University College Dublin
An Coláiste Ollscoile, Baile Átha Cliath

MIDTERM EXAMINATIONS - 2021/2022

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

Figure 1 shows an ac circuit represented both in time domain and in frequency domain. Suppose $v_g(t) = 15\cos(20t)$ V, $\bar{Z}_1 = 15.3\angle -24.1^\circ\ \Omega$ and $\bar{Z}_2 = 14.4\angle 53.1^\circ\ \Omega$. Determine:

1. The voltage $v(t)$. 40%
2. The values of R_1, R_2, L and C. 30%
3. The power consumed by the resistances (P_{R1} and P_{R2}) and the complex power ($\bar{S}_g$) delivered by the voltage source. 30%

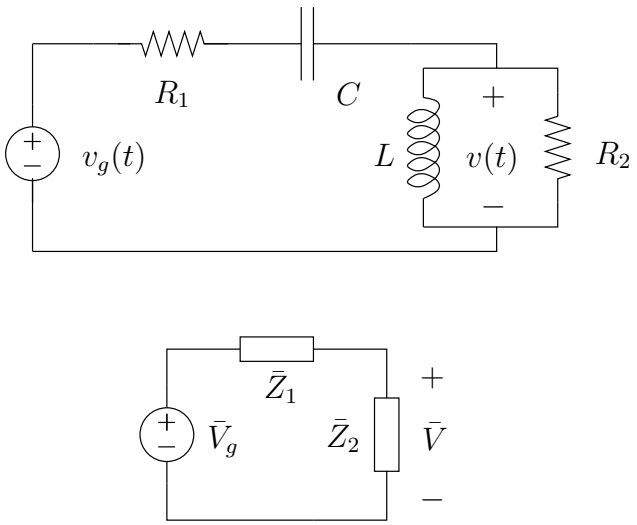

Figure 1

Section B

The magnetic circuit shown in Figure 2 has infinite permeability, two coils and three airgaps with reluctances $\mathcal{R}_1$, $\mathcal{R}_2$ and $\mathcal{R}_3$.

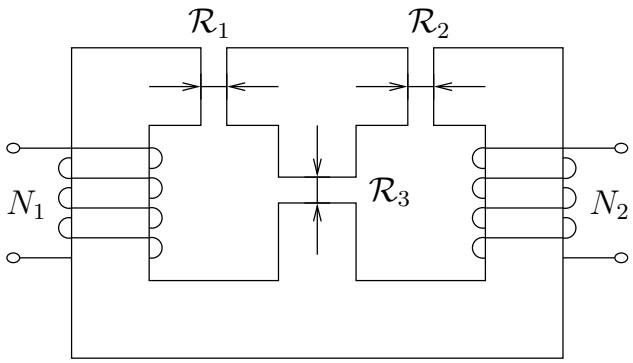

Figure 2

4. Determine the expressions of the self-inductances L_{11} and L_{22} of the coils. 50%
5. Determine the expressions of the mutual-inductances L_{12} and L_{21} of the coils. 40%
6. Discuss the conditions for which the equalities $L_{12} = L_{21} = \sqrt{L_{11}L_{22}}$ hold. 10%

Section C

A single-phase transformer has the following nominal parameters: $S_N = 160$ kVA, $V_{1N} = 2,000$ V, $V_{2N} = 200$ V.

The open-circuit test of a single-phase transformer was carried out leaving in open circuit the low-voltage winding. The test yielded the following data: $2,000$ V, 1 A and $1,000$ W.

The following data were obtained in a short-circuit test of the transformer, with its high-voltage winding short-circuited: 8 V, nominal current, $2,560$ W.

Calculate:

7. The iron equivalent resistance R_{Fe}, and magnetising reactance X_μ of the transformer referred to the high-voltage winding. 25%

8. The equivalent short-circuit resistance R'_{sc} and rectance X'_{sc} of the transformer referred to the high-voltage winding. 25%

9. The voltage V_2 on the low-voltage winding when the transformer is feeding a load consuming $I_2 = 400$ A with power factor $\cos\phi_2 = 0.8$ lagging and $V_1 = V_{1N}$. 25%

10. Apparent power when the transformer efficiency is maximum ($S_{\eta\,\max}$) and the maxiumum efficiency ($\eta_{\max}$) for a load with power factor 0.8 leading. 25%

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