CT248 Revision Questions

***Note**: These sample questions are indicative examples of the types of problems that will be presented in the examination. Questions relating to MATLAB theory are not included in this list of questions, but may well appear on the examination paper.*

1. Given the following matrices A and B, calculate results for the following operations in MATLAB. Distinguish between matrix operations and element-wise operations.

$$A = \begin{pmatrix} 1 & 2 & 3 \\ 4 & 5 & 6 \\ 7 & 8 & 9 \end{pmatrix} \qquad B = \begin{pmatrix} 1 & 0 & 2 \\ 2 & 1 & 1 \\ 1 & 2 & 1 \end{pmatrix}$$

```
A * B;

5 * A;

2 * B;

B.* A;

A + B;

A .^ B;
```

2. What would each of the following evaluate to in MATLAB. What will the type of the output be?

```
A = [1 2 0 3];
B = [0 1 0 0 1];

any(A)
any(B)
all(A)
all(B)
```

3. Write a function called partition, which takes a vector of numbers and splits the input into four new vectors:

   - All odd numbers less than the median
   - All odd numbers greater than or equal to the median
   - All even numbers less than the median
   - All even numbers greater than or equal to the median

4. Given the following two vectors:

```
x = 1:20;
y = 11:30;
```

Write MATLAB code (no loops) to generate the following.

$$ans = \sqrt[2]{\sum_i (x_i - y_i)^2}$$

5. Write a function (m file) that takes a 2-dimensional array and an input number. It should then create an output 2-dimensional array that contains only those values of the 2-dimensional array that are less than the input number. For example, if input number is 5, the input array is:

```
A =
   1   2   3
   4   5   6
   7   8   9
```

Then the function output should be.

```
ans =
   1   2   3
   4   0   0
   0   0   0
```

6. Write an anonymous function that returns the mean and standard deviation of a vector. MATLAB functions can be used to calculate the statistical values, and a column vector should be returned.

7. Implement Newton's Law of Cooling for a pizza cooling after being taken out of the oven. Represent the temperature model as a differential equation.

Assume:

- The initial temperature of the pizza is 220^0C
- The room temperature is 18^0C.
- k = 0.08.

Make use of the **ode45** MATLAB function, and run the model from [0-60] minutes. The room temperature and the cooling constant should be passed into the anonymous function.

8. Assume there are three restaurants (A, B and C) in a city with a population of 100000. After each month, assume that the following changes take place:

    - For Customers in A:
        - 70% remain in A
        - 25% go to B
        - 5% go to C
    - For Customers in B
        - 80% remain in B
        - 10% go to A
        - 10% go to C
    - For Customers in C
        - 100% remain in C

    Based on this, show:
    - The state transition diagram
    - The Leslie Matrix
    - Code to simulate 10 time cycles

    What do you think the steady state values might be?

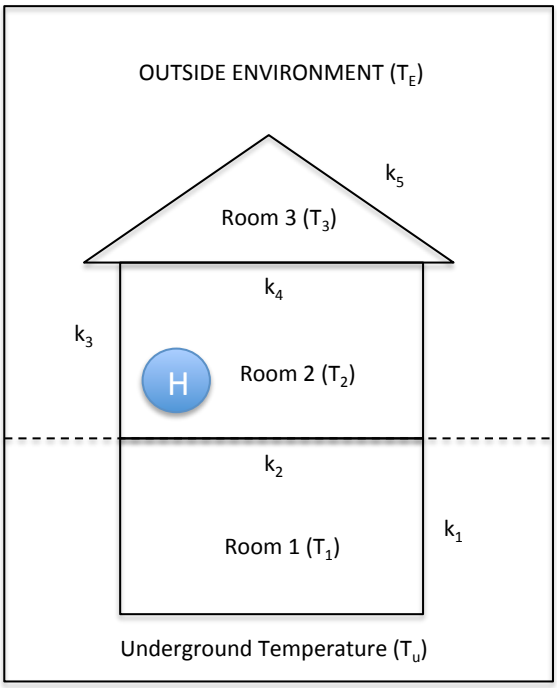
9. Consider a species that is divided into three ages classes: Young, Adult and Elderly. Assume an initial population of 100 adults, and the following information:

    - Adult produce on average 4 young
    - 70% of young transfer to adult
    - 70% of adult transfer to Elderly

    Based on this:
    - Generate the Leslie Matrix
    - Show the state transition diagram
    - Write an algorithm that will predict the population after 10 time cycles

    Show how you could use a single equation to predict the total population after 100 time cycles.

10. Consider the following house plan.



Based on this, generate a differential equation model for the temperature in each room, based on Newton's Law of Cooling. Assume that:

- The temperature of Room 1 is T_1, where the initial value = 10^{0}C
- The temperature of Room 2 is T_2, where the initial value = 15^{0}C
- The temperature of Room 3 is T_3, where the initial value = 15^{0}C
- The outside temperature is T_E (constant = 12^0 C)
- The underground temperature is T_U (constant = 5^0 C)
- The cooling constants are k_1 (0.20), k_2 (0.40), k_3 (0.05), k_4 (0.15), k_5 (0.70)
- The heat generated by heater (H) is controlled by a thermostat system, where the desired temperature is T_G (=25^0 C) and the heating constant is *l* (0.75).

Implement this differential equation model using the Simulink Framework.

Each area should have a separate subsystem, and the Heater Unit (including the thermostat equation) should also be in a separate subsystem.

The model should also have the capacity to display the temperature values T_1, T_2, T_3, T_E and T_U.