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

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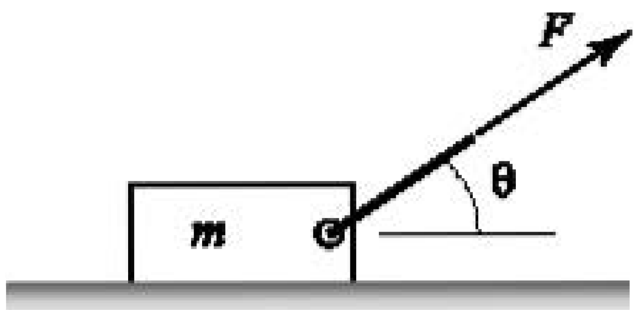
1. **Question 1**

A box of mass $m = 25$ kg is being pulled by a rope. The force that is required to move the box is given by:

$$F = \frac{\mu m g}{\cos\theta + \mu sin\theta} \tag{1}$$

where $\mu = 0.55$ is the friction coefficient and $g = 9.81$ m/s^2. Determine the angle θ, if the pulling force is 150 N.



2. **Question 2**

The growth of a fish is often modeled by the von Bertalanffy growth model:

$$\frac{dw}{dt} = aw^{2/3} - bw \tag{2}$$

where w is the weight and a and b are constants. Solve the equation for w for the case $a = 5$ lb$^{1/3}$, $b = 2$ day^{-1}, and $w(0) = 0.5$ lb. Make sure that the selected time span is just long enough so that the maximum weight is approached. What is the maximum weight for this case? Make a plot of w as a function of time.

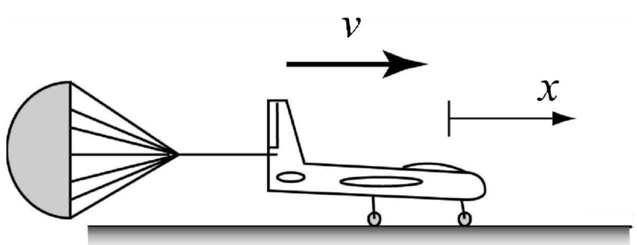
3. **Question 3**

An airplane uses a parachute and other means of braking as it slows down on the runway after landing. Its acceleration is given by $a = -0.0035v^2 - 3$ m/s^2. Since $a = \frac{dv}{dt}$, the rate of change of the velocity is given by:

$$\frac{dv}{dt} = -0.0035v^2 - 3 \tag{3}$$

Consider an airplane with a velocity of 300 km/h that opens its parachute and starts decelerating at $t = 0$ s.

- By solving the differential equation, determine and plot the velocity as a function of time from $t = 0$ s until the airplane stops.
- Use numerical integration to determine the distance x the airplane travels as a function of time. Make a plot of x versus time.



4. Question 4

The population growth of species with limited capacity can be modeled by the equation:

$$\frac{dN}{dt} = kN\left(N_M - N\right) \tag{4}$$

where N is the population size, N_M is the limiting number for the population, and k is a constant. Consider the case where $N_M = 5000$, $k = 0.000095$ 1/yr, and $N(0) = 100$. Determine N for $0 \leq t \leq 20$. Make a plot of N as a function of t.