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

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1. Question 1

The growth of some bacteria populations can be described by

$$N = N_0 e^{kt} \tag{1}$$

where N is the number of individuals at time t, N_0 is the number at time $t = 0$, and k is a constant. Assuming the number of bacteria doubles every 40 minutes, determine the number of bacteria every two hours for 24 hours starting from an initial single bacterium.

2. Question 2

Decay of radioactive materials can be modeled by the equation $A = A_0 e^{kt}$, where A is the amount at time t, A_0 is the amount at $t = 0$, and k is the decay constant ($k \leq 0$). Iodine-132 is a radioisotope that is used in thyroid function tests. Its half-life time is 13.3 hours. Calculate the relative amount of Iodine-132 (A/A_0) in a patient's body 48 hours after receiving a dose. After determining the value of k, define a vector $t = 0, 4, 8, \ldots, 48$ and calculate the corresponding values of A/A_0.

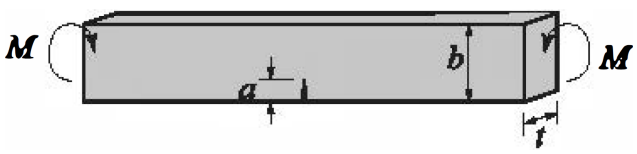
3. Question 3

The stress intensity factor K at a crack in a beam exposed to pure bending M is given by:

$$K = C\sigma\sqrt{\pi a} \tag{2}$$

where $\sigma = \frac{6M}{tb^2}$. a is the crack length, b is the width, t is the thickness, and C is a parameter that depends on the geometry of the specimen and crack. For the case of pure bending,

$$C = \sqrt{\frac{\tan\beta}{\beta}}\left[\frac{0.923 + 0199\,(1 - \sin\beta)^2}{\cos\beta}\right] \qquad \text{where } \alpha = a/b, \text{and } \beta = (\pi\alpha)/2 \tag{3}$$



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Write a program in a script file that calculates the stress intensity factor K. The program should read the values of M, b, t, and a from an ascii text file using the `load` command. The output should be in the form of a paragraph combining text and numbers, i.e. something like "The stress intensity factor for a beam that is 0.25 m wide and 0.01 m thick with an edge crack of 0.05 m and an applied moment of 20 N-m is XX Pa-sqrt(m)." where XX stands for the value of K. Use the program to calculate K when M=20 N-m, b=0.25 m, t=0.01 m, and a=0.25 m.

4. Question 4 *(Optional)*

The intrinsic electrical conductivity σ of a semiconductor can be approximated by:

$$\sigma = e^{\left(C - \frac{E_g}{2kT}\right)} \tag{4}$$

where σ is measured in $(\Omega - m)^{-1}$, E_g is the band gap energy, k is Boltzmann's constant (8.62×10^{-5} ev/K), and T is temperature in kelvins. For Germanium, C=13.83 and E_g=0.67 ev. Write a program in a script file that calculates the intrinsic electrical conductivity for Germanium for various temperatures. The values of the temperature should be read from an xls spreadsheet using the `xlsread` command. The output should be presented as a table where the first column is the temperature and the second column is the intrinsic electrical conductivity. Use the following values for temperature: 400, 435, 475, 500, 520, and 545 K.