Repeater

# BITS, PILANI - DUBAI CAMPUS

## Knowledge Village, Dubai

**Year II - Semester II 2005 - 2006**

**COMPREHENSIVE EXAMINATION (Closed Book)**

| | |
|---|---|
| Course No.: ES UC272 | Course Title: Electrical Sciences - II |
| Date: May 22, 2006 | 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 (MAIN-SHEET)AND PART-B (EXTENSION-SHEET)IN SEPARATE ANSWER SHEETS. MARK YOUR ANSWER SHEETS CLEARLY AS 'A' AND 'B'.
(iv) Answer all parts of a question in continuation.
(v) Do not leave any blank page(s) in between the answers.

## Part -- A

### QUESTION 1 [5+10=15]

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

(b) Consider an AC single-phase circuit consisting of a load $Z_L = (8 + j6)\ \Omega$ connected to a voltage source $V = 240\ V$, $f = 50\ Hz$, as shown in Figure (1).

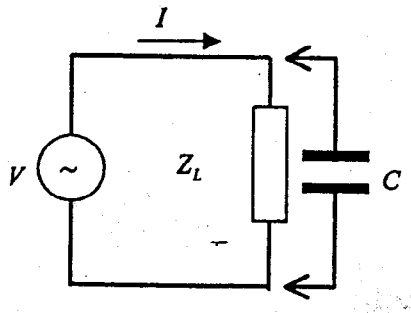



Figure (1)

(i) Find the current I, the active power, and the power factor of the circuit.

(ii) One wants to correct the power factor to unity by paralleling a capacitor C to the load. Determine the value of C and draw the phasor diagram showing the voltage and current.

## QUESTION 2

[5+10=15]

(a) Consider the unbalanced delta-connected load of Figure (2). Find the line currents.

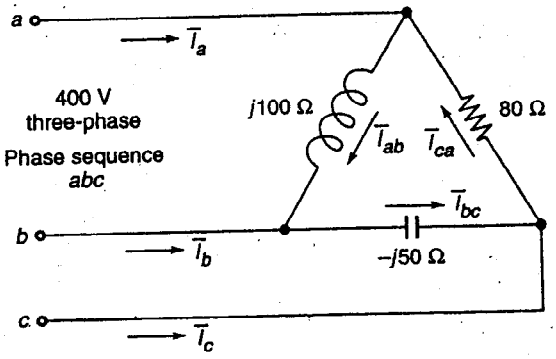



Figure (2)

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

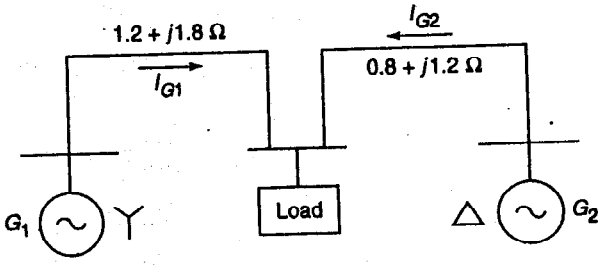



Figure (3)

## QUESTION 3

[10]

An iron ring of mean diameter 15 cm and 10 $cm^2$ in cross-section is wound with 200 turns of wire. There is an air-gap of 2 mm cut in the ring. For a flux density of 1 $Wb/m^2$ and a relative permeability of 500, find the exciting current, the inductance, and the stored energy.

## Part -- B

## QUESTION 4

[5+10=15]

(a) Draw the equivalent circuit of a single phase transformer, referred to the primary side, and label the component parts. Which losses are represented by the series and shunt parameters?

(b) 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.

## QUESTION 5 [8+7=15]

(a) A series-wound dc motor draws 100 A from a 200 V supply when running at 1000 rpm. If the armature resistance is 0.1 Ω and the field winding resistance is 0.03 Ω, what additional series resistance must be placed in the armature circuit to reduce the speed to 800 rpm; the load torque is reduced in the square ratio of speed. Assume linear magnetization.

(b) Obtain the expression for the slip at maximum torque of an induction machine. Write down the expressions for break-down torque and starting torque of IM. Plot the complete T-s characteristic of IM.

