EDD 112 – Introduction to Engineering Analysis
SPRING 2022

DUE DATE & TIME: At the start of lab time during the last week of your lab class

LAB PRACTICAL REVIEW HOMEWORK

Assignment:

The purpose of these assignments is to help you prepare for the LPE given during the last week of labs.

Instructions:

- You will be completing four separate assignments for this which each will require you to submit the following respectively:
  - Three MATLAB assignments
    - "Lastname_Firstname_LPE_P1.m"
    - "Lastname_Firstname_LPE_P2.m"
    - "Lastname_Firstname_LPE_P3.m"
  - Simio assignment
    - "Lastname_Firstname_LPE_P4.spfx"
- Each file should include proper headings and **applicable comments**
- Due by the start of lab time the last week of classes (5/5 – 5/11). Late homework will be accepted until 10:00 AM the following day.
- When submitting the files, submit all files at once. If you want to re-submit a file, again make sure you submit all four files.
- File organization and legibility will be considered when grading, so make sure to label your inputs/outputs and to make the file easy to read.
- When an assignment includes inputs and/or outputs, it is up to you how you employ user input and how to display the output.

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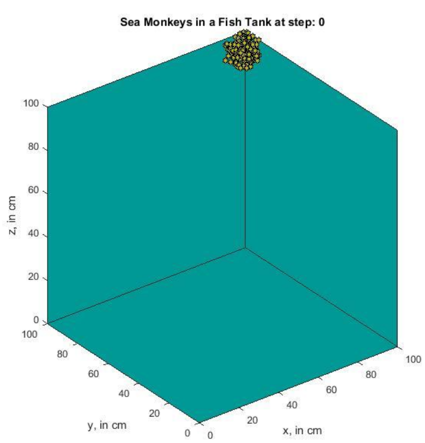
Part 01: MATLAB 1

Part 1-a)

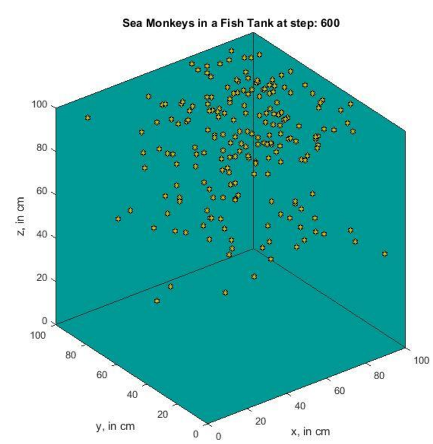
When creating simulations of natural systems, the motion of individual entities in the simulation is often defined as a random step in any direction. For this problem you will be required to use MATLAB to display the random motion of a user entered number of points on a 3D plot.

Your goal is to create a program that shows the random movement of a user entered number of sea monkeys in a glass fish tank with dimensions of 100cmx100cmx100cm. The Sea monkeys are all introduced to the system at top corner meaning that the sea monkeys should all have an initial x, y, and z coordinate between 90cm and 100cm. Once the simulation is started, the sea monkeys should take 400 steps in a random direction. Since the sea monkeys are not too fast, they can only move by a maximum of ±1cm in each direction per step; and cannot move beyond the outer boundaries of the tank.

Below are examples of both a possible starting condition and the location of all the molecules after 400 steps in random directions. Also, see the LPE Assignment Folder for a video example of the movement of the Sea Monkeys.



Initial Distribution



Possible Final Distribution

Program requirements:

- 1 Required input:
  - Number of points to plot
- Required output:
  - A 3D plot that shows the movement of the sea monkeys

Hints:

An example file has been posted that you can use to help you get started.
The following would be good functions to look up in the help files:

- Scatter3
- Pause

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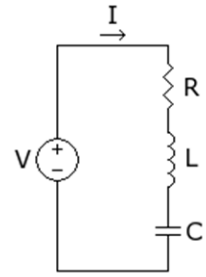
Part 02: MATLAB 2:

<u>DO NOT USE SYMBOLIC EQUATIONS FOR THIS PROBLEM</u>

RLC circuits are often used in electrical engineering to tune a radio frequency. They are circuits that are comprised of a Resistor (R), an Inductor (L), and a Capacitor (C).

