Assignment 1 - Modelling

Course code: ***ECEN315* -** Will Browne & Daniel Burmester

Coursework description: The aim of this assignment is to assess the student's ability to model systems using block diagram techniques, analyse systems using the Laplace transform method, use MATLAB to simulate system behaviour and understand the system.

Deadline: 29th March @ 23:59 on-line submission

Work will be marked and returned by 5pm 13.04.20

This piece of coursework is regarded as major.

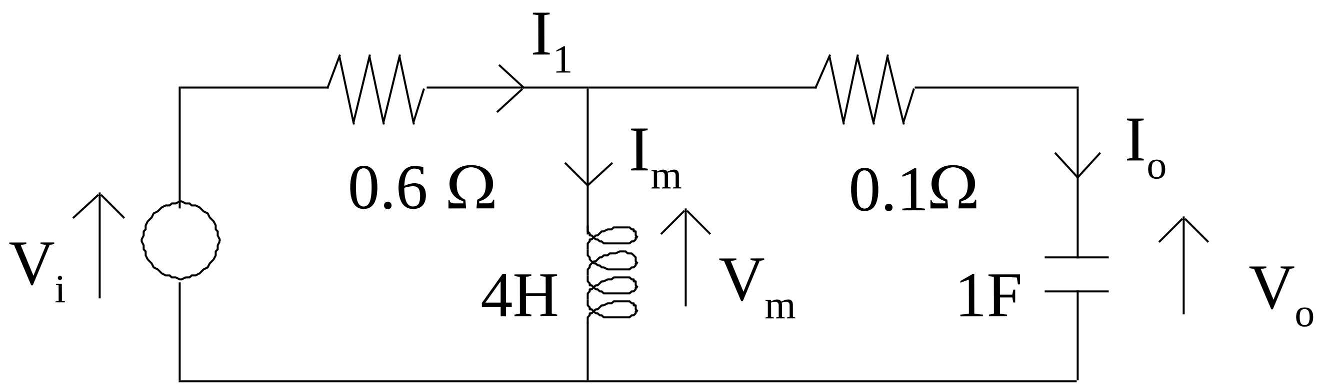
Working Together and Plagiarism

We encourage you to **discuss the principles** of the course and assignments with other students, to help and seek help with programming details, problems involving the lab machines. However, any work you hand in **must be your own work**.

The School policy on Plagiarism (claiming other people's work as your own) is available from the course home page. Please read it. We will penalise anyone we find plagiarising, whether from students currently doing the course, or from other sources. Students who knowingly allow other students to copy their work may also be penalised. If you have had help from someone else (other than a tutor), it is always safe to state the help that you got. For example, if you had help from someone else in writing a component of your code, it is not plagiarism as long as you state (eg, as a comment in the code) who helped you in writing the method.

This work takes 4~6 sides of A4 and ~8Hrs to complete - do not leave it to the last minute!

Model of an electronic system



Derive the block diagram of the above circuit, reorganise it and then use the loop reduction method to find V_o/V_i. Use the inverse transfer function to find $V_o(t)$ for a unit step input.

Hint: the following equations may be useful:

$$V_i - V_m = 0.6 I_i, I_m = I_i - I_o, \; V_m = 4s\, I_m, \;\; V_m - V_o = 0.1 I_o, \; V_o = \frac{1}{s} I_o$$

[You may *verify* the transfer function by another method, e.g. a two port network.]

Use MATLAB to plot V_o if V_i is a unit step voltage both numerically and theoretically. **Compare the time responses.**

Task 2 : Thermal system

How long does it take a casserole dish to come up to temperature?

- Heat is energy flow due to temperature difference.
- It is measured in Joules (J), i.e. kg.m^2/s.
- The casserole dish at temperature T_0 is placed in an oven, which is held at a constant temperature T_1.
- The rate of heat flow $\dot{q}$ into the casserole dish is given by:

$$\dot{q}=hA(T_1-T)$$

Where h is the coefficient of heat transfer, A is the surface area and T is the current temperature of the dish.

- The rate of heat flow is proportional to the change in temperature, where the specific heat C for 1 kg of a body is the constant of proportionality.

If the casserole dish has mass M and average specific heat C, determine the change of temperature as a function of time using the block diagram method.

Given C = 0.45 J/g.K and h = 100w/m^2.K, ESTIMATE how long it will take for the casserole dish in an oven set at 200°C to reach a cooking temperature of 80°C?

Appendix 1 - Useful Laplace transforms

Time domain	**Laplace domain**		**Time domain**	**Laplace domain**
K	$\frac{K}{s}$		$K*\sin(\omega t)$	$\frac{K*\omega}{s^2+\omega^2}$
$K*t$	$\frac{K}{s^2}$		$K*\cos(\omega t)$	$\frac{K*s}{s^2+\omega^2}$
$K*t^n$	$\frac{K*n!}{s^{n+1}}$ {for n>1}		$K*e^{-at}*\sin(\omega t)$	$\frac{K*\omega}{(s+a)^2+\omega^2}$
Ke^{-at}	$\frac{K}{s+a}$		$K*e^{-at}*\cos(\omega t)$	$\frac{K*(s+a)}{(s+a)^2+\omega^2}$
$K*t*e^{-at}$	$\frac{K}{(s+a)^2}$			