Scientific Computing and Mathematical Modeling
MSc by Research in Electrical and Electronics Engineering
Department of Electrical and Electronics Engineering
Final Exam Sample

You can use any method and any Scientific Computing Environment to solve the following problems.
In your solution you should develop the rationale of the solution and include the setup of the problem and the solution runs. Upload your answers in EClass Final Exam Assignment.

Subject 1. The growth rate g of a fungus produced in response to taking an antibiotic is a function of the food concentration c available to the fungus and is described by the function:

$$g(c) = \frac{2c}{4 + 0.8c + c^2 + 0.2c^3}$$

Plot the function for $0 \leq c \leq 15$. Theory says that the rate tends to 0 when the food concentration is low and has the same behavior when the food concentration is high due to toxicity. Calculate the maximum value of the rate and the concentration for which it is achieved.

Subject 2. Suppose you are performing an experiment to determine the percentage elongation of a material that is good conductor of electricity as a function of temperature. The results are presented in the following table. Graph the data, choose the best approximation methodology and explain this choice. Predict the percentage elongation for temperature $400^\circ C$.

Temperature in C	200	250	300	375	425	475	600
Enlogation	7.5	8.6	8.7	10.0	11.3	12.7	15.3

Subject 3. Sometimes resistances do not follow Ohm's law. For example the voltage drop across a resistor can be non-linear and the circuit dynamics can be described by the equation

$$L\frac{di}{dt} + R\left(\frac{i}{I} - \left(\frac{i}{I}\right)^3\right) = 0$$

where i is the current, L the coil inductance and R the resistance. Determine i when $L = 1$, $R = 1.5$, I a known reference current equal to 1 and $i(0) = 0.5$. Solve the problem numerically and present the solution in the interval $[0, 5]$. What is the approximation of current intensity at the time $t = 5$.