Ollscoil na hÉireann, Gaillimh GX 683
National University of Ireland, Galway

Semester II Examinations, 2002/2003
Front Page Template

Exam Code(s)	3BN121, 3BM121
Exam(s)	Third Year Electronic Engineering Third Year Mechanical Engineering
Module Code(s)	EE302
Module(s)	Electrical Power and Machines
Paper No.	2
Repeat Paper	Special Paper
External Examiner(s)	Professor S. McLaughlin
Internal Examiner(s)	Professor D.J. Wilcox Dr. M. Duffy
Instructions:	Answer three questions $\mu_0 = 4\pi \times 10^{-7}$ H/m
Duration	2hrs
No. of Answer books	1
Requirements:	
Handout	
MCQ	
Statistical Tables	
Graph Paper	
Log Graph Paper	
Other Material	
No. of Pages	3
Department(s)	Electronic Engineering

1. Draw a phasor diagram to illustrate the relationship between phase voltages and line currents for a balanced 3-phase, delta-connected load with lagging power factor. [**6 marks**]

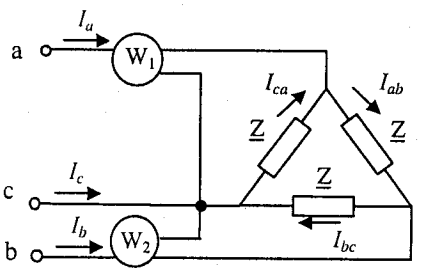

Fig. 1. Balanced 3-phase, delta-connected load

The balanced 3-phase delta-connected load shown in Fig. 1 has an impedance per phase of $Z = (15.5 + j7.5)\ \Omega$. The load is connected to a balanced 3-phase, 415 V supply. Taking $\underline{V_{ab}} = 415\angle 30^\circ$:

(a) Calculate the phase currents. [**6 marks**]

(b) Calculate the line currents. [**6 marks**]

(c) What is the total power delivered to the load ? [**6 marks**]

(d) Determine the wattmeter readings, W_1 and W_2. [**9 marks**]

2. The magnetizing impedance of a 440 V, 50 Hz, 960 rpm, 3-phase induction motor is given as $R_0 = 200\ \Omega$, $X_0 = 980\ \Omega$. Locked rotor tests on the motor gave the following results :

V = 243.5 V, I = 20.2 A, T = 4.68 Nm, P = 1102 W

(a) Draw the approximate equivalent circuit model of the motor referred to the stator side. [**15 marks**]

(b) Calculate the full load current drawn from the supply. Include the contribution of magnetising current in this case. [**10 marks**]

(c) Given that mechanical losses of 1500 W were deduced from no-load tests, determine the torque provided to a mechanical load running at rated speed. [**8 marks**]

3. Answer *each* of the following questions :

(a) Describe the construction and basic operation of a permanent magnet stepper motor. [**11 marks**]

(b) Derive an equation to describe the speed-torque characteristic of a universal motor operated under AC conditions. [**11 marks**]

(c) Describe how a switched reluctance motor can be modeled as a variable inductor. [**11 marks**]

4. What is meant by voltage distortion in a power system ? Describe how such distortion is caused. **[5 marks]**

The load shown in Fig. 4 is provided with a distorted voltage waveform, e(t), from a 50 Hz supply, where :

$$e(t) = 200\text{Sin}(\omega t) + 50\text{Sin}(3\omega t + 25^\circ)$$

(a) Write the corresponding equation for the current waveform drawn by the load. **[10 marks]**

(b) Calculate (i) the rms source voltage, (ii) the rms source current. **[5 marks]**

(c) Calculate the average power delivered to the load. **[8 marks]**

(d) What is the power factor of the source ? **[5 marks]**

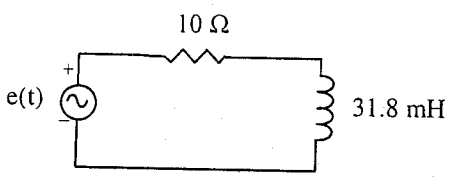

Fig. 4 : Linear RL load