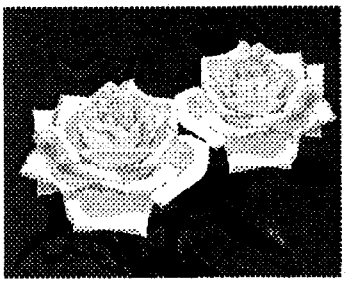
## QUESTION 6 [10]

The OC and Sc test data of a 3-phase, i MVA, 6.6 kV, star-connected synchronous generator is given below:

| | | | | | | |
|---|---|---|---|---|---|---|
| $I_f$ (A) | 60 | 70 | 80 | 90 | 100 | 110 |
| $V_{OC}$ (Line) (A) | 4693 | 5500 | 6160 | 6600 | 6967 | 7260 |
| $I_{SC}$ (A) | 98 | | | | | |

Find:

(i) Unsaturated synchronous reactance,
(ii) Adjusted synchronous reactance
(iii) Excitation voltage needed to give rated voltage at full load, 0.8 pf lagging. Use adjusted synchronous reactance.
(iv) Also the voltage regulation for the load specified in part (iii).



# BITS, PILANI - DUBAI CAMPUS

## Knowledge Village, Dubai

**Year II - Semester II 2005 - 2006**

**COMPREHENSIVE EXAMINATION (Closed Book)**

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

**Date: May 25, 2006** **Time: 3 Hours M.M. = 80 (40 %)**

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**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 (MAIN-SHEET)AND PART-B (EXTENSION-SHEET)IN SEPARATE ANSWER SHEETS. MARK YOUR ANSWER SHEETS CLEARLY AS 'A' AND 'B'.
(iv) Answer all parts of a question in continuation.
(v) Do not leave any blank page(s) in between the answers.

## Part -- A

### QUESTION 1 [8+7=15]

(a) For a sinusoid $i = I_m \sin\theta$, derive the expression for its rms value and average value in terms of its peak value.

(b) A series RLC circuit is connected to a 230 V, 50 Hz, single-phase ac supply. The values given are $R = 5\ \ \Omega$, $L = 13\ \ mH$, and $C = 140\ \ \mu F$. Find (i) Total Reactance (ii) Impedance (iii) Current drawn by the circuit (iv) Power Factor of the circuit.

### QUESTION 2 [10+5=15]

(a) A 480 V Y-connected source supplies a Δ-connected load composed of 3 identical impedances $Z = 16 - j9$ ohms. It is assumed that the angle of $V_{AN}$ is reference at $0^0$ and that the source is positive sequence.
(i) What is the magnitude of the phase voltage of the source and phase voltage of the load?
(ii) What is the power factor of the load?
(iii) Calculate the magnitude of the phase current in the delta load.
(iv) Calculate the magnitude of the line current.
(v) Calculate the phasor values of $\bar{I}_{AB}$, $\bar{I}_{BC}$, and $\bar{I}_{CA}$ in the load. Calculate the phasor values of the line currents $\bar{I}_A$, $\bar{I}_B$, and $\bar{I}_C$ flowing toward the load.

(b) An air-cored solenoid 1 m in length and 10 cm in diameter has 500 turns. Calculate:
(i) Self-inductance,
(ii) Energy stored in magnetic field when the current of 2 A flows in the solenoid.

## QUESTION 3

[10]

Figure (1) shows a simplified rotor and stator for a dc motor. The mean path length of the stator is 50 cm, 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 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?

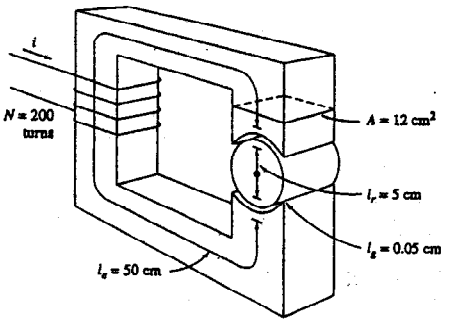



Figure (1)

## Part -- B

## QUESTION 4

[8+7=15]

(a) For a single phase 50 Hz, 200/2000 V, transformer OC / SC test results are as follows:

| | | | |
|---|---|---|---|
| OC Test (LV Side): | 200 V, | 6.4 A, | 380 W |
| SC Test (HV Side): | 80 V, | 20.0 A, | 620 W |

Draw the equivalent circuit model of the transformer referred to HV and LV side.

(b) The primary and secondary windings of a 500 kVA transformer have resistances of 0.42 Ω and 0.0011 Ω respectively. The primary and the secondary voltages are 6600 V and 400 V, respectively, and the iron loss is 2.9 kW. Calculate the efficiency at full-load, assuming the power factor of the load to be 0.8.

