Assignment 1 - Modelling

Course code: ***ECEN315*** **-** Will Browne, Daniel Burmester & Chris Hollitt

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: 17th March @ 5 p.m. to ECS Submission system

Work will be marked and returned by 5pm 3.04.21

This piece of coursework is regarded as major.

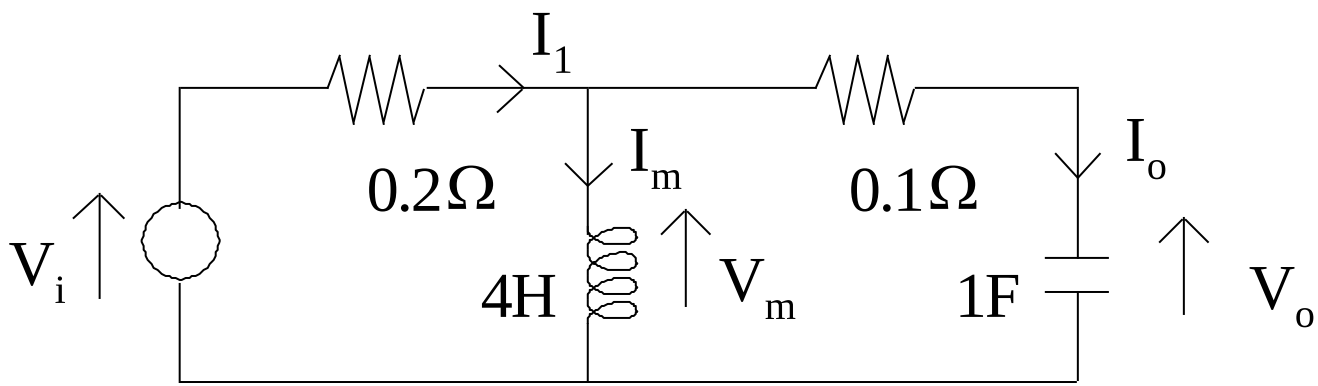
Working Together and Plagiarism

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 ~6 sides of A4 and ~10Hrs 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.

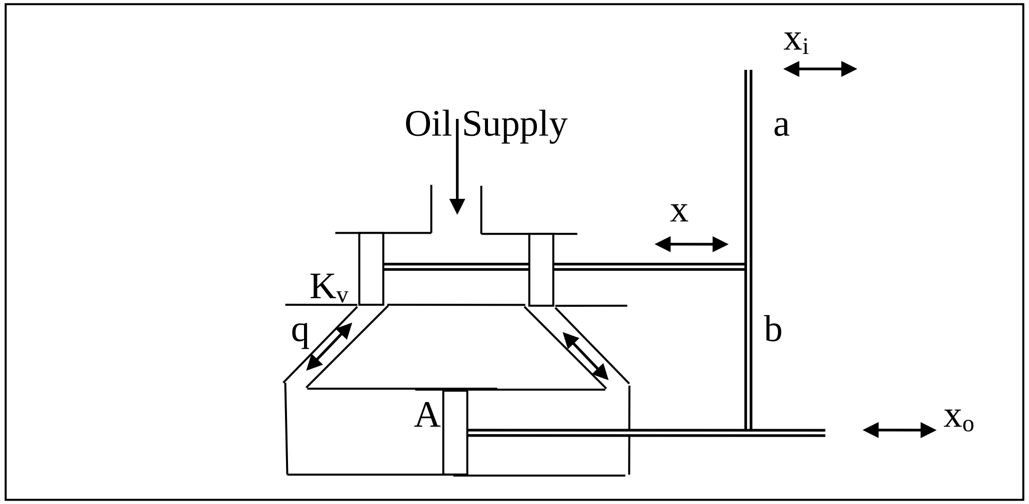
Hint: the following equations may be useful:

$$V_i - V_m = 0.2 I_i \quad I_m = I_i - I_o \quad V_m = 4s\, I_m \quad V_m - V_o = 0.1 I_o \quad V_o = \frac{1}{s} I_o$$

[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 : Model of a hydraulic system



Hydraulic systems are used where large forces are required to be controlled from small input signals. The input displacement (x_i) and output displacement (x_o) combine to give the displacement of the spool (x).

Prove the following relationship:

$$x = \left(\frac{b}{a+b}\right)x_i - \left(\frac{a}{a+b}\right)x_0$$

The flow rate *q* is proportional to the displacement of the spool, with constant K_v. Consider the relationship between the flow rate, area of piston (A) and the output displacement. The system contents are a = 4 cm, b = 12 cm, A = 10 cm^2 and K_v = 20 cm^3/s/cm.

Determine the transfer function of the system relating output to input displacement.

[440 Students only: Examine the dynamic response to a step input of 0.5 cm and a sinusoidal input of amplitude 1 and frequency 2 rads/s]

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}	$\frac{K}{s+a}$		$K*e^{-at}*\cos(\omega t)$	$\frac{K*(s+a)}{(s+a)^2+\omega^2}$
$K*t*e^{-at}$	$\frac{K}{(s+a)^2}$			