PROBLEM 1: In the simplified boost dc-dc converter shown in Fig. 1 the input voltage source and the inductor are replaced with the ideal current source. Assume that all other components are ideal.

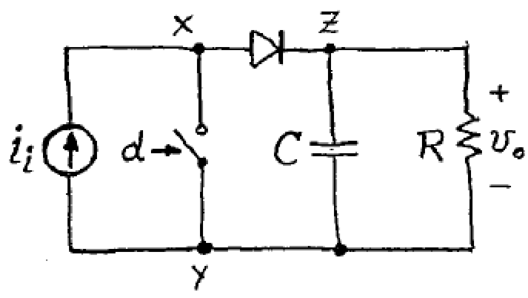

Fig. 1.

a) Draw the large-signal average model of the circuit.

b) Find the differential equation describing the time response of the output voltage $v_o(t)$ in the form

$$\frac{dv_o}{dt} = f(v_o, i_i, d),$$

with R and C as parameters.

c) Find the value of the steady-state duty cycle D that will produce the output voltage $V_o = 12$ V, when $R = 4\ \Omega$ and $I_i = 4$ A.

PROBLEM 2: The buck-boost dc-dc converter shown in Fig. 2.a was simulated using the average model and assuming that all components are ideal. Bode plot of the small-signal, duty-cycle-to-output transfer function, $g(j\omega)$, of the converter is shown in Fig. 2.b. Asymptotes of $|g(j\omega)|$ are also shown to help you identify characteristic features of the transfer function.

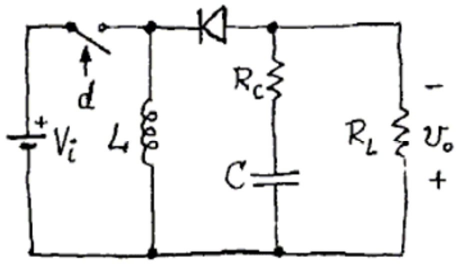

Fig. 2.a.

a) Write the expression for the duty-cycle-to-output transfer function, $g(s)$, that corresponds to the one plotted in Fig. 2.b.
b) Estimate the values of all the parameters (constants) in $g(s)$.
c) Using the results in b) estimate the values of the steady-state duty-cycle, D, the input voltage, V_i, and the output voltage V_o.

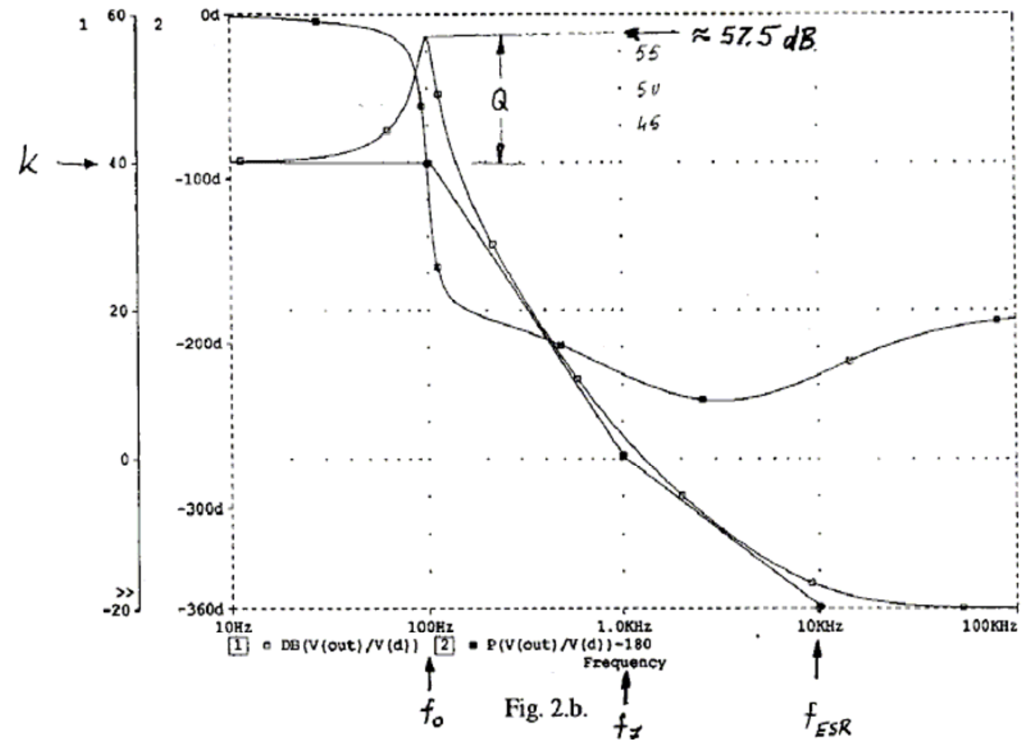

Fig. 2.b.

PROBLEM 3: Simplified dc-dc converter shown in Fig. 3 does not use the output capacitor for filtering. Assume that all the components are ideal.

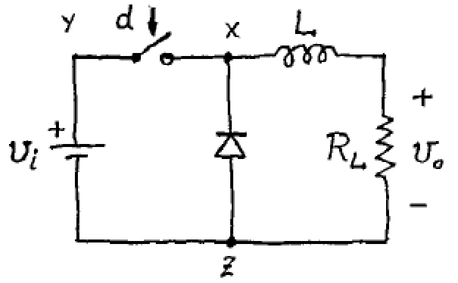

Fig. 3.

a) Draw the small-signal circuit diagram of the converter.
b) Find the expression for the audio-susceptibility, $a(s) \equiv \tilde{v}_o/\tilde{v}_i$.
c) Sketch to scale the Bode plot (gain and phase) of $a(s)$ for R_L = 0.25 Ω, L = 400 μH, V_o = 12 V, and V_i = 38 V. Clearly mark all the characteristic points on the graph.