## QUESTION 5 [8+7=15]

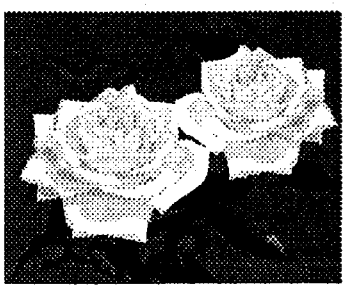
(a) A 4 pole dc shunt generator with a wave-wound armature having 390 conductors has to supply a load of 500 lamps, each of 100 W at 250 V. Allowing 10 V for the voltage drop in the connection leads between the generator and the load and a contact drop of 1 volt per brush. Calculate the speed at which the generator should be driven. The flux per pole is 30 mWb and the armature and the shunt field resistances are $R = 0.05 \ \Omega$ and $R = 65 \ \Omega$, respectively.

(b) The line current drawn by a three-phase induction motor is 14.7 A, while the line voltage is 415 V. The stator is delta wound with a phase resistance of 1.2 Ω. The total friction and windage losses are 210 W. Assuming the iron losses in the stator as half the copper losses in the stator, calculate the overall efficiency if the motor operates at a power factor 0.87, a synchronous speed of 750 rpm and a running speed of 734 rpm.

## QUESTION 6 [5+5=10]

(a) Explain the procedure for determination of synchronous reactance of a synchronous machine using its OCC and SCC. What do you mean by $X_S$(adjusted).

(b) Why a single-phase induction motor is not a self-starting machine? Draw its torque vs. speed characteristic.



# BITS, PILANI - DUBAI CAMPUS

## Knowledge Village, Dubai

**Year II - Semester II 2005 - 2006**

**COMPREHENSIVE EXAMINATION (Closed Book)**

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

**Date: May 25, 2006** **Time: 3 Hours** **M.M. = 80 (40 %)**

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**NOTE:**

(i) Answer all the questions.

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## Part -- A

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(a) For a sinusoid $i = I_m \sin\theta$, derive the expression for its rms value and average value in terms of its peak value.

(b) A series RLC circuit is connected to a 230 V, 50 Hz, single-phase ac supply. The values given are $R = 5\ \ \Omega$, $L = 13\ \ mH$, and $C = 140\ \ \mu F$. Find (i) Total Reactance (ii) Impedance (iii) Current drawn by the circuit (iv) Power Factor of the circuit.

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(a) A 480 V Y-connected source supplies a Δ-connected load composed of 3 identical impedances $Z = 16 - j9$ ohms. It is assumed that the angle of $V_{AN}$ is reference at $0^0$ and that the source is positive sequence.

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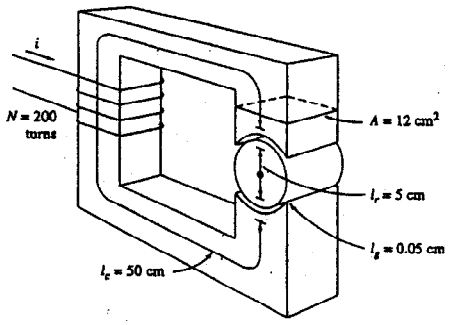


Figure (1)

## Part -- B

## QUESTION 4 [8+7=15]

(a) For a single phase 50 Hz, 200/2000 V, transformer OC / SC test results are as follows:

| | | | |
|---|---|---|---|
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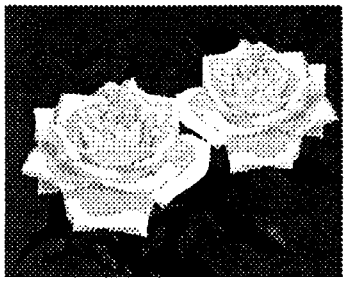

# BITS, PILANI - DUBAI CAMPUS

## Knowledge Village, Dubai

**Year II - Semester II 2005 - 2006**

**MAKEUP COMPREHENSIVE EXAMINATION (Closed Book)**

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

**Date: , 2006** **Time: 3 Hours M.M. = 80 (40 %)**

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**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 (MAIN-SHEET)AND PART-B (EXTENSION-SHEET)IN SEPARATE ANSWER SHEETS. MARK YOUR ANSWER SHEETS CLEARLY AS 'A' AND 'B'.
(iv) Answer all parts of a question in continuation.
(v) Do not leave any blank page(s) in between the answers.

