LOTI.05.019 Data Analysis and Computational Methods with MATLAB
Sixth Practical Session

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1. Question 1

Evaluate the following expressions without using MATLAB. Check the answers with MATLAB.

- `-3&3`
- `~5<4&~0>-3`
- `-2&2>3|8/3`
- `-3<-1<~0|5<4<3`

2. Question 2

Write a program that asks the user to input a vector of integers of arbitrary length. The program then counts the number of elements, the number of positive elements, and the number of negative elements divisible by 3. The program displays the vector that was entered and the results in sentence form, i.e. "The vector has XX elements. XX elements are positive and XX elements are negative divisible by 3", where XX stands for the corresponding number of elements. Execute the program and when the program ask the user to input a vector type `randi([- 20 20],1,16)`. This creates a 16-element vector with random integers between -20 and 20.

3. Question 3

The concentration of a drug in the body C_P can be modeled by the equation:

$$C_p = \frac{D_G}{V_d}\frac{k_a}{(k_a - k_e)}\left(e^{-k_e t} - e^{-k_a t}\right) \tag{1}$$

where D_G is the dosage administered (mg), V_d is the volume of distribution (L), k_a is the absorption rate constant (h^{-1}), k_e is the elimination rate constant (h^{-1}), and t is the time (h) since the drug was administered. For a certain drug, the following quantities are given: $D_G = 150$ mg, $V_d = 5O$ L, $k_a = 1.6$ h^{-1}, and $k_e = 0.4$ h^{-1}.

- A single dose is administered at $t = 0$. Calculate and plot C_P versus t for 10 hours.
- A first dose is administered at $t = 0$, and subsequently four more doses are administered at intervals of 4 hours (i.e. at $t = 4, 8, 12, 16$). Calculate and plot C_P versus t for 24 hours.

4. Question 4

Cam is a mechanical device that transforms rotary motion into linear motion. The shape of the disc is designed to produce a specified displacement profile. A displacement profile is a plot of the displacement of the follower as a function of the angle of rotation of the cam. The motion of a certain cam is given by the following equations:

$$
\begin{aligned}
y &= 6[2\theta - 0.5\sin\theta]/\pi \quad \text{for} \quad 0 \le \theta \le \pi/2 \\
y &= 6 \quad \text{for} \quad \pi/2 \le \theta \le 2\pi/3 \\
y &= 6 - 3\left[1 - 0.5\cos\left(3\left(\theta - 2\tfrac{\pi}{3}\right)\right)\right] \quad \text{for} \quad 2\pi/3 \le \theta \le 4\pi/3 \\
y &= 3 \quad \text{for} \quad 4\pi/3 \le \theta \le 3\pi/2 \\
y &= 3 - 1.5\left(\tfrac{\theta - 3(\pi/2)}{\pi/4}\right)^2 \quad \text{for} \quad 3\pi/2 \le \theta \le 7\pi/4 \\
y &= 0.75 - 0.75\left(1 - \tfrac{t - 7(\pi/4)}{\pi/4}\right)^2 \quad \text{for} \quad 7\pi/4 \le \theta \le 2\pi
\end{aligned}
\tag{2}
$$

Write a MATLAB program that plots the displacement profile for one revolution. First create a 100 element vector for θ, then by using a loop and conditional statements calculate the value of y for the corresponding values of θ. Once y and θ are known, plot y vs. θ.