University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

MIDTERM EXAMINATIONS - 2019/2020

School of Electrical and Electronic Engineering

EEEN20090 – Electrical Energy Systems

Module Coordinator: Prof. Federico Milano *

Time Allowed: 50 minutes

Instructions for Candidates

Answer all questions from any two of the three 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.

Section A

For the voltage support of a single-phase AC system, a system operator wants to connect a shunt element to the feeder. The nominal voltage of the feeder bus is 20 kV. The shunt element has to provide 200 kVAr of reactive power to the grid and dissipate no more than 2 kW. Determine:

1. The values of the real and imaginary parts of the admittance ($\bar{Y}$) assuming a parallel connection of its elements. Also indicate the component(s), i.e. (i.e., resistors, inductors, capacitors, etc., that you would use to implement such an admittance. — 50%
2. The value of the equivalent series impedance ($\bar{Z}$) that provides the same active and reactive power than the admittance calcucated at the point above. Also indicate the component(s) that you would use to implement such an impedance. — 50%

Section B

A magnetic circuit consists of a rectangular iron core with constant cross section $A = 20$ cm^2, average length $\ell = 0.1$ m. The core has an air gap of 2 mm. The coil of the circuit has $N = 500$ turns and a current of 2 A. The relationship between magnetic induction B and magnetic field H is:

$$B = \frac{2H}{230 + H}\,, \tag{1}$$

where B is in Tesla and H in Ampere-turn/meter. Determine:

3. The flux in the iron core (ϕ_{Fe}) and the flux in the air gap (ϕ_{g}) — 60%
4. The equivalent permeability (μ) and relative permeability (μ_r) of the iron core at the given operating conditions. — 20%
5. The self-inductance (L) of the magnetic circuit assuming the permeability calcuated at the previous point. — 20%

Section C

A 10 kVA, 2400-240 V, single-phase transformer has the following resistances and leakage reactances.

$$R_1 = 3\ \Omega, \quad R_2 = 0.03\ \Omega, \quad X_1 = 15\ \Omega, \quad X_2 = 0.15\ \Omega.$$

Find the primary voltage V_1 and the the voltage regulation $\epsilon_{\%}$ required to produce 240 V at the secondary terminals at full load, when the load power factor is:

6. 0.8 power factor lagging. — 50%
7. 0.8 power factor leading. — 50%

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