ENG1060: COMPUTING FOR ENGINEERS

Lab 11 – week 12

2019 S2

This lab is for practice only and not assessed.

Learning outcomes:

1. To revise user-defined functions and apply good programming practices
2. To identify the mathematics that represents the problem to be solved
3. To apply techniques to solve linear systems both by hand and with MATLAB

Background:

Linear systems of equations appear everywhere in life. Within engineering, these systems may become very large and therefore there needs to be ways to efficiently solve these systems using computers.

Primary workshops involved:

- Workshop 3: Functions, commenting, debugging and strings
- Workshop 11: Linear systems

Assessment:

This lab is not assessed.

Lab 11 – Non-assessed questions

Remember good programming practices for all tasks even if not specifically stated. This includes, but is not limited to:

- using clc, close all, and clear all, where appropriate
- suppressing outputs where appropriate
- labelling all plots, and providing a legend where appropriate
- fprintf statements containing relevant answers

PRELIMINARY

Create function files implementing each of the following linear-system solver methods following the function declarations provided. This will help you consolidate your understanding of the techniques involved.

- Naïve Gaussian elimination: function x = naive_gauss(A,b)
- Gaussian elimination: function x = gauss(A,b)
- Guass-Jordan elimination: function x = gauss_jordan(A,b)

TASK 1

[L011A]

Solve the following linear system by hand. Use partial pivoting if required.

$$-x_2 + 7x_3 = 2$$
$$x_1 + 2x_2 - x_3 = 3$$
$$5x_1 - 2x_2 = 2$$

TASK 2

[L011B]

Solve the following linear system using Naïve Gaussian elimination, Gaussian elimination and Gauss-Jordan elimination.

$$x + 2y + 3z = 1$$
$$4x + 5y + 6z = 1$$
$$7x + 8y + 9z = 1$$

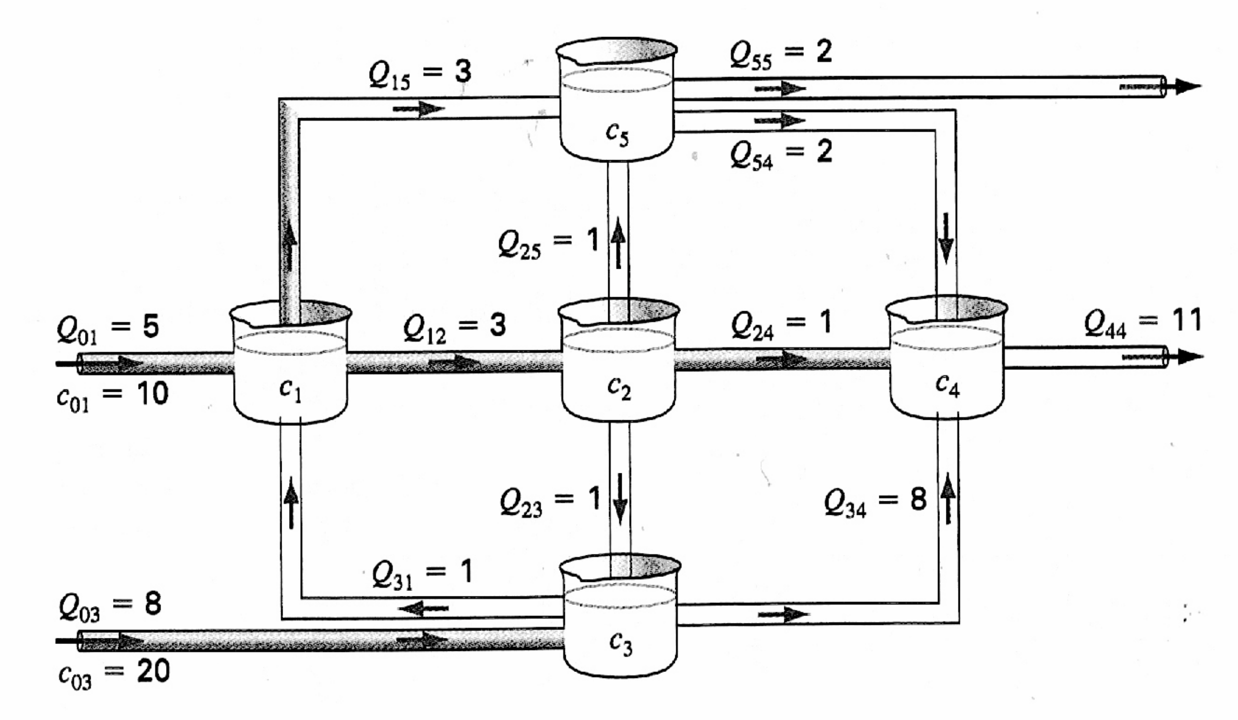
TASK 3

[L011C]

Consider the simplified plant represented schematically below containing 5 reactors linked by pipes. The rate of mass flow through each pipe can be calculated as the product of the flow rate (Q) and concentration (c). Under steady-state conditions, the mass flow into and out of each pipe must be equal (i.e. mass balance).

For example, the mass balance for the first reactor can be written: $Q_{01}c_{01} + Q_{31}c_3 = Q_{15}c_1 + Q_{12}c_1$

A. Write the mass balances for each of the 5 reactors by hand and arrange these linear equations in matrix form.
B. Use the Naïve Gaussian elimination to solve for concentrations c_1, c_2, c_3, c_4, and c_5.

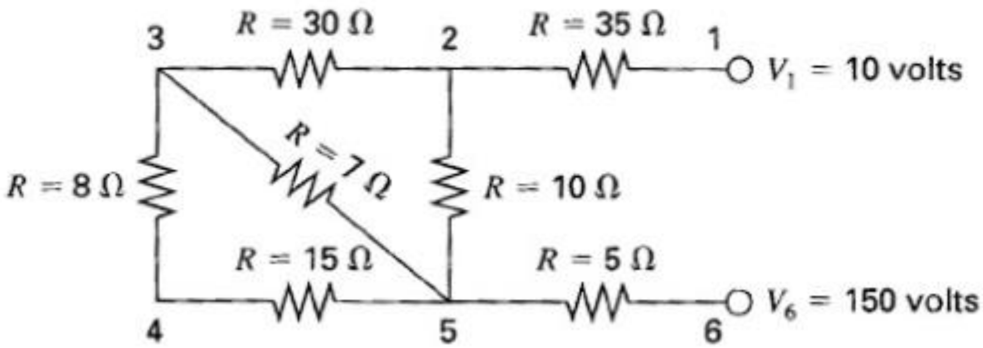


TASK 4

[L011D]

You can ignore this question if you are not familiar with Kirchhoff's law. Consider the electrical circuit below.

A. Apply Kirchhoff's law to derive a set of liner equations describing the current through each segment and arrange them in matrix form.
B. Use the Gaussian elimination to solve for the currents through each segment



TASK 5

[L011E]

A polynomial of degree n that will fit exactly through $n+1$ points. Recall that the equation of a polynomial is as follows.

$$f(x) = p_1 x^n + p_2 x^{n-1} + \cdots + p_n x + p_{n+1}$$

A straightforward way to determine the coefficients $p_1, p_2, \ldots, p_{n+1}$ is to generate $n+1$ linear equations and solve the linear system.

You have been given five data points $(x, f(x))$:
$(200,0.746), (250,0.675), (300,0.616), (400,0.525)$ and $(500,0.457)$

A. Write the five linear system equations for a 4th-order polynomial using the five data points
B. Use the Gauss-Jordan to solve for the coefficients of the 4th-order polynomial