %)**

QUESTION NO.1: Choose the most appropriate one. **[10 × 1 = 10]**

a. **The power consumed by pure capacitance is given by**

(i) $VI\cos\theta$

(ii) $VI\sin\theta$

(iii) VI

(iv) **Zero**

b **In Star connection**

(i) **Phase voltages lag line voltages by 30°**

(ii) **Phase voltages lead line voltages by 30°**

(iii) **Line voltages lag phase voltages by 30°**

(iv) **Line voltages lead phase voltages s by 30°**

c. **Which of the following statement is correct for a balanced three-phase system?**

(i) **Sum of three-phase voltages is zero at all times.**

(ii) **Sum of three-phase currents is zero at all times.**

(iii) **Magnitude of three phase voltages/currents is equal.**

(iv) **All the above three statements are true.**

d. Which value of the alternating voltage or current is registered by ammeters and voltmeters during measurement?

(i) Maximum or peak value

(ii) Root Mean Square (rms) value

(iii) Average value

(iv) $\sqrt{2}$ times the peak value

e. Quantity $\frac{I(rms)}{I_{av}}$ of a sinusoid is referred as

(i) Crest Factor

(ii) Amplitude Factor

(iii) Peak Factor

(iv) Form Factor

f. Quadrature component of an alternating current contribute

(i) Oscillating component of power (of frequency 2ω) with zero average.

(ii) Oscillating component of power (of frequency 2ω) with nonzero average.

(iii) Oscillating component of power (of frequencyω) with zero average.

(iv) Oscillating component of power (of frequencyω) with nonzero average.

g. Which one of the statements (iii) and (iv) is correct?

(i) Reactive power is absorbed by the leading pf load.

(ii) Reactive power is supplied by the lagging pf load.

(iii) Both of above statements (i) & (ii) are correct.

(iv) Both of above statements (i) & (ii) are incorrect.

h. Which one of the following statement is incorrect?

- (i) No energy is expended in maintaining the flux in a magnetic circuit.
- (ii) The value of relative permeability is not constant for a given magnetic material.
- (iii) There is no perfect magnetic insulator.
- (iv) Air has permeability μr times that of iron.

i. For AC electrical application, one should select a

- (i) Material with narrow hysteresis loop
- (ii) Material with thick hysteresis loop
- (iii) Material without bothering about size of the hysteresis loop.
- (iv) Nonmagnetic material

j. Permeance of the magnetic circuit is

- (i) Inversely proportional to the path length of the flux
- (ii) Directly proportional to the cross sectional area of the medium
- (iii) Directly proportional to the relative permeability of the medium
- (iv) All of the above statements (i) – (iii) are true for permeance.

QUESTION NO.2: [10 × 1 = 10]

a. If two sinusoidal of the same frequency but of different amplitudes and phase angles are subtracted, the resultant is sinusoidal.

True / False

b. If an air gap is cut at right angle to the core cross section on a laminated core of sheet steel, what would be the effect on the value of coil current to maintain the same flux density?

- (i) Currant will increase
- (ii) Current will decrease
- (iii) Current will not be effected

c. **Draw the hysteresis loop and show 'Coercivity' in the curve.**

d. **Inductance is independent of excitation and depends only upon its geometry**

True / False

e. **Coil is stationary and flux through it changes with time, induced emf is dynamic induced emf.** **True / False**

f. **The current i(t) in a 10 Ohm resistor is shown in Figure 1. Draw the profile of v(t).**

g. **A balanced three phase star load is connected to three phase 230 V. Per phase impedance of the load is 8+j6 Ohm. Find the line current.**

h. **Each of the three coils generates an e.m.f of 230 V. The e.m.f of second leads that of the first by 120° and the third lags behind the first by the same angle. What is the resultant e.m.f across a series combination of the coil?**

i. **Write the Similar magnetic quantities of the following electrical quantities**

Electrical Quantities		**Magnetic Quantities**
Current	I	
Voltage drop	IR	

j. **If three same Impedances equal in magnitude and angle are connected in star form. What will be the equivalent Impedance in delta form?**