Middle East Technical University (METU)
Electrical and Electronics Engineering Department

EE 202 CIRCUIT THEORY II PROJECT

Assigned: October 15:
Due for Part 1: November 15 23:00pm
Due for Part 2: December 20 23:00pm

In this project, there are two parts that should be submitted at different due dates. In each part, you have to solve the problems by using systematic techniques of Circuit Analysis on paper first. Then you will use MATLAB to write the necessary equations and evaluate them numerically. In the first part, once you write the state equations, you will use MATLAB to solve them in time by numerical integration. In the second part, a similar approach will be used to solve the problem on paper first. Then the solution will be obtained in MATLAB by numerical evaluation in sinusoidal steady-state. You will return your solutions on paper by converting the documents to the pdf format. The MATLAB codes and the written report about your solution with the required plots will be submitted to the ODTUClass on due date. The reference material which you can find examples in MATLAB will be uploaded to ODTUClass. Before starting the project, please read the notes at the end.

PART 1 (30 points)

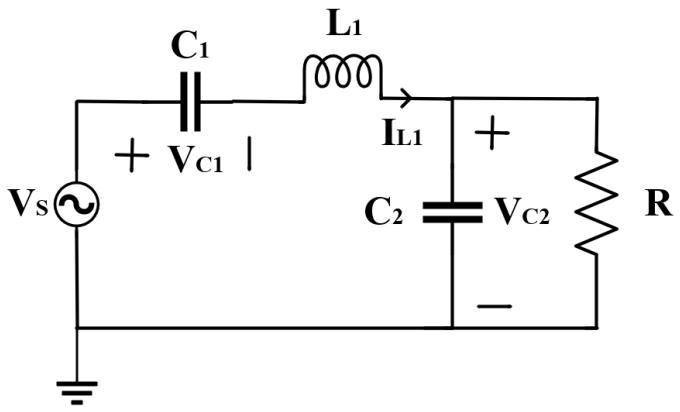

Figure 1

a) Obtain the state equations for the circuit at Figure 1. The state vector should be taken as:

$$\mathbf{X} = [\mathbf{x_1(t)}, \mathbf{x_2(t)}] = [\mathbf{V_{C1}(t)}, \mathbf{V_{C2}(t)}, \mathbf{I_{L1}(t)}]^{\mathbf{T}}$$

V_{C1}, V_{C2}, I_{L1} are the voltage across the capacitor C_1 , the voltage across the capacitor C_2 ,the current passing through L_1 respectively.

The state equations have following form,

$$\dot{\boldsymbol{x}} = \mathbf{Ax} + \mathbf{Bu}$$
$$\mathbf{y} = \mathbf{Cx} + \mathbf{Du}$$

Where **x** is state vector and U is input vector.

b) The input voltage is sinusoid ($V_S = sin(150\pi t)$.
$Take\ C_1 = 10\mu F$, $C_2 = 100\mu F$, $L_1 = 0.5H$ and $R = 100\Omega$

Find the states, $V_{C1}(t), V_{C2}(t), I_{L1}(t)$, by solving the equation in part a) by MATLAB and plot them.

PART 2 (70 points)