## Part -- A

**QUESTION 1** [4+3+8=15]

(a) Draw on the same phasor diagram the phasors representing the following sinusoids.
(i) $\sin \omega t$ (ii) $3\cos(\omega t - 135^o)$ (iii) $2\sin(\omega t + 30^o)$ (iv) $-2\sin \omega t$

(b) Evaluate the following phasor expressions.
(i) $1\angle 30^o + 2\angle 60^o$ (express result in rectangular and polar form)
(ii) $(2 + j3) \times (2\angle 45^o)$ (express result in polar form)
(iii) $\dfrac{1 + j2}{2\angle 20^o}$ (express result in rectangular form)

(c) 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 $\omega = 10^5 \ \ rad/s$. 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?

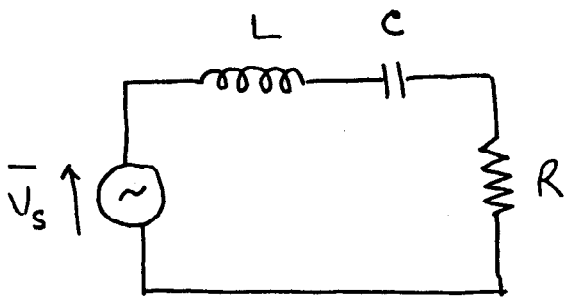



Figure (1)

## QUESTION 2 [15]

In the power distribution system of Figure (2), if $G_2$ supplies 5 kW at 0.707 pf lagging, find:

(i) Power factor and complex power supplied by $G_1$, and

(ii) Generator terminal voltages.

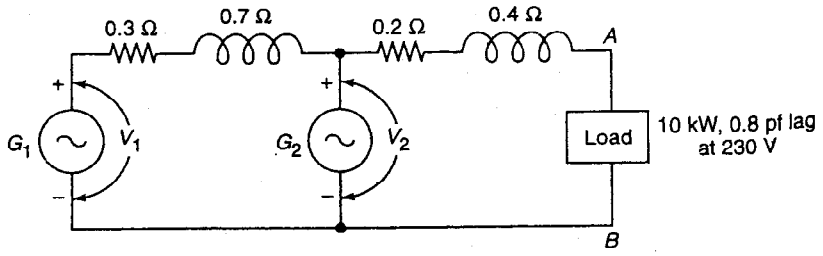



Figure (2)

## QUESTION 3 [10]

In the magnetic circuit shown in Figure (3), the coil $F_2$ is supplying 500 AT in the direction indicated. Find the AT that the coil $F_1$ must provide to produce a flux of 4 mWb in the air-gap in the central limb from A to B. The relative permeability of the core is 4500. Cross-sectional area is 30 $cm^2$, AB = 15 cm, ABC = 40 cm, and ABD = 40 cm.

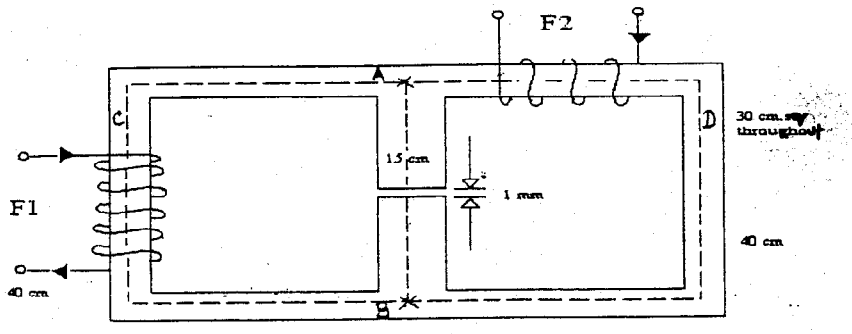



Figure (3)

## Part -- B

### QUESTION 4

[5+10=15]

(a) In a 25 KVA, 3300/230 V, single phase transformer, the iron and full-load copper losses are 350 W and 400 W respectively. Calculate (i) the efficiency at half load at 0.8 p.f., and (ii) at load at which the efficiency is maximum.

(b) Tests are performed on a single phase, 10 kVA, 2200/220 V, 60 Hz transformer and the following results are obtained.

| | Open-Circuit Test (High-voltage side open) | Short-Circuit Test (low-voltage side shorted) |
|---|---|---|
| Voltmeter | 220 V | 150 V |
| Ammeter | 2.5 A | 4.55 A |
| Wattmeter | 100 W | 215 W |

(i) Derive the parameters for the approximate equivalent circuits referred to the low-voltage side and the high-voltage side.

(ii) Express the excitation as a percentage of the rated current.

(iii) Determine the power factor for the no-load and short-circuit tests.

