Exam 13.10.2026

Q1.

Q1:

a) Find Thevenin equivalent for the circuit shown in Figure 1. The rms voltage of the sinusoidal voltage source $V_g = 230 \angle 0°$ V and frequency 50 Hz. R1 = 27 Ω, R2 = 8 Ω, L1 = 150 mH, L2 = 60 mH and $C = 67$ μF. [3 pts]

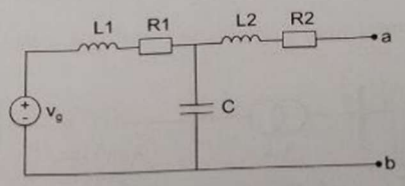


Figure 1. Electric circuit of Question 1 a).

b) Below are presented unbalanced three-phase voltages for Phases a, b and c. Find the symmetrical components for the voltage of Phase a. Draw the phasor diagram which includes the original voltage phasor V_a and its symmetrical components. [3 pts]

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 1.1\angle 9° \\ 0.8\angle 130° \\ 1.2\angle -70° \end{bmatrix} p.u.$$

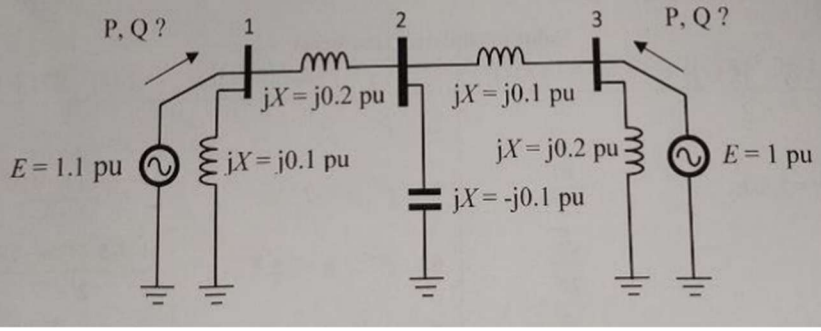
Q2.

The electric circuit in Figure 3 comprises three nodes in addition to the reference node 0 (ground), two voltage sources, 5 reactive branches, one of which is capacitive, connected as shown in Figure 3. All the relevant parameter values are given on the figure (2pts/sub-question).

a) Determine the nodal admittance matrix of the electric circuit.

b) Calculate the voltage at Node 2.

c) Determine the real (P) and reactive (Q) powers injected by two voltage sources at Nodes 1 and 3.



Q3.

What is Constant impedance?

List **technical constraints** in distribution planning.

What is a Primitive network?

What is the damping factor?

Define electromagnetic induction.

What is i-controller?

What is Ampere circuital law?

Sources of **faults** in distribution planning?

What is connectivity matrix?

What is Air gap in synchronous generator?

What are sources of unbalance in generator?

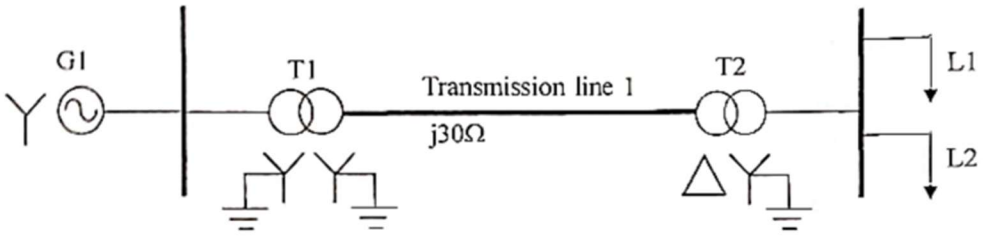
Q4.

A three-phase power system consisting of one generator, two transformers, a transmission line and loads is presented in Figure 3. The parameters of the system are the following:
Generator 1 (G1): 50 MVA, 11 kV, X1 = 0.15, X2 = 0.1, X0 = 0.03 pu
Transformer 1 (T1): 50 MVA, 11/110 kV, X1 = X2 = X0 = 9 %
Transformer 2 (T2): 25 MVA, 110/20 kV, X1 = X2 = X0 = 10 %
Transmission line 1: Z1 = Z2 = j30 Ω, Z0 = 2.3*Z1
Load 1 (L1): P_{nom} = 10 MW, 20 kV
Load 2 (L2): Q_{nom} = 5 MVAr, 20 kV

a) The loads are modelled using a constant impedance load model such that they consume their nominal powers at the nominal voltage. The given power is three-phase power and the voltage 20 kV is the nominal line-to-line voltage. Calculate the impedance values for the loads. [1 pts]

b) Draw the positive and zero sequence impedance networks of the circuit. Use per unit values and 50 MVA base power. [3 pts]

c) Calculate the load current (pu) flowing through the transmission line according to the positive sequence network. The internal emf (field voltage) of the synchronous generator G1 can be assumed to be $1.05\angle 0°$ pu. [2 pts]



Q5.

Q5: Figure 4 presents a first order RC circuit. A step change of 10 V is applied to the input voltage u_{in}. Initial conditions are zero, i.e. u_{in} and u_o are zero.

a) Determine transfer functions for determining u_o and i_{in}. [3 pts]

b) Apply Laplace transform and determine the responses for u_o and i_{in} in a time domain. Utilize the table of Laplace Transforms below. The mathematical expressions as a function of time are acceptable, the graphs are not required. [3 pts]

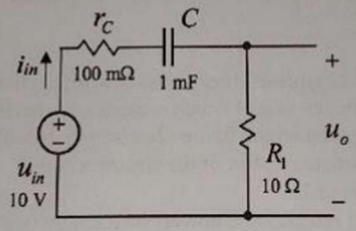


Figure 4. RC circuit of Question 5.

Table of Laplace Transforms

$f(t)=\mathcal{L}^{-1}\{F(s)\}$	$F(s)=\mathcal{L}\{f(t)\}$	$f(t)=\mathcal{L}^{-1}\{F(s)\}$	$F(s)=\mathcal{L}\{f(t)\}$
1. 1	$\frac{1}{s}$	2. e^{at}	$\frac{1}{s-a}$
3. t^n, $n=1,2,3,\ldots$	$\frac{n!}{s^{n+1}}$	4. t^p, $p>-1$	$\frac{\Gamma(p+1)}{s^{p+1}}$
5. $\sqrt{t}$	$\frac{\sqrt{\pi}}{2s^{\frac{3}{2}}}$	6. $t^{n-\frac{1}{2}}$, $n=1,2,3,\ldots$	$\frac{1\cdot3\cdot5\cdots(2n-1)\sqrt{\pi}}{2^n s^{n+\frac{1}{2}}}$
7. $\sin(at)$	$\frac{a}{s^2+a^2}$	8. $\cos(at)$	$\frac{s}{s^2+a^2}$