Question 1. Explain shortly the following concepts related to the dynamics of a switched-mode converter (Note: Repeating the English words does not suffice): a) SSA method, b) two-port model, c) state space, d) PI, e) PCM-control, and f) DDR-control. (1 pt)

Question 2. Fig. 1 shows an electrical equivalent circuit representing the dynamics of a certain class of switched-mode converters. Define symbolically based on Fig. 1 a) $Z_{in-o}$, b) $Z_{in-o}$, and c) $T_{o-o}$ (Each subquestion gives 2 pts).

![Fig. 1](image)

Question 3. A control-block diagram representing a generalized closed-loop input dynamics of an input-side-controlled converter is given in Fig. 2. a) Define the equation for the feedback-loop gain ($L_{in}$) using the symbols of Fig. 2, b) Define symbolically the closed-loop $\dot{y}_{in}$ / $\dot{u}_{in}$, and c) Define symbolically $\dot{y}_{in}$ / $\dot{u}_{in}$ (Each subquestion gives 2 pts).

![Fig. 2](image)

Question 4. The frequency responses of the control-to-output-voltage transfer function ($G_{o-o}$) and the output-voltage-feedback loop gain ($L_{out}$) of a buck converter are shown in Fig. 3a, and Fig. 3b, respectively.

a) Compute the approximate value of the output capacitor of the converter when its output inductor is 400 $\mu$H? (2pts)
b) Evaluate the feasibility of the control design based on Fig. 3b: Why it is / Why it is not? (2pts)
c) What is the type of the used controller? I, P, PI, PID? Justify your answer! (2pts).
Question 5. The measured open-loop ($Z_{no}$), closed-loop ($Z_{nc}$), and short-circuit ($Z_{nsc}$) input impedances of the output-voltage-feedback-controlled converter as well as the output impedance ($Z_o$) of the input EMI filter are given in Fig. 4. Analyze the effect of the input filter on a) the stability of the converter, b) load-transient responses, and c) voltage-loop gain. Without the input filter, the converter is stable and the transient performance is excellent. Justify your thoughts based on Fig. 4 and the underlying formulas. The value of each sub-question is 2 points.
$$G_{e-o}^S = \frac{1 + Z_s / Z_{in-c}}{1 + Z_s / Z_{in-o}}$$

$$Z_{e-o}^S = \frac{1 + Z_s / Z_{in-c}}{1 + Z_s / Z_{in-o}}$$

$$Y_{in-e} = \frac{Y_{in-o}}{1 + L_{out}} + \frac{L_{out}}{1 + L_{out}} Y_{in-o}$$