University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

SEMESTER II EXAMINATIONS - 2016/2017

School of Electrical and Electronic Engineering

EEEN20090 – Electrical Energy Systems

External Examiner: Prof. Andrew Gibson

Head of School: Prof. Andrew Keane

Module Coordinator: Prof. Federico Milano *

Time Allowed: 2 hours

Instructions for Candidates

Answer all questions from any four of the five sections.
All question papers **must** be handed up with the answer booklets at the end of the exam.
The distribution of marks in the right margin gives an approximate indication of the relative importance of each part of the question.

Instructions for Invigilators

Non-programmable calculators are permitted.
No rough-work paper is to be provided for candidates.

Student No: _____ **Seat No:** _____

Section A

The system shown in Figure 1 is symmetrical and balanced. The impedance of each load inductance is $j10\ \Omega$ and the impedance of each capacitor is $-j10\ \Omega$. Determine:

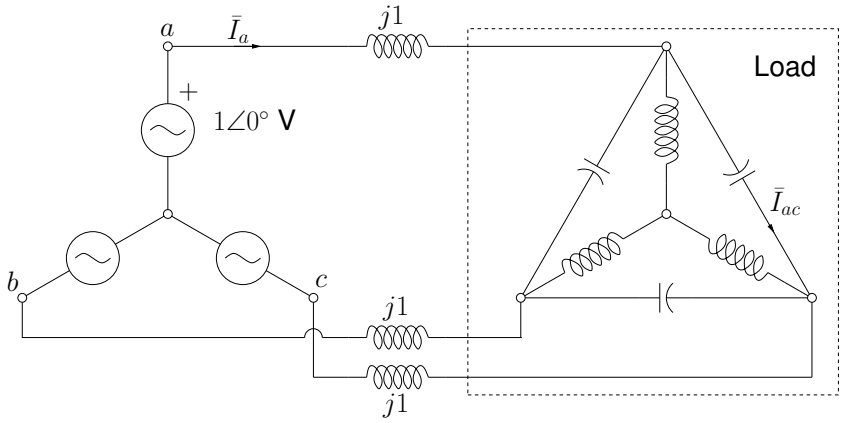

Figure 1

1. The current $\bar{I}_a$. 40%
2. The current $\bar{I}_{ac}$. 40%
3. The complex power consumed by the load, $\bar{S}_{\text{load}}$. 20%

Section B

The magnetic circuit shown in Figure 2 consists of a fixed magnetic core and a mobile one. The depth of both the magnetic core and the mobile part is $\ell = 1$. The mobile part of the circuit can move along both the x and the y axis. Determine

4. The expression of the inductance $L(x, y)$. 40%
5. The force f_x along the x axis. 30%
6. The force f_y along the y axis. 30%

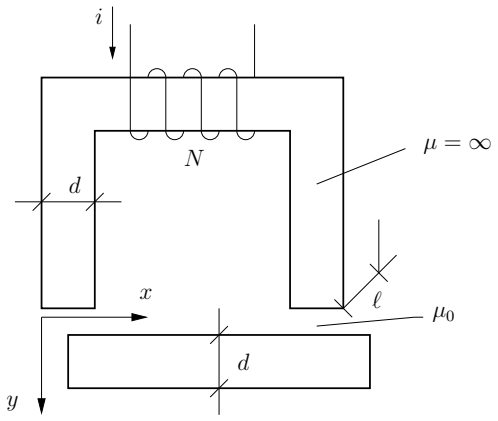

Figure 2

Section C

The rotor speed of a three-phase induction motor is 720 rpm at full load. The nomial frequency of the motor is 50 Hz. The net mechanical power, efficiency and the power factor of the motor at full load are 7360 W, 83% and 0.75, respectively. The motor has 8 poles and its nominal voltage is 380 V. Determine:

7. The synchronous speed of the motor, Ω_s. 25%

8. The slip factor σ at full load. 25%

9. The line current magnitude I_L at full load. 25%

10. The mechanical torque T_m at full load. 25%

Section D

A round-rotor three-phase synchronous generator is connected to a infinite bus whose voltage is 11 kV. The synchronous reactance of the machine is $X_s = 10\ \Omega$ and the armature resistance is negligible. The generator injects into the grid active and reactive power with a power factor 0.673 (inductive) and a load angle $\delta = 10^\circ$. Determine:

11. The magnitude of the current I and the internal e.m.f. E_0 of the generator. 40%

12. The active power P produced by the generator. 20%

13. The new magnitude E_0 and load angle δ_0 of the internal e.m.f. if the generator is working with unity power factor and same current magnitude as the one determined above. 40%

Section E

The three-phase power system shown in Figure 3 consists of a feeder, a transmission line and two loads, L_1 and L_2.

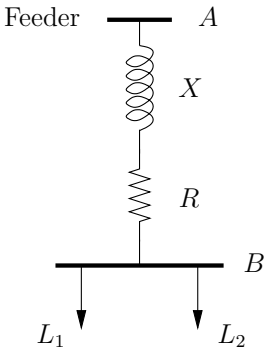

Figure 3

The parameters of the transmission line are: $R = 3.5\ \Omega$ and $X = 5.0\ \Omega$. Load consumptions are:

L_1: $P_1 = 250$ kW, $\cos\phi_1 = 0.9$

L_2: $P_2 = 300$ kW, $\cos\phi_2 = 0.87$

Assuming that the voltage magnitude at bus B is 20 kV, determine:

14. Total active and reactive power consumptions, P_B and Q_B, as well as the power factor $\cos\phi_B$ at bus B. 30%

15. Total active and reactive power injections, P_A and Q_A, as well as the power factor $\cos\phi_A$ at bus A. 30%

16. The voltage phasor $\bar{V}_A$ at bus A using the voltage phasor at bus B as phase angle reference. 40%

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