### QUESTION 5

[5+10=15]

(a) A 50 kW, 230 V dc shunt motor takes a current of 14.5 A when running light at 1640 rpm. The armature and field resistances are 0.15 Ω and 120 Ω respectively. Estimate the motor efficiency when the motor is drawing 215 A. What would be the maximum efficiency of the motor and the load current at which it would occur?

(b) A 4-pole, 5 Hz, 3-phase induction motor when running on full load develops a useful torque of 100 Nm while the rotor mf is observed to make 120 cycles/min. It is known that the torque lost on account of friction and core loss is 7 m. Calculate:

(i) Shaft power output,
(ii) Rotor copper loss
(iii) Motor input, and
(iv) Motor efficiency

The total core loss is given as 700 W.

### QUESTION 6

[10]

The OC and SC test data of a 3-phase, i MVA, 6.6 kV, star-connected synchronous generator is given below:

| | | | | | | |
|---|---|---|---|---|---|---|
| $I_f$ (A) | 60 | 70 | 80 | 90 | 100 | 110 |
| $V_{OC}$ (Line) (A) | 4693 | 5500 | 6160 | 6600 | 6967 | 7260 |
| $I_{SC}$ (A) | 98 | | | | | |

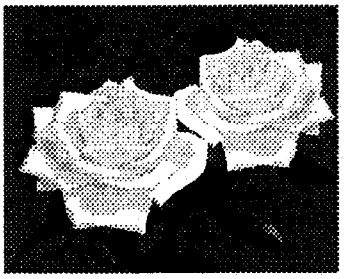
Find:

(i) Unsaturated synchronous reactance,

(ii) Adjusted synchronous reactance

(iii) Excitation voltage needed to give rated voltage at full load, 0.8 pf lagging. Use adjusted synchronous reactance.

(iv) Also the voltage regulation for the load specified in part (iii).



# BITS, PILANI - DUBAI CAMPUS
## Knowledge Village, Dubai

**II Year (EEE/EIE/CSE/ME) 2005 - 2006, Semester - II**
**TEST - II (Open Book)**

**Course Title:** Electrical Sciences-II (ES UC272)

**Date:** April 23, 2006 **Time:** 50 Minutes **M.M. = 40 (≈20 %)**

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**NOTE:** (i) Only prescribed text book is permitted for answering.
(ii) Answer all the questions.
(ii) Answer all the parts of a question in continuation.
(iii) Do not leave any blank page(s) in between the answers.

**Question1**

a. An iron core choking coil has a length of 1 m, a mean diameter of 0.06 m and is wound uniformly with 1000 turns of wire. Find the energy stored in joules when the coil is carrying a current of 10 A. Take relative permeability = 1. **(10)**

b. In the magnetic circuit of Figure (1), the relative permeability of the ferromagnetic material is 1200. Neglect magnetic leakage and fringing. All dimensions are in centimeters, and the magnetic material has a square cross-sectional area. Determine the air gap flux, the air gap flux density, and the magnetic field intensity in the air gap. **(15)**

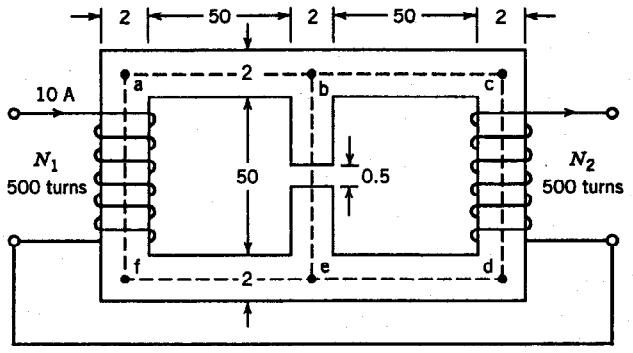



Figure (1)

**Question 2** **(15)**

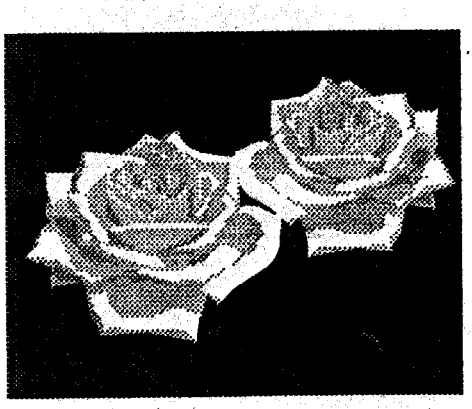
Tests are performed on a single phase, 10 kVA, 2200/220 V, 60 Hz transformer and the following results are obtained.

| | Open-Circuit Test (High-voltage side open) | Short-Circuit Test (low-voltage side shorted) |
|---|---|---|
| Voltmeter | 220 V | 150 V |
| Ammeter | 2.5 A | 4.55 A |
| Wattmeter | 100 W | 215 W |

(i) Derive the parameters for the approximate equivalent circuits referred to the low-voltage side and the high-voltage side.

