**Modeling and Simulation**
**2024/2025**

**Exercise 02**
**Deadline: see elearning**

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**Aufwand (h):** 7

**Punkte:** _____

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## Task 1 (8 Pkt): MATLAB

Polynomials can be defined as vectors; a polynomial of order n can be defined by a vector of length n+1.
Example: The polynomial

$p = 5s^5 – 3s^4 + s^2 + 2s$

is in its complete form

$p = 5s^5 – 3s^4 + 0s^3 + s^2 + 2s + 0s^0$

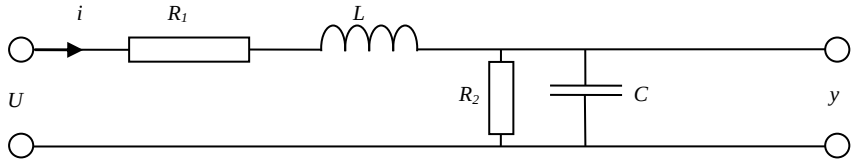
and can befined by the vector

p = [5 -3 0 1 2 0].

Write a MATLAB function that takes a polynomial of any degree as a line vector plus specification of the area for which this polynomial is to be evaluated and drawn; the step size of the evaluation or graphical representation should optionally be given, if not defined it should be 0.01.
Pay attention to the generation of meaningful diagram headings for the graphical output.
(And don't just call a MATLAB polynomial function for this exercise!)

## Task 2 (8 pt): Electrical engineering basics: The series resonant circuit

Let the following electrical circuit be given:




Additionally we know:

$$u(t) = R_1 * i(t) + L * \frac{\partial i(t)}{\partial t} + y(t)$$

$$i(t) = \frac{1}{R_2} y(t) + C \frac{\partial y(t)}{\partial t}$$

We now need to find a description of the electrical voltage *y* in response to the applied voltage *u*.

Bring this system into the (A, B, C) standard form and simulate it in MATLAB without using simulation tools (such as SIMULINK, e.g.). Hints:

- Use the Symbolic Math Toolbox for MATLAB
- Model the system based on the state variables *i(t)* and *y(t)*

**Task 3 (8 pt): Continuous modeling and systems theory**

The description of systems can (as discussed in the lecture) be presented using the so-called (A, B, C) method.
Describe this method in your own words in the form of a short essay (max one page). Explain the meaning / function of A, B and C, and also how the dimensions of these matrices correlate to the number of inputs, outputs and state variables of the described system.

Discuss also the following issues:

- What are the advantages of this method?
- What are the disadvantages or limitations of this method? (I.e., when can you not use them?)
- What can you do if you cannot use it?

Explain the meaning of the formulas

$$x'(t) = Ax(t) + Bu(t); x(0) = x_o$$

$$y(t) = Cx(t)$$

and

$$x(t) = e^{tA}x(0) + \int_0^t e^{(t-\tau)A}Bu(\tau)d\tau$$

$$y(t) = Ce^{tA}x(0) + \int_0^t Ce^{(t-\tau)A}Bu(\tau)d\tau$$

and how they are connected to the aspects discussed above.

*General remark: Make sure that you can present your submitted examples in the lecture*.