The RLC circuit in this case is connected in series as is shown in the figure, the properties of which can be found through the following equations:

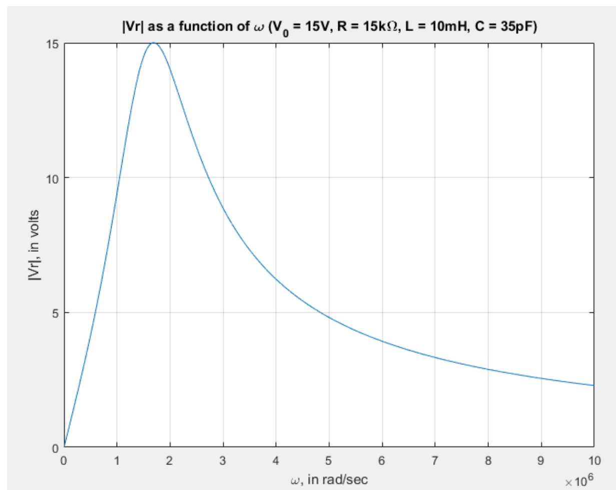


$$\omega_0 = \frac{1}{\sqrt{LC}}$$

$$\Delta\omega = \frac{R}{L}$$

$$Q = \frac{\omega_0}{\Delta\omega}$$

$$|V_R| = \frac{V_0 R}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$



The Q-Value (or Quality Factor) of a system measures the how damped the circuit is. Q-Factor values fall into three categories; $Q < ½$ is an Overdamped System, $Q > ½$ is and underdamped system, and $Q = ½$ is a critically damped system.

Program requirements:

- 4 Required inputs:
  - V_0 in Volts, R in kiloOhms*, L in milliHenries, and C in picoFarads
- Required output:
  - Plot of voltage, $|V_R|$, as a function of frequency, ω (ω from 0 to 10x10^6)
  - Values for ω_0 , $\Delta\omega$, and Q
  - A statement indicating if the system is underdamped, critically damped, or overdamped.

NOTE: ω is NOT the same as either the values of ω_0 or $\Delta\omega$. In the Calculation for $|V_R|(\omega)$, ω is the independent variable.

***This means that if the user enters 5 for R, then it is read as 5 kΩ**

Part 03: MATLAB 3:

For each of the following equations, find and display the indicated derivatives and/or integrals:

Equation 1:

Find the derivative of this equation with respect to x

$$f(x) = \sin(2\,x^3)$$

Equation 2:

Find the double derivative of this equation first with respect to x and then with respect to q

$$f(x,q) = 3\,q\,x^3 - e^{x\,q}$$

Equation 3:

Find the integral of this equation with respect to y

$$f(y) = 6\,y^2\cos(2\,y^3)$$

Equation 4:

Find the definite integral of this equation with respect to x from 5 to 10

$$f(x) = \sin(x)\cos(x)$$

Equation 5:

Find the definite integral of this equation with respect to t from 0 to x

$$f(t) = \frac{e^t}{1 + e^{2\,t}}$$

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Part 04: Simio:

You have been approached by a hospital to model the layout of their Emergency Department (ED).