(ii) Express the excitation as a percentage of the rated current.

(iii) Determine the power factor for the no-load and short-circuit tests.



# BITS, PILANI - DUBAI CAMPUS
## Knowledge Village, Dubai

**II Year (EEE/EIE/CSE) 2005 - 2006, Semester - II**
**TEST - I (Closed Book)**

**Course Title:** Electrical Sciences-II (ES UC272)

**Date:** March 05, 2006 **Time:** 50 Minutes **M.M. = 40 (≈20 %)**

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**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.

**Question1** **(3+4+3=10)**

(i) Evaluate the following phasor expressions.

(a) $2\angle 45^o + 4\angle 30^o$ (Express result in rectangular and polar forms)

(b) $(1+j)\times(3-j2)$ (Express result in rectangular form)

(c) $\dfrac{3\angle 30^o}{3+j4}$ (Express result in polar form)

(ii) Determine the rms value of the voltage waveform shown in figure (1).

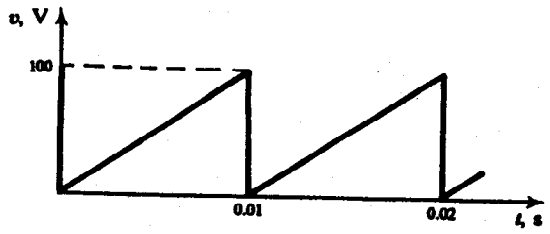


Figure (1)

(iii) Sketch the following waveforms:

(a) A sine wave of frequency 50 Hz and amplitude 100 V.

(b) The sinusoid $v = 10\cos(3.14\times10^7 t - 45^o)$

(c) The sinusoids $v_1 = 10\cos(314t - 30^o)$ and $v_2 = 5\sin(314t + 60^o)$

**Question2** **(10)**

For the circuit of Figure (2) find the value of V and the circuit pf.

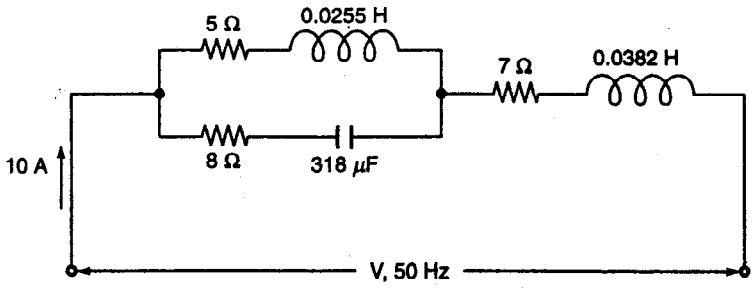


Figure (2)

**Question3** **(10)**

In the power distribution system of figure (3), if $G_2$ supplies 5 kW at 0.707 pf lagging, find:

(a) Power factor and complex power supplied by $G_1$, and

(b) Generator terminal voltages.

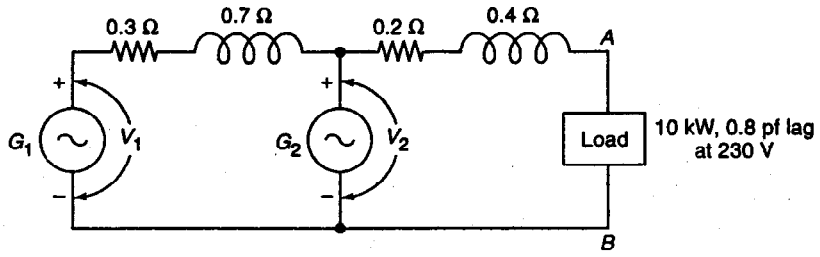


Figure (3)

**Question4** **(4+6=10)**

(a) What is the need for improving the power factor of an industrial load? How is it done?

(b) A 46-mH inductance is connected in series with a resistance of 10 Ω.

(i) How much current will it draw if connected across a 100 V, 60 Hz source?

(ii) What is the power factor of the coil?

(iii) Determine the value of the capacitance that must be connected across the coil to make the power factor of the overall circuit unity.