

Note: The answers can be given either in English or Finnish.

**Question 1.** The transfer function of a certain system is given below. Each question below will give 2 pts if the answer and its justification are correct.

- What is the order of the system? (Justify your answer)
- Is the system stable? (Justify your answer).
- Is the system critically damped? (Justify your answer)

$$G(s) = \frac{s^2 + s \cdot 9.66 \cdot 10^4 + 6.72 \cdot 10^7}{s^2 \cdot 30.3 + s \cdot 21431 + 1.74 \cdot 10^7}$$

**Question 2.** The set of transfer functions of a second-order switched-mode converter, which operates in CCM, can be given in a general form as shown in Fig. 1. Each question will give 2 pts.

- Compute the output impedance of the converter.
- Compute the input-to-output transfer function of the converter.
- Compute the control-to-output-voltage transfer function of the converter.

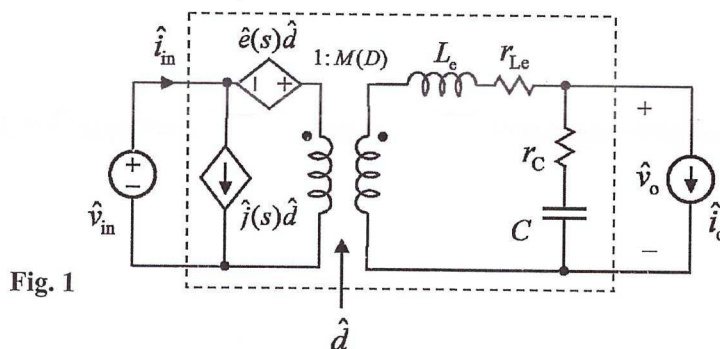


Fig. 1

**Question 3.** Fig. 2 shows two-port network model of a switched-mode converter in general. Construct the corresponding input-to-output variable representation of the dynamics of the converter with correct input and output-variable vectors connected by the corresponding transfer functions. The correct input and output variable vectors will give 2 points and the correct transfer function matrix 4 points.

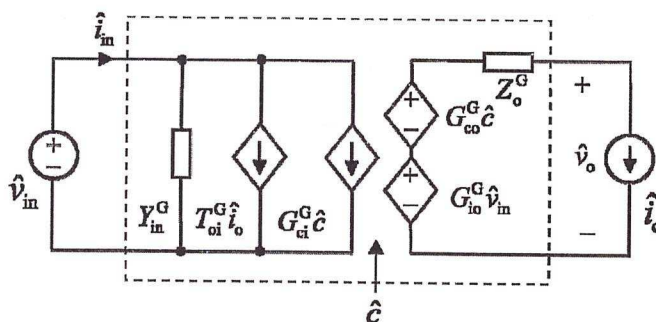


Fig. 2

**Question 4.** Fig. 3 shows the single-section LC filter with the component definitions, where the resonant frequency and the maximum value of the magnitude are given below in terms of the standard second-order system.

- Compute the transfer function of the output impedance of the circuit (2 pts)
- Compute the characteristic impedance of the circuit (1 pt)
- Compute the resonant frequency of the circuit in Hz (1 pt)
- Compute the maximum value of the output impedance of the circuit in Ohms (2 pts)

$$G(s) = \frac{\omega_n^2}{s^2 + s2\zeta\omega_n + \omega_n^2} \quad \omega_{\text{res}} = \omega_n \sqrt{1 - 2\zeta^2} \quad |G(s)|_{\text{max}} = \frac{1}{2\zeta\sqrt{1 - \zeta^2}}$$

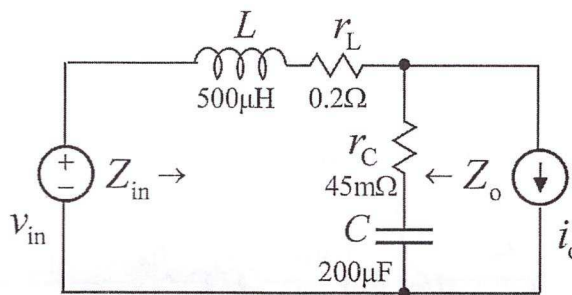


Fig. 3