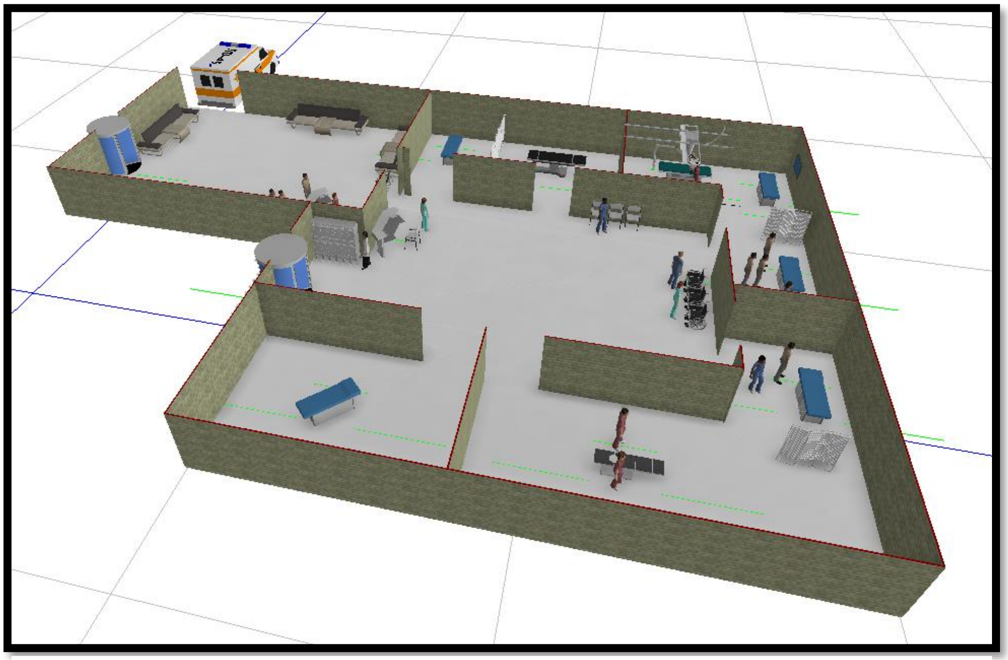

Figure 1: ED Example

ED Layout Example

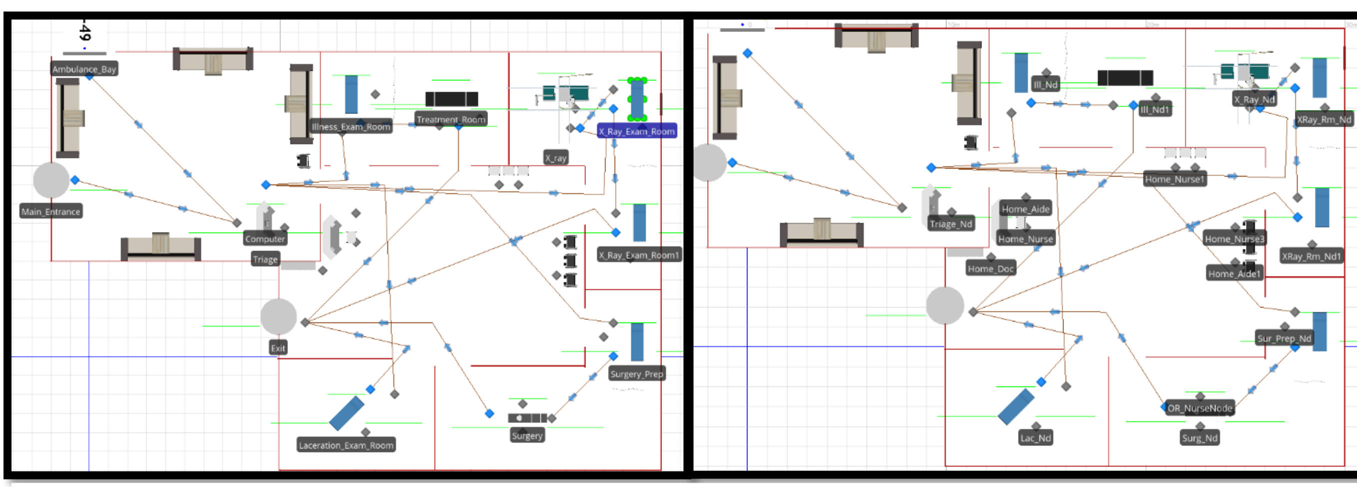

Figure 2: ED Layout Examples - (Zoom in to read labels)

(NOTE: In the creation of this assignment, I have grossly oversimplified an ED and have also taken an **extreme** bit of creative license with the duties and procedures. This is not to trivialize any aspect of an ED but rather to make your homework assignment somewhat manageable.)

LAB PRACTICAL REVIEW HOMEWORK

Emergency Department Properties:

- The ED is open for 24 hours
- Staff:
  - 4 Emergency Room Nurses
  - 1 Triage Nurse
  - 1 Attending Doctors
  - 1 Surgeon
  - 1 Operating Room Nurse
  - 1 Radiology Technician
  - 2 Nursing Aides
- Patient Arrival Information:
  - Patients arrive at the main entrance to the building with an exponential arrival time distribution with mean of 22 minutes with the first traveler arriving at time 0.
  - Patients also arrive at the Ambulance entrance with an exponential arrival time distribution with mean of 17 minutes with the first traveler arriving at time 0.
  - Upon arrival patients go to the Triage station and are seen by a triage nurse find out where to go next.
    - This process takes the triage nurse with a computer and is found to follow a triangular probability distribution, with a minimum of 5 minutes, and mode of 10 minutes, and a maximum of 12 minutes.
- Following admittance, the patient population is found to consist of:
  - 25% of the patients are suffering from a broken limb
  - 30% have an unknown illness
  - 30% have a laceration and need stiches
  - 15% need emergency surgery
- All admitted patients will be escorted through the hospital by Nursing Aides
- Based on the patient categories, the patients will follow different paths before leaving the system
  - Broken Limb
    - Patients need to have an x-ray administered by a Radiology Technician which is a process that follows an exponential distribution with parameters of β=8.8 minutes
    - Following this the patients are moved to an examination room with a Viewing screen where the Attending Doctor will see them to discuss the findings. This process follows a triangular probability distribution, with a minimum of 2 minutes, and mode of 3 minutes, and a maximum of 7 minutes.
    - Next, the patients are moved to a second bed where an emergency room nurse will see them to apply the cast. This process follows a triangular probability distribution, with a minimum of 6.75 minutes, and mode of 20 minutes, and a maximum of 45 minutes.
  - Illness
    - The patients are moved to an examination room where an emergency room nurse will see them to do tests (bloodwork, labs, etc.). This process follows a triangular