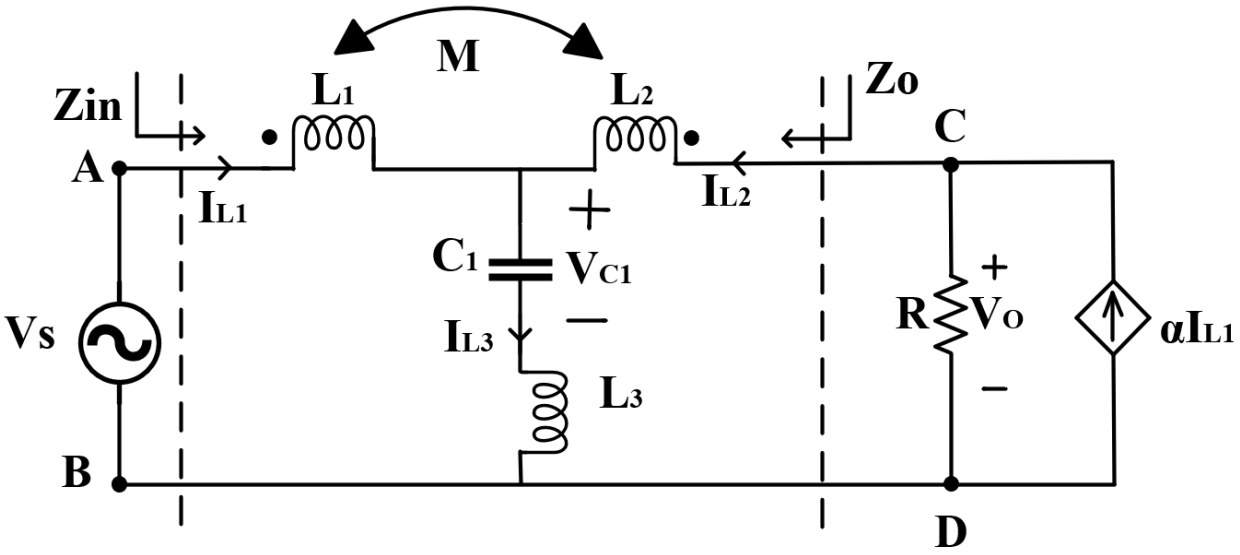

Figure 2

a) Write the mesh equations of circuit in the Figure 2 in matrix form in SSS.
b) Find the phasor values of $I_{L1}(j\omega)$, $I_{L2}(j\omega)$ by taking
$V_s(t) = 10\cos(220\pi t)$, $C_1 = 10$ μF, $L_1 = 100$mH,
$L_2 = 500$mH, $L_3 = 200$mH, $M = -200$mH, $R = 100\ \Omega$
and $\alpha = 0.5$
c) Plot $I_{L1}(j\omega)$ and $I_{L2}(j\omega)$.
Hint: (ω-axis can be plotted in a range between $\omega = 150\pi$ and $\omega = 300\pi$)
d) Find the $V_o(j\omega)$ in terms of $I_{L1}(j\omega)$ and $I_{L2}(j\omega)$.
e) Plot $V_o(j\omega)$.
f) Plot the input impedance (the impedance between terminal A and B) vs. frequency $Z_{in}(j\omega)\ vs.\ \omega$
g) Plot the output impedance (the impedance between terminal C and D) vs. frequency $Z_o(j\omega)\ vs.\ \omega$
h) Plot the total average power dissipated on this circuit vs. frequency $P_{av}(j\omega)\ vs.\ \omega$
i) Plot the reactive power vs. frequency $[Q_C(j\omega) + Q_L(j\omega)]vs.\ \omega$

Notes

1) Please write how many hours you spent on this project (This does not affect your grade. It is asked for the statistical issues).

2) This project will be evaluated by Enes Ayaz (eayaz@metu.edu.tr),Nurullah Gülmüş (ngulmus@metu.edu.tr) and Safa Çelik(celiksa@metu.edu.tr) (Any specific question about the project is to be addressed to them.

3) Submission of the project will be through the ODTUClass system. Unexpected problems happen. Therefore, do not wait until the last minute to submit.

4) You will submit m-files and a pdf project report document all zipped in a single zip-file. The m-files will contain working code. In addition to the m-files, a pdf document to present your solutions, results, and plots.

5) Before submitting the homework, be sure that all the m-files work in a clear workspace.

6) Clarity and the structure of the code will also be graded. The evaluator must be able to easily read and understand what your code does. Place comments to explain your code.

7) Format and appearance of your figures/(numeric outputs)/(text outputs) will also be graded. Do not forget figure titles, legends, labels, etc. Please take some time for the consideration of those issues. Do not just randomly give an unknown plot. Do not just randomly throw some unknown values to the command prompt.