probability distribution, with a minimum of 20 minutes, and mode of 35 minutes, and a maximum of 50 minutes.

- With the tests completed the patients will be moved to a second room where the attending doctor will see them to diagnose the illness and discuss treatment. This process follows a triangular probability distribution, with a minimum of 5 minutes, and mode of 20 minutes, and a maximum of 30 minutes.

- Lacerations
  - Patients are attended by an emergency room nurse that will suture the wound. This process follows an exponential distribution with β=15 minutes.
- Emergency Surgery
  - Patients are prepped for surgery by an emergency room nurse which is a process that follows an Exponential distribution with parameters of β=13.3
  - Following this the patients are moved to surgery where a Surgeon and Operating Room Nurse will see them to perform the operation. This process follows a triangular probability distribution, with a minimum of 15 minutes, and mode of 28 minutes, and a maximum of 120 minutes.

Example Output:

While the actual output is very dependent on the locations of everything, your results should be relatively close to these.

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average	Minimum	Maximum	Half Width
ModelEntity	Patient	[Population]	Content	NumberInSystem	Average	10.8408	5.6602	18.0209	2.6937
					Maximum	20.5000	12.0000	29.0000	4.1195
			FlowTime	TimeInSystem	Average (Hou...	1.7691	1.0684	2.5404	0.3168
					Maximum (Ho...	5.2002	2.4991	11.9216	1.9326
					Minimum (Hou...	0.2109	0.1664	0.3012	0.0292
					Observations	134.2000	21.0000	150.0000	6.1515
			Throughput	NumberCreated	Total	146.3000	25.0000	174.0000	9.9919
				NumberDestroyed	Total	134.2000	21.0000	150.0000	6.1515

Object Type	Object Name	Data Source	Category	Data Item	Statistic	Average	Minimum	Maximum	Half Width
Worker	Aide	[Population]	Capacity	ScheduledUtilization	Percent	2.6004	2.3198	2.8657	0.1337
	Aide1	[Population]	Capacity	ScheduledUtilization	Percent	0.6930	0.5895	0.8069	0.0434
	Doctor	[Population]	Capacity	ScheduledUtilization	Percent	60.0825	43.6346	72.2532	6.1991
	Nurse	[Population]	Capacity	ScheduledUtilization	Percent	80.4061	69.6575	97.5325	7.1900
	Nurse1	[Population]	Capacity	ScheduledUtilization	Percent	42.7375	9.6561	79.4271	16.6457
	Nurse2	[Population]	Capacity	ScheduledUtilization	Percent	35.1304	14.5289	58.0922	11.5720
	Nurse3	[Population]	Capacity	ScheduledUtilization	Percent	40.3071	20.4800	60.9560	8.6784
	ORNurse	[Population]	Capacity	ScheduledUtilization	Percent	66.6223	44.0975	85.3798	8.8255
	Rad_Tech	[Population]	Capacity	ScheduledUtilization	Percent	22.4275	17.5220	30.2235	2.4982
	Surgeon	[Population]	Capacity	ScheduledUtilization	Percent	66.6223	44.0975	85.3798	8.8255
	Triage_Nurse	[Population]	Capacity	ScheduledUtilization	Percent	89.5160	78.6422	98.0364	4.5724

Figure 3: Example Output

Problem Requirements:

- You must fully animate your program (You don't need to go as far as adding walls and decorations, but should have all the servers/workers/resources fully animated)
- For this problem, you will need to submit the Simio Model file:
  - "Lastname_Firstname_LPE_P